Waterloo Train Station

Reference Design Report Transport Planning and Rail

Greater Wellington Regional Council

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1 Executive Summary

This technical report provides a comprehensive account of the transport planning and rail design inputs underpinning Stage 3 of the Waterloo Station Reference Design, focusing on the development and evaluation of the Reference Design - the preferred station configuration identified through an integrated multi-criteria assessment process.

Drawing from existing network conditions, forecast travel demand, and strategic goals, the Reference Design has been developed to deliver a safe, legible, and future-ready public transport interchange that directly supports mode shift, transit-oriented development (TOD), and the long-term resilience of the Hutt Valley transport system.

The Reference Design includes aligned, upgraded platforms with level boarding to improve passenger experience and operational flexibility. While the design avoids major track realignment, minor platform encroachment into the southern curve will require KiwiRail approval. A Systems Breakdown Structure (SBS) has been developed to manage requirements and support future assurance processes. Early engagement with KiwiRail will be essential to confirm impacts on signalling, safety cases, traction power, and corridor structures, ensuring the design remains certifiable, buildable, and safe.

The Reference Design delivers a unified, customer-centric multimodal interchange that addresses current operational constraints, enhances multimodal connectivity, and unlocks strategic development opportunities within Greater Wellington Regional Council's (GWRC) designated Priority Development Area (PDA) at Waterloo. It is designed to meet the needs of current and future users through the integration of aligned upgraded platforms, a new pedestrian overpass and at-grade crossing, a rationalised Park and Ride facility, and upgraded bus interchange infrastructure, while maintaining and improving active mode access across the precinct. This configuration is best aligned with the region's transport, land use and climate change objectives.

2 Introduction

Waterloo Station is a key node in the Wellington Region's public transport network. Located on the Hutt Valley and Wairarapa Lines, it serves as the primary interchange for Naenae, Wainuiomata, Seaview, and Kelson, and connects into regional services linking Upper Hutt, Wellington City, and the Wairarapa. With over 14,000 rail boardings weekly and functioning as a key bus-rail transfer point, the station is strategically positioned to enable mode shift, reduce transport emissions, and unlock urban development within Lower Hutt City.

The Reference Design process responds to several interrelated drivers:

- End-of-life infrastructure, including the legacy 1987 spaceframe canopy and associated accessibility, safety, and maintenance challenges.
- Patronage growth linked to service upgrades under the Lower North Island Rail Integrated Mobility (LNIRIM) programme.
- Regional commitments to deliver housing and employment intensification through the Wellington Regional Growth Framework (WRGF).
- Greater Wellington's ambitions for TOD and station precinct optimisation under the WRLC Priority Development Area framework.

This report details the transport planning and rail design rationale for The Reference Design, including forecast demand, layout configuration, modal integration, customer outcomes, risk mitigation and strategic value alignment.

2.1 Strategic Alignment and Design Drivers

The Reference Design responds directly to the strategic policy environment within which the station operates. Key alignments include:

- **Wellington Regional Growth Framework (WRGF)**: Supports housing intensification and sustainable urban form within the Hutt Valley corridor.
- **GWRC Long-Term Plan and Public Transport Plan**: Prioritises improvements to customer experience, station access, and regional connectivity.
- **Smarter Connections Strategy**: Reinforces station hierarchy, optimising interchange function and reducing walking distances.
- **Park and Ride Strategy**: Supports rationalisation of oversupplied parking in favour of access improvements and urban development.
- **Access Hutt City, Our Climate Future**: Supports a shift to lower-emission travel through increased PT mode share and high-amenity interchanges.

The design brief sets out specific transport outcomes, including achieving Level of Service C for rail passengers during the peak 15-minute period, ensuring that all modal connections are accessible and legible, minimising customer walking distances between arrival modes, and delivering a compact interchange footprint that preserves the potential for the TOD.

3 Forecast Passenger Demand

Passenger demand forecasting is a foundational component of the Waterloo Station Reference Design. Waterloo is a strategically significant station for the region, with demand forecast to grow substantially in coming years.

This work ensures the station, and its facilities are appropriately scaled to meet future user needs while allowing flexibility to accommodate growth driven by transit-oriented development (TOD) and network investment.

Despite a recent softness in passenger numbers across the rail network, there are a number of factors that will lead to substantial growth in patronage at Waterloo Station in the medium to long term. This includes:

- Significant uplift in housing numbers within the direct catchment of Waterloo Station, with new, denser housing already built or planned.
- Wider growth (e.g. Wainuiomata) increasing patronage on feeder bus routes.
- National Ticketing System is coming – zonal fares (bus + rail) likely to drive increased demand.
- LNIRIM and other planned investment will also increase frequency and reliability, as well as quality of rolling stock.

Understanding this growth is critical to ensure that a rebuilt Waterloo Station is fit for purpose to meet future demand – and to futureproof where required to avoid inefficient investment or oversizing of some station elements (e.g. lifts, stairs, platforms). Further information can be found in the **Appendix A** (Waterloo Station Pedestrian Modelling Memo).

3.1 Approach and Methodology

Passenger forecasting was undertaken using a combination of:

- Snapper card data (March 2024) representing the 95th percentile of demand across the year.
- Wellington Transport Analytics Unit (WTAU) modelling, informed by Sense Partners' regional growth assumptions.
- Statistical interpolation and extrapolation to derive 2046 and 2061 design year figures.
- Pedestrian modelling and station sizing analysis, including static level-of-service assessments.

This analysis considered typical weekday conditions (Tues - Thurs) and excluded Monday and Friday to account for post-COVID hybrid work patterns.

3.2 Forecast Growth and Station Demand

Rail passenger growth projections from 2018 to 2053 range between 30% and 70%, depending on the scenario used. Sense Partners' upper growth estimates - used for design - anticipate a 180% increase in patronage between 2024 and 2061, while Stats NZ data suggests a 120% increase over the same period

In absolute terms, the busiest 15-minute evening peak in 2046 could see:

- **Inbound**: 7 boardings, 38 alightings
- **Outbound**: 12 boardings, 433 alightings

For the **morning peak**:

- **Inbound**: 430 boardings, 15 alightings
- **Outbound**: 22 boardings, 23 alightings

These forecasts reflect continued tidal commuter flows, with high inbound demand in the morning and outbound in the evening, predominantly on the Hutt Valley Line.

3.3 Station Sizing and Design Implications

To meet future needs, the station must maintain Level of Service C (LOS C) during peak periods under normal operations. However, a temporary degradation to LOS D during delayed services in peak conditions from the 2040s is accepted as a cost-effective compromise.

The 2061 dimensions are retained as a futureproofing target, although actual built provision at opening (2031) may be lower, with the option to scale up.

Key insights from the modelling include:

- Capacity is sufficient for expected peak 15-minute loads in both 2046 and 2061 with the proposed sizing.
- Platform circulation and vertical access elements (e.g., stairs) will require design attention to meet peak clearance needs.
- Snapper gate numbers and positioning must allow for redundancy and peak throughput (minimum 4 per entrance recommended).

These modelling outputs have informed the functional and spatial requirements in the design brief and have informed sizing of specific elements in the Stage 3 Reference Design development.

3.4 Station Sizing: Performance of the Reference Design

Station sizing assessment of the Reference Design highlights the following:

- Platform circulation and vertical access elements provide sufficient space to meet LOS C during peak periods under normal operations and meet LOS D during delayed services in peak conditions for the years 2046 and 2061.

- Additional Snapper gates required on the outbound platform to cater to the alighting passenger demand in the evening peak (six additional gates required for year 2046, and a further three for 2061).
- Lack of alternative (or redundant) step-free access to and from the overpass in the event of a lift failure.

The pedestrian level of service performance of the station elements over time (with the exception of platforms, which provide sufficient width for the 2061 design year) are provided in Figure 3-1 to Figure 3-4 based on the widths provided in The Reference Design.

The figures provide an indication of potential level of service performance from Rail Day One to the 2061 design year for both normal and degraded operations. In general, the figures show that the target level of service performance for normal and degraded operations can be met, with a slight exceedance at the overpass stairs for beyond the year 2058. the year 2058.

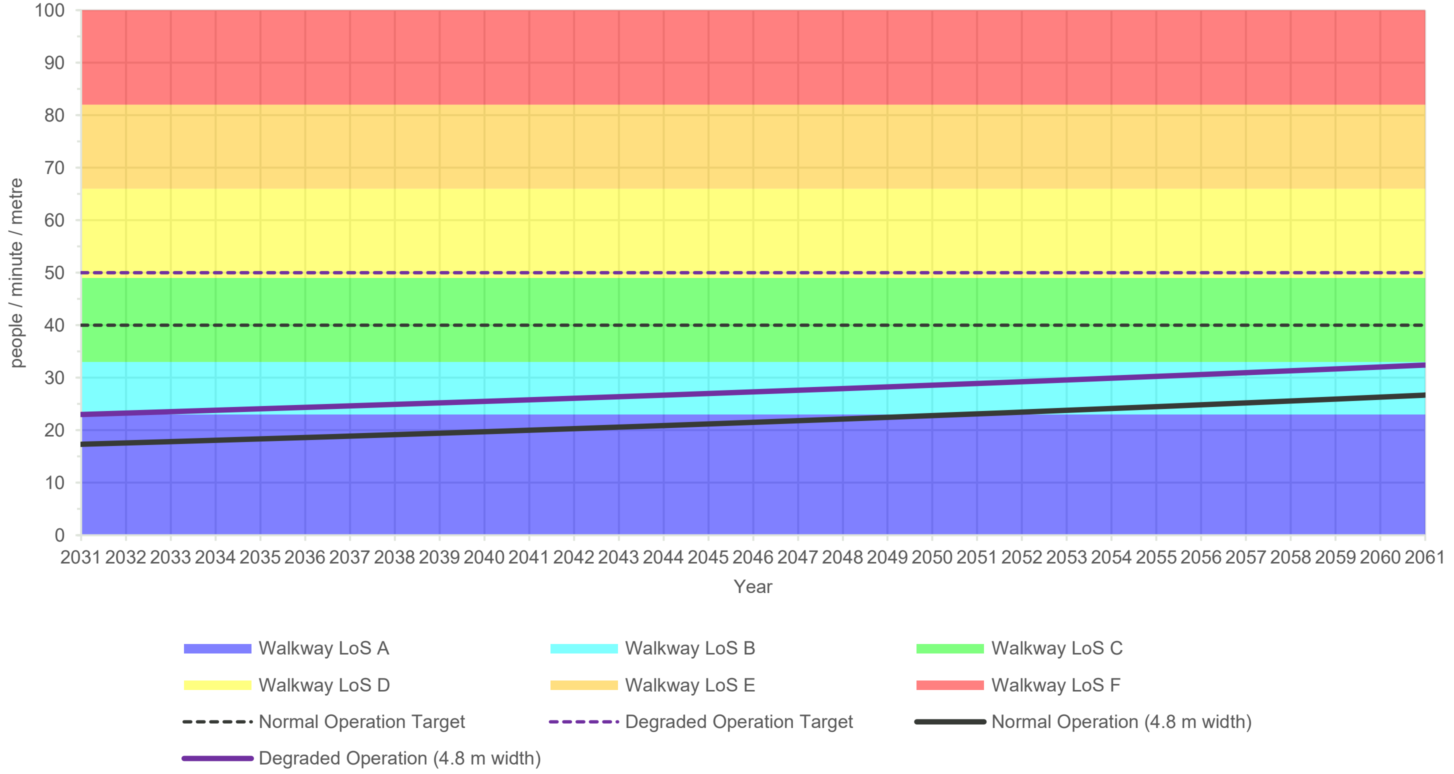

Figure 3-1 Overpass evening peak walkway Level of Service performance

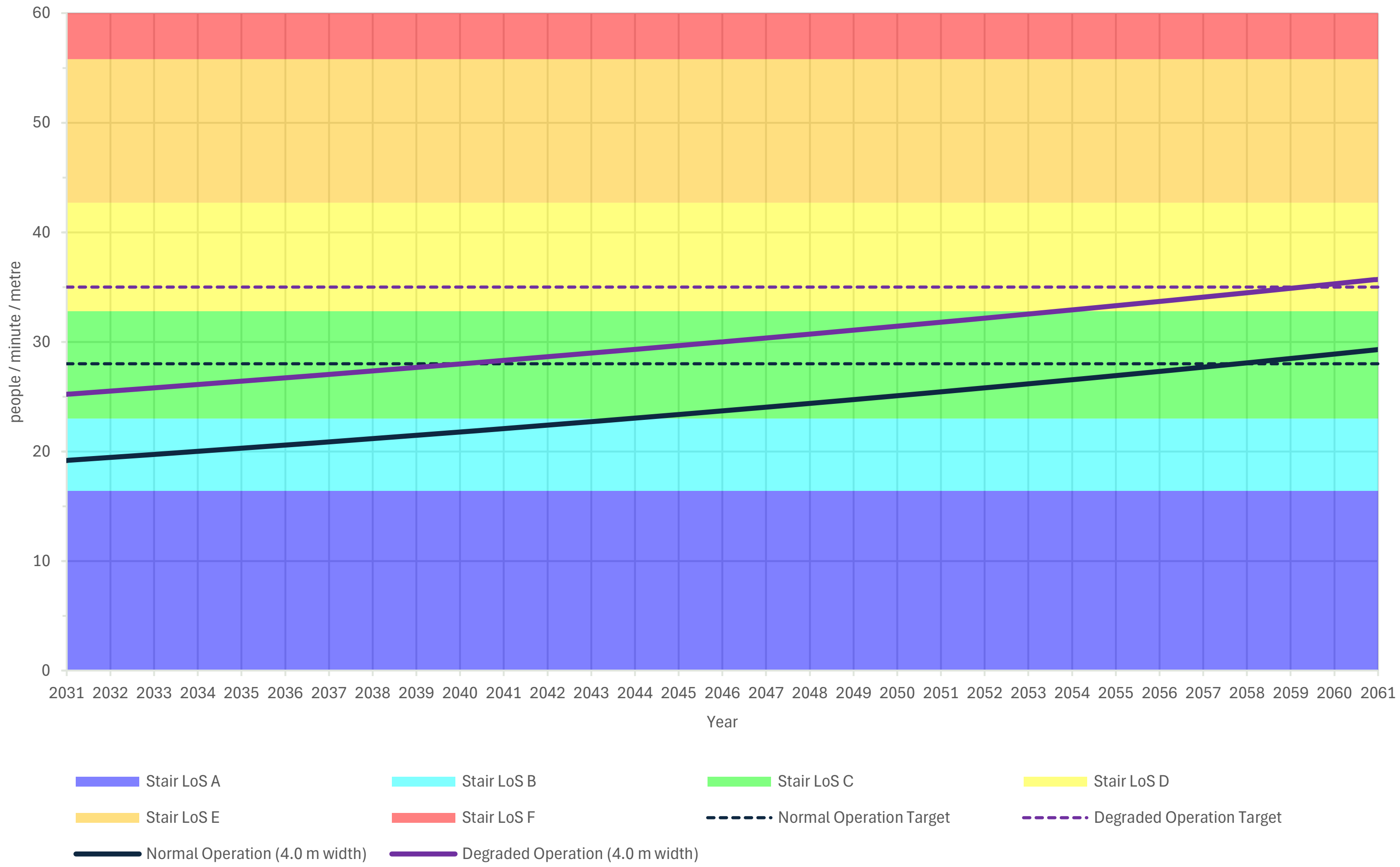

Figure 3-2 Overpass staircase evening peak stair Level of Service performance

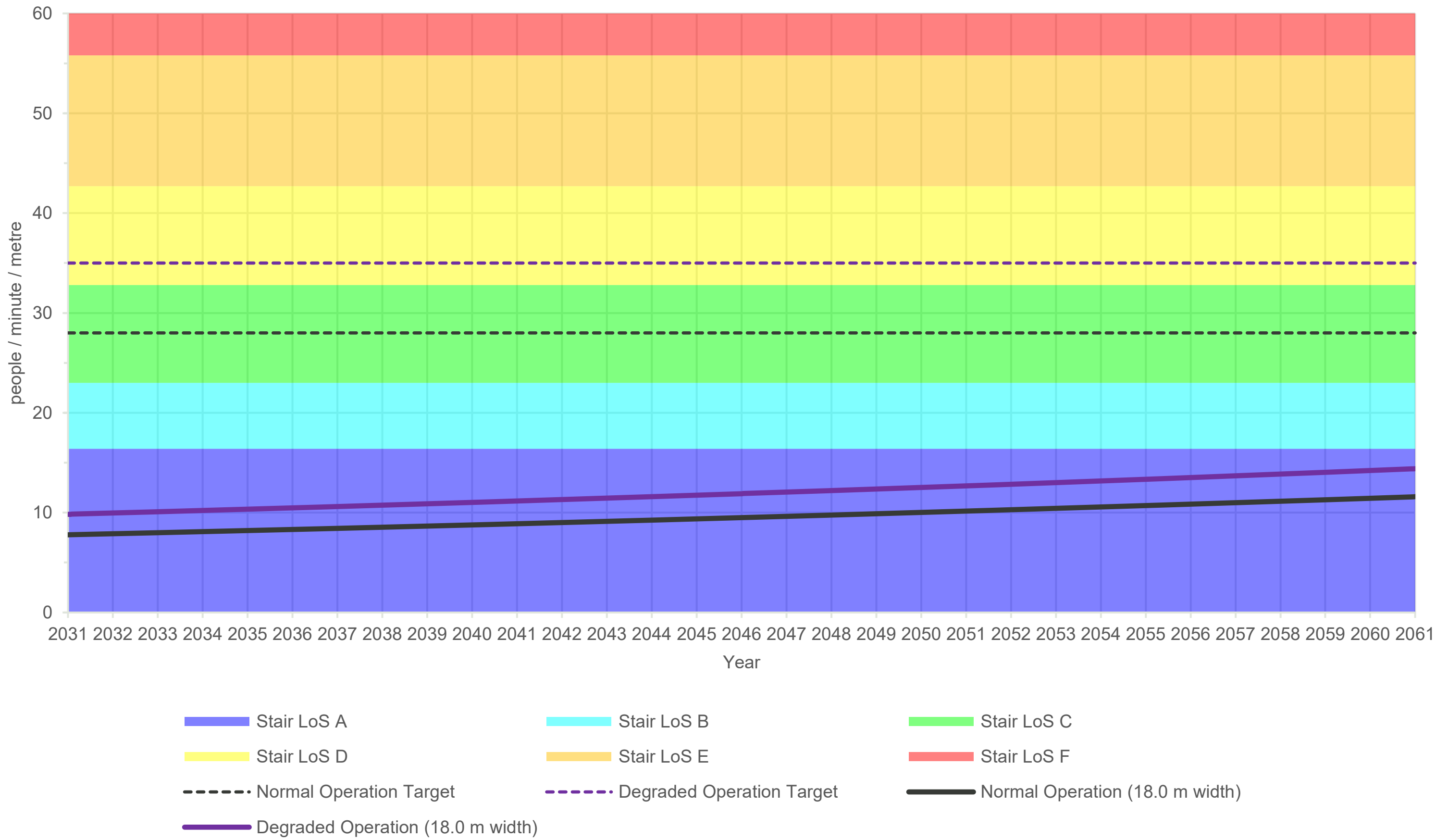

Figure 3-3 Oxford Terrace staircase evening peak stair Level of Service performance

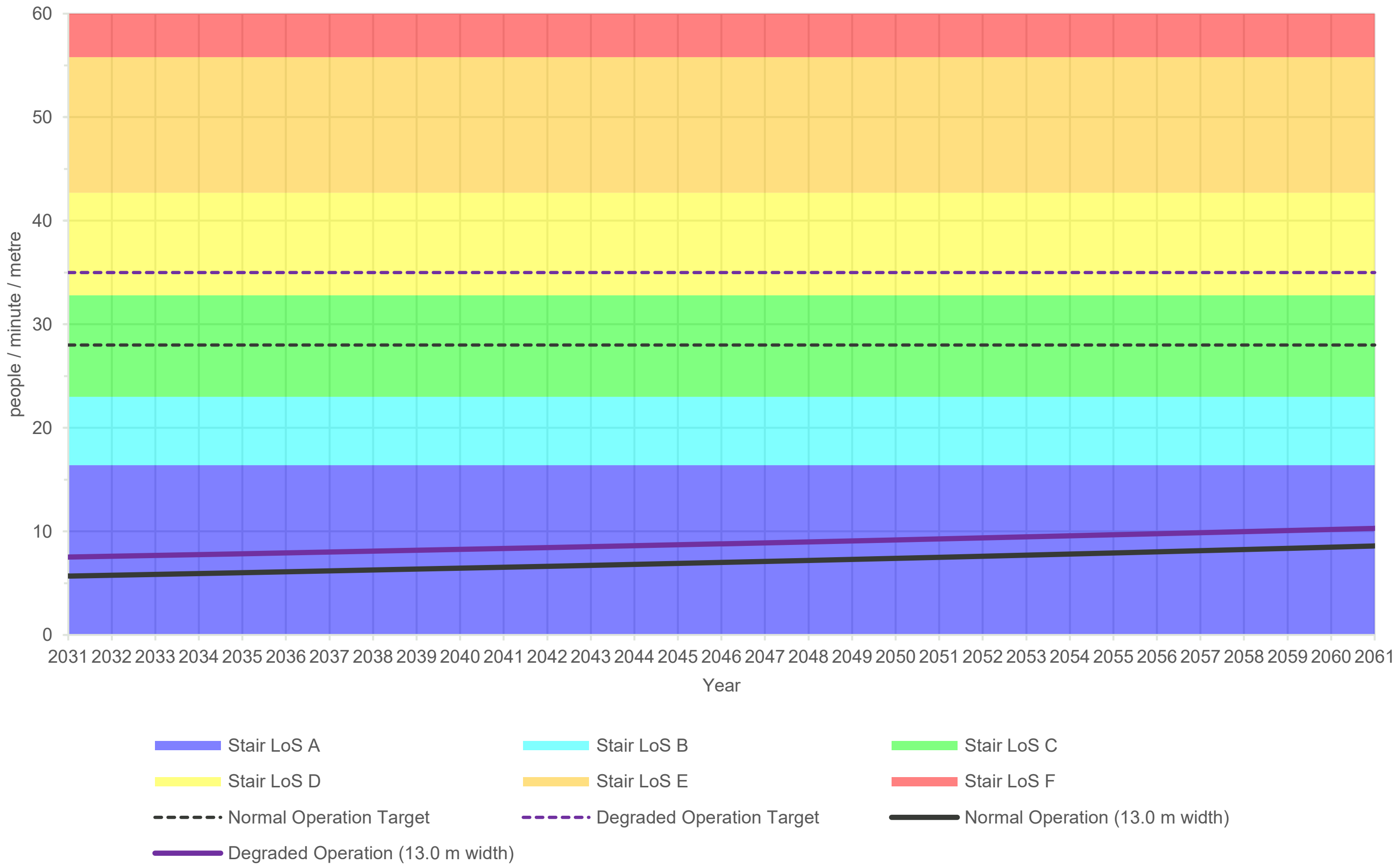

Figure 3-4 Cambridge Terrace staircase evening peak stair Level of Service performance

4 Reference Design by Mode

4.1 Bus Interchange Configuration

Waterloo Station performs a critical multimodal role in the Wellington public transport system. It acts as the principal interface between the Hutt Valley and Wairarapa rail lines and a range of high-frequency bus services connecting Lower Hutt's key growth areas including Wainuiomata, Naenae, Kelson and Seaview. The Reference Design strengthens this role by delivering a bus interchange that is legible, scalable and aligned with future network growth and intensification.

The interchange has been deliberately configured to enable seamless bus to rail transfers while supporting efficient operations (balanced with the needs of other modes), future service flexibility and land use uplift in the surrounding precinct. This aligns with Greater Wellington's strategic goals for mode shift, access equity and integrated land use and transport outcomes.

4.1.1 Functional and Operational Requirements

The interchange design reflects the expectations outlined in Greater Wellington's Public Transport Minimum Requirements and is grounded in evidence from current usage patterns and future demand modelling.

Key functional expectations include:

- **Capacity for long-term growth**
  The design accommodates peak service volumes through to 2046 and 2061, including provision for fleet electrification and increased boarding activity driven by higher-density land use.
- **Flexible stop layout**
  Bus stops are designed for efficient headways, minimising delays while enabling consistent dwell times. Lengths and configurations support GWRC vehicle specifications and allow for future timetable intensification or service reorganisation.
- **Passenger amenities and infrastructure**
  Each bus bay includes high-quality shelters, lighting, real-time information displays and accessible kerbside infrastructure. This supports a consistent and comfortable experience for all users.

4.1.2 Bus Network

The 2041 future bus network is assumed to remain unchanged from the existing conditions. Figure X illustrates this network (taken from the Metlink database), with bus routes servicing the station identified by the red outline. Of the following routes, only the 145 – and 149 – terminate at Waterloo Station. All other services through-route.

- 121 – Stoke Valley Heights
- 121 – Seaview
- 130 - Naenae
- 130 – Petone
- 145 – Belmont
- 145 – Waterloo Station
- 149 – Waterloo Station (Loop Service)
- 150 – Kelson
- 150 – Maungaraki
- 160 – Wainuiomata North
- 160 – Lower Hutt
- 170 - Wainuiomata South
- 170 - Lower Hutt

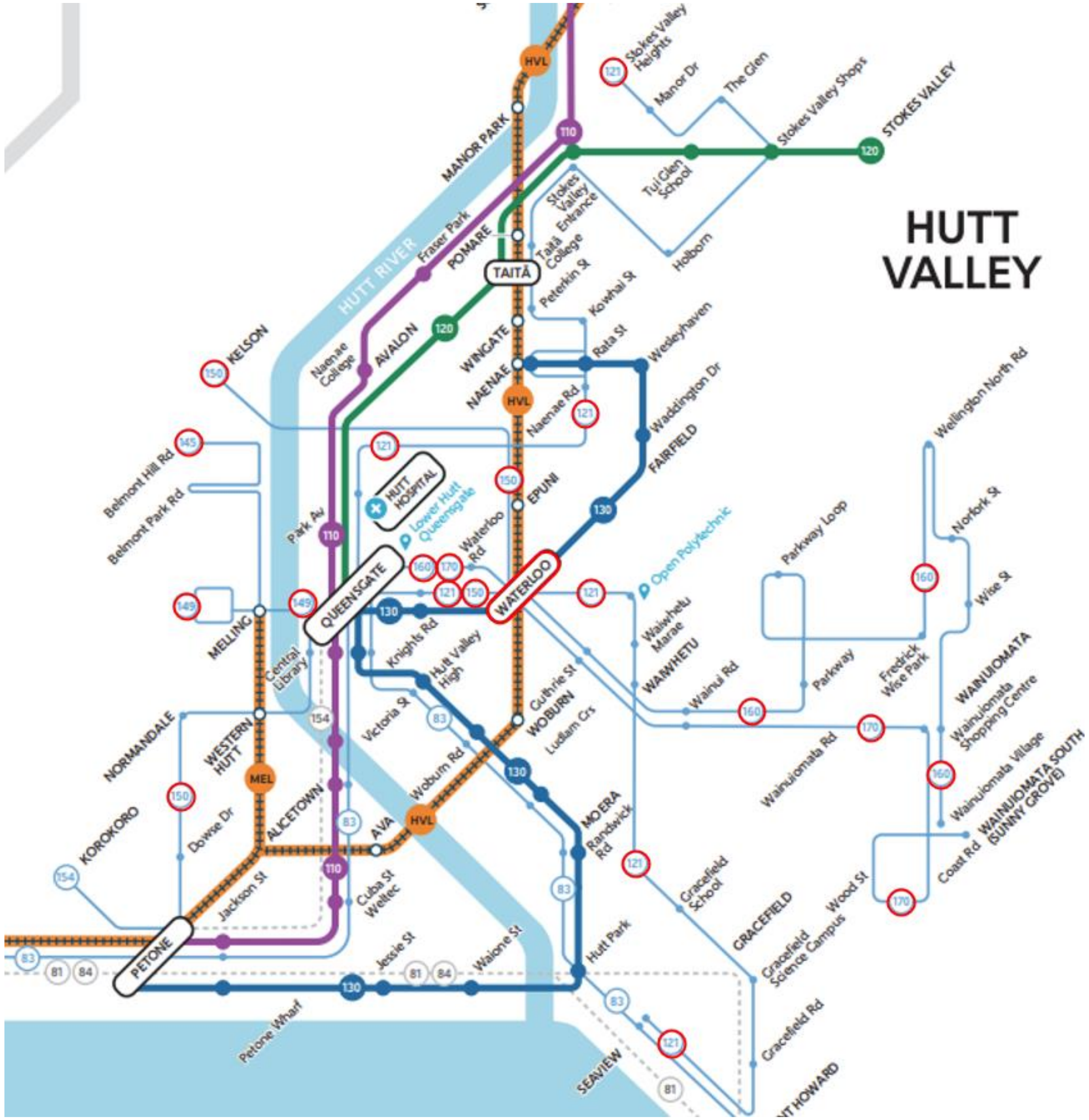

Figure 4-1: Existing and Future Bus Network (Source: Metlink[1])

4.1.3 Bus Volumes

Table 4-1 below lists the existing and future 2041 bus volumes for all Waterloo station bus services. Note the future scenario volumes were taken from GWRC's Minimum Requirements document. In the 2041 scenario, 72 buses per hour will service Waterloo Station, an increase of 34 from the existing volumes.

Table 4-1: Existing and Future (2041) Bus Volumes

Service Name (With Destination)	Existing Peak Hour Volume (buses per hour)	2041 Peak Hour Volume (buses per hour)
121 – Stoke Valley Heights	2	4
121 – Seaview	3	4
130 – Naenae (Timed Rail Connection)	4	6
130 – Petone	4	6
145 – Belmont (Timed Rail Connection)	3	4
145 – Waterloo Station	3	4
149 – Waterloo Station (Termination - Loop Service)	2	4
149 – Waterloo Station (Commencement - Loop Service – Timed Rail Connection)	2	4
150 – Kelson (Timed Rail Connection)	3	6
150 – Maungaraki	3	6
160 – Wainuiomata North (Timed Rail Connection)	6	6
160 – Lower Hutt	4	6
170 - Wainuiomata South (Timed Rail Connection)	3	6
170 - Lower Hutt	5	6
Total	**48**	**72**

4.1.4 Service Grouping

Four bus stops currently serve Waterloo Station (Figure 3-2). Stops A and B are located on the western side of the station, with stops C and D to the east. There is an additional rail replacement bus service stop (double stop), northeast of stop D. This stop is only used by buses serving as a replacement service for the rail services when they are inoperable.

4.1.5 Stop Requirements

Given the 2041 bus network does not feature any changes from the existing, the service grouping for each stop will remain unchanged.

The 2041 stop requirements are based on NZTA public transport design guidance for 'split' bus stops[1]. As each stop serves separate bus routes, the design needs to allow for independent operation i.e. buses can enter and exit the stop independently of each other.

With a 60 second dwell time (based on best practice), one bus bay can service ~25 buses per hour, with two split bus bays, 50 buses per hour. Whilst one bus bay per stop is enough capacity, the inclusion of timed rail connection services will increase this requirement. For each 'timed rail connection', a dedicated bay is required as these services wait for the connecting rail service.

Table 4-2 below lists the services that use each stop in 2041, the number of bays required, and the stop length.

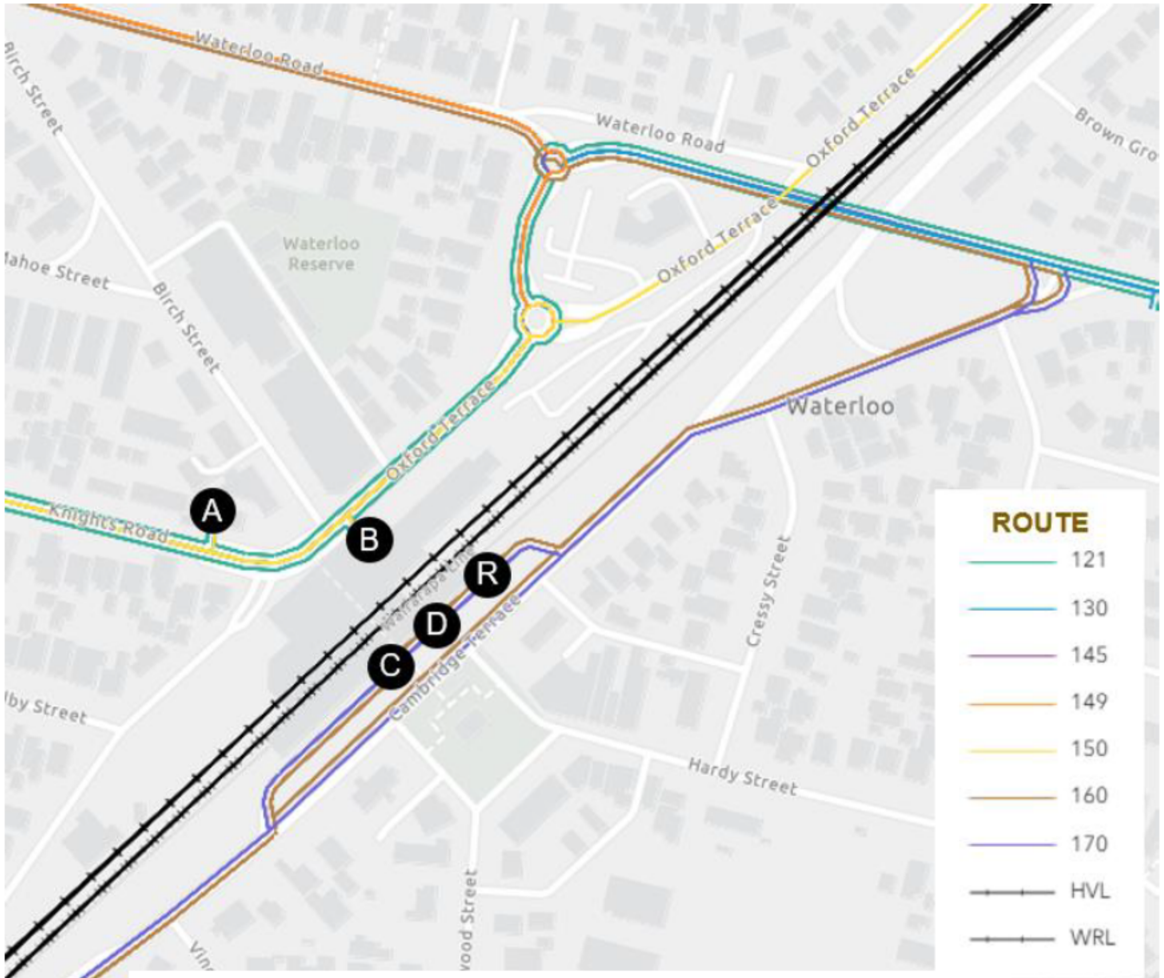

Figure 4-2: Waterloo Station Stops / Services (existing stop arrangement)

[1] Public transport design guidance: bus stop - updated 10 May 2023

Table 4-2: Waterloo Station Stop Requirements

Stop	Service	2041 Stop Volumes		2041 Bay Requirement	
A	121 – Seaview	4	16	1	3 (Triple Stop)
	130 – Naenae (Timed Rail Connection)	6		1	
	150 – Kelson (Timed Rail Connection)	6		1	
B	121 – Stoke Valley Heights	4	24	1	3 (Triple Stop)
	130 – Petone	6			
	150 – Maungaraki	6			
	145 – Belmont (Timed Rail Connection)	4		1	
	145 – Waterloo Station	4		1	
C	160 – Lower Hutt	6	12	1	2 (Double Stop)
	170 - Wainuiomata South (Timed Rail Connection)	6		1	
D	160 – Wainuiomata North (Timed Rail Connection)	6	12	1	2 (Double Stop)
	170 - Lower Hutt	6		1	
R	Rail Replacement Services	Triple stop as per minimum requirements			

4.1.6 Stop Lengths

GWRC's minimum requirements set out lengths for bus stops. As the design vehicle, a 13.5m standard bus has been selected. With this design vehicle, each stop is made up of the following dimensions:

- Entry taper – 15 metres
- Bus bay – 15 metres
- Exit taper – 9 metres (6 metres for rail replacement services)

This results in a single stop length is 39 metres. For double and trip stops, only an additional exit taper (9m), and bus bay (15m) is required per bay. This gives the following stop lengths:

- Single bay/stop - 39m
- Double bay/stop (split operation) – 63m
- Triple bay/stop (split operation) – 87m
- Triple bay/stop for rail replacement services (split operation) – 78m

Should there be spatial constraints that do not support these GWRC minimum requirements, best practise lengths can be used as an alternative:

- Entry taper – 9 metres
- Bus bay – 15 metres
- Exit taper – 5 metres

With these requirements, the following stop lengths are provided:

- Single bay/stop - 29m
- Double bay/stop (split operation) – 49m
- Triple bay/stop (split operation) – 69m

Table 4-3 below provides a summary of the stop length requirements for each Waterloo Station stop, based on both the GWRC minimum requirements, and best practise guidelines.

Table 4-3: Waterloo Station Stop Lengths

Stop	Stop Requirement	Stop Length (GWRC Minimum Requirements)	Stop Length (Best Practise Guidelines)
A	Double Stop	63m	49m
B	Double Stop	63m	49m
C	Double Stop	63m	49m
D	Double Stop	63m	49m
R	Triple Stop	78m	69m

4.1.7 Interchange Design Philosophy

Throughout the optioneering and evaluation process, the bus interchange design was guided by four core principles:

- **Consolidation and integration**
  The eastern interchange is consolidated into a compact, high-amenity cluster located adjacent to the station's primary entry. This enhances wayfinding, simplifies transfers and creates a clearer spatial relationship between modes.
- **Proximity to rail platforms**
  Bus stops are positioned as close as practicable to platform entrances to minimise walking distances and streamline passenger movement. This supports faster and more intuitive transfers and reduces overall journey times.
- **Operational optimisation**
  Stop locations and assignments were informed by existing service data and adjusted to reflect future ridership volumes, headways and turnback requirements. Design testing considered both normal operations and degraded scenarios such as rail replacement.

The interchange layout has been designed to enable future service integration, supporting emerging transport modes that improve flexibility and coverage. This includes provision for Demand Responsive Bus (DRB) services which can adapt to dynamic user needs and support equitable access.

The layout also accommodates Bus Replacing Train (BRT) operations during rail service disruptions, ensuring continuity of travel during planned or unplanned outages. Additionally, the design allows for first and last mile solutions targeted at low-density or disconnected areas, extending the functional reach of the station and supporting a more resilient and inclusive network.

4.1.8 Features of the Recommended Configuration (The Reference Design)

The final recommended configuration under the Reference Design strikes a balance between user experience, operational efficiency and long-term adaptability.

Key features include:

- **Upgraded western interchange**
  Upgrades existing bus stops with significant improvements to infrastructure, including widened footpaths, weather protection, lighting and real-time service information.
  - Introduction of a new double-stop on Oxford Terrace (stop A)
- **Consolidated eastern interchange**
  Forms a new, high-quality cluster of stops immediately adjacent to the rail station entrance. This delivers seamless interchange connections and improves precinct legibility.
- **Seven active bus bays in total**
  Including layover and set-down bays, the interchange is designed for efficient throughput and reduced congestion during peak periods. (*requires signalisation due to the relocated bus access).

- **Separation from car-based access**
  The interchange layout clearly separates bus movement from pick-up and drop-off and private vehicle areas, improving safety and reducing modal conflict at the station entrance

The bus interchange configuration under The Reference Design supports a step change in public transport performance at Waterloo Station. It enhances the station's function as a multimodal hub, integrates with long-term urban growth patterns and delivers a high-quality customer experience. This unlocks broader network efficiency and enables the land use transformation objectives sought through the precinct redevelopment.

4.2 Active Mode Access

Improved access for people walking and cycling is central to The Reference Design, which prioritises safe, direct, and high-quality active mode connections as an enabler of mode shift, health, and social outcomes. These upgrades align with the Wellington Regional Mode Shift Plan, reinforce Waterloo Station's role as a high-performing interchange, and futureproof the precinct for higher-density, transit-oriented development.

The design responds directly to constraints identified in earlier assessments - including fragmented crossings, poor visibility, and low perceptions of safety - and implements a suite of interventions that remove barriers and unlock access to key destinations such as Lower Hutt CBD, Wainuiomata, Naenae, local schools, and community facilities.

Key interventions include:

- **New at-grade signalised crossing on Cambridge Terrace**
  A strategically located, legible pedestrian crossing provides a direct east–west desire line between the station entrance and surrounding community, aligned with existing key walking routes. The signalised facility replaces reliance on the subway, improving safety and visibility, and supporting more direct and equitable access for all users, including children and people using mobility aids.
- **Improved western access via Oxford Terrace**
  Access routes are upgraded to support safe and comfortable walking connections from the western residential catchments. Raised safety platforms across side roads reduce vehicle speeds, enhance pedestrian visibility, and improve permeability through the street network.
- **CPTED-informed overpass with weather protection**
  A weather-protected overbridge provides an all-weather alternative route between platforms and across the corridor. It is designed with passive surveillance, clear sightlines, and universal access features - including gentle gradients, lifts, and tactile guidance.
- **Prominent, secure cycle parking**
  Cycle parking is located in highly visible, passively surveilled areas near key station entrances. This supports user confidence, encourages uptake of active modes, and deters theft or vandalism. The facilities are designed to accommodate a mix of bike types, including e-bikes and cargo bikes.
- **Integration with the Beltway Cycleway and street network**
  The station connects directly into existing and future active mode corridors, including the Beltway Cycleway, Oxford Terrace, and Birch Street. These connections enable catchment expansion, reduce pressure on parking, and support end-to-end multimodal journeys.

- **Scalable infrastructure for future micro-mobility**
  The design includes space for expansion of bike parking and allows for the introduction of additional facilities such as shared e-scooter parking and end-of-trip amenities. These futureproofing measures ensure flexibility as user needs and technologies evolve.

The Reference Design repositions active transport as a primary access mode to Waterloo Station. The design not only removes longstanding barriers to walking and cycling but embeds high-quality infrastructure into the fabric of the precinct. This elevates the station's role as a civic anchor, supports sustainable travel behaviour, and reinforces the precinct's readiness for higher-density, transit-oriented growth.

4.3 Pick-up, Drop-off and Taxi Facilities

A high-performing multimodal interchange requires deliberate planning for short-stay access movements. In The Reference Design, dedicated Pick-Up and Drop-Off (PUDO) and taxi facilities are provided at both primary station entries - supporting customer choice, reducing reliance on informal behaviours, and improving the overall user experience.

By formally accommodating these access needs, the design strengthens the station's role as a local and regional hub, while aligning with the modal access hierarchy established in the Wellington Regional Public Transport Plan. This hierarchy prioritises walking, cycling, and public transport over private vehicles, but acknowledges the essential function of short-stay vehicular access for certain users - including families, the elderly, and those with limited mobility.

Key features include:

- **Co-located PUDO and accessible parking bays**
  Drop-off areas are integrated with mobility parking near station entries, reducing walking distances and supporting universal access. This co-location allows for intuitive use by drivers and ensures compliance with best-practice access standards.
- **Safe and legible access design**
  PUDO areas are designed with clear wayfinding, passive surveillance, and logical placement within the station forecourt. Dedicated turning movements are separated from pedestrian desire lines to reduce conflict, while surface treatments and signage reinforce appropriate use.
- **Efficient turnaround and dwell space**
  Designated zones allow for short dwell times without impeding through movement or compromising bus circulation. Turnaround capacity has been dimensioned to accommodate typical AM and PM peak demand, while maintaining reliable access for taxis and drop-off vehicles during special events or rail disruptions.
- **De-risking informal behaviour**
  By formalising taxi and PUDO access, the design mitigates the safety risks associated with current informal practices (e.g. stopping in live traffic lanes or at bus stops). This is a critical enabler of station safety and system reliability - particularly in a precinct expected to see significant patronage growth and urban intensification.
- **Integrated within wider interchange movement patterns**
  PUDO facilities are strategically located to complement pedestrian and micromobility networks, enabling seamless transition for all users without compromising the operational efficiency of higher-priority modes such as buses or active transport.

The proposed PUDO and taxi facilities represent a shift from ad hoc accommodation of car-based access toward a more intentional, user-centred approach that supports system performance, accessibility, and safety. This is essential to delivering a complete and inclusive interchange experience - and to achieving the long-term mode shift, accessibility and placemaking goals of the Waterloo Station redevelopment.

4.4 Park and Ride Provision

Waterloo Station currently provides one of the largest Park and Ride (P&R) facilities in the Wellington region, with approximately 780 spaces. However, analysis of demand patterns reveals inefficient use of this resource. A high proportion of users originate from within the local walk-up or bus catchments - indicating that car-based access is displacing more sustainable modes, undermining mode shift objectives and reducing the opportunity to leverage precinct land for higher value uses.

The Reference Design responds to these challenges by rebalancing car access within a broader integrated access strategy. The total supply of P&R spaces is reduced to approximately 341, better aligning provision with regional access priorities and freeing up significant developable land for transit-oriented development and public realm improvements.

Key features and strategic outcomes include:

- **Alignment with the Station Access Hierarchy**
  The reduced parking supply reflects GWRC's access hierarchy, which prioritises walking, cycling, and public transport as the primary modes for station access. Car-based access is preserved for users from outlying areas beyond the public transport catchment - but de-emphasised for those with viable non-car alternatives.
- **Incentivises mode shift for short-distance users**
  By removing the oversupply of free parking, the Reference Design encourages local residents and commuters from nearby suburbs (e.g. Waterloo, Woburn, Naenae) to walk, bike, or use connecting bus services. This supports a more efficient use of transport capacity and reduces traffic congestion on approach roads.
- **Releases land for precinct uplift**
  The reduction in P&R footprint unlocks a substantial portion of the Greater Wellington-owned site for higher-value land uses. This includes mixed-use development, public spaces, and improved interchange infrastructure - creating a more vibrant, people-centred station precinct that contributes to Hutt City's long-term growth objectives.
- **Supports future parking management strategies**
  Whilst the Reference Design establishes the spatial baseline, further optimisation will be enabled through active parking management tools. These may include:
  - **Pricing strategies** to manage peak demand and prioritise high-need users.
  - **Access prioritisation** for carpooling, mobility users, and regional travellers.
    These tools ensure flexibility to adapt to future travel patterns and regional emission reduction goals.

The Reference Design transitions Park and Ride from a blunt access mechanism to a targeted, demand-responsive tool that supports regional transport and land use objectives. It balances the needs of longer-distance travellers with the imperative to shift short-trip users to more sustainable modes - while unlocking land for urban intensification and amenity enhancement. This approach is consistent with national direction, local strategy, and best practice in transport hub development.

5 Design Refinement

This section outlines specific aspects that require further refinement and coordination during the next stage of the project, beyond the Reference Design stage. This is primarily because the road controlling authority is Hutt City Council, and the on-road changes will need to be developed in partnership with the council. This includes proposed bus stops, proposed signals and proposed on-road changes, including restrictions to turning movements.

5.1 Bus Stops

As part of the development of the Reference Design package, the design and layout of stop stops C, D and R were refined due to the spatial constraints, primarily caused by the relocation of the bus station access on Cambridge Terrace.

Swept path analysis confirmed that buses entering the interchange via a right-turn from Cambridge Terrace are unable to access the southernmost stop due to insufficient manoeuvring space.

A spatial assessment confirmed that there is a total of 144 meters of usable length within the interchange for safe bus movements. To meet the GWRC's minimum requirements and provide two double bay stops and one triple, 204 meters would be needed. Applying the best practice guidelines the required length could be reduced to 167 meters. The current Reference Design layout utilised 157 meters, but due to the spatial constraints revealed through vehicle tracking, only 144 meters can be considered realistically usable.

To resolve this, a revised bus stop layout (Figure4-1) has been proposed for stops C, D and R. The proposed layout maintains the seven-stop configuration by modifying the entry and exit taper lengths to best utilise the available 144m:

- A head-of-stop operation is recommended for each route group, whereby buses are instructed to always proceed to the front-most available bay.
- The revised design will support the requirement of independent entry and exit for each bus, maintaining operational flexibility.

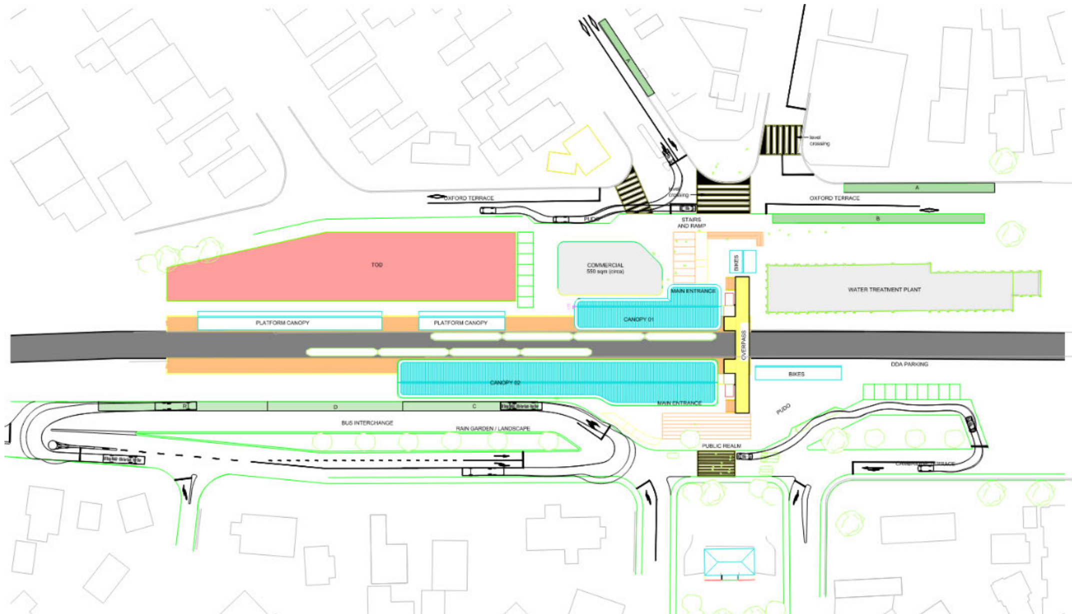

Figure 5-1: Vehicle tracking - bus interchange and PUDO

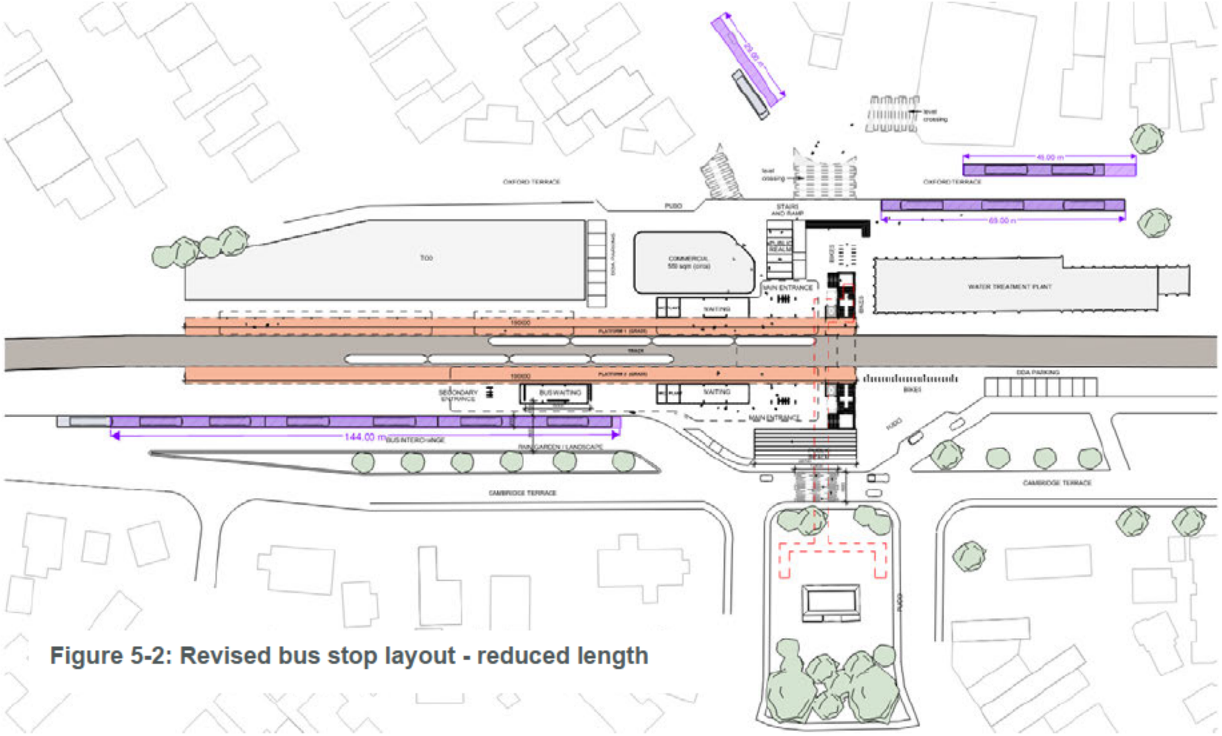

Figure 5-2: Revised bus stop layout - reduced length

Figure 4.2 illustrates the components of the revised layout:

- Stop A – 3rd stop (single) retained in existing location on Knights Road.
  - Double stop increased in length to match requirements
- Stop C and D - two double bus bays (44m each)
- Stop R - One triple bus bay (55m) to accommodate for the rail replacement services
  - Removed the 9m entry taper for Stop R
  - Removed 5m exit tapers between route groups to maximise effective use of constrained space.
  - Removed 5m exit taper at the head of stop of Stop C.

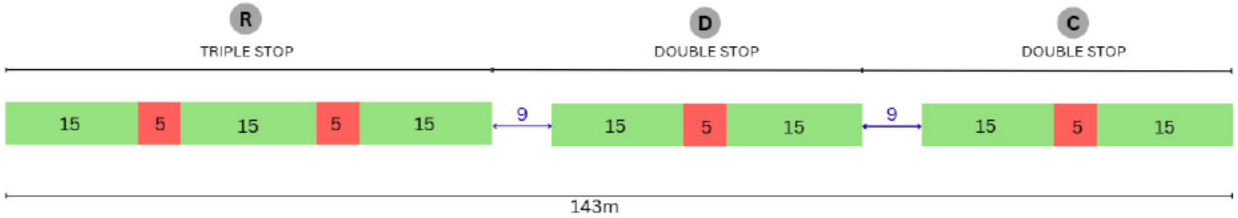

Figure 5-3: Schematic illustration of bus stop configuration

5.2 Pedestrian Crossings

All pedestrian crossings included in the Reference Design are assumed to be raised and designed in accordance with NZTA and Hutt City Council's design standards. As the detail needs to be worked through with Hutt City Council, the nature of the crossings shown in the Reference Design are indicative only and subject to design development.

While the revised crossings have not been developed in detail – the revised design should include similar safety features to maintain and/or improve on the existing layout.

One of the key client requirements is to prioritise pedestrian access and connections to the surrounding community via walking and cycling networks, with pedestrians given priority at all crossings. The two proposed pedestrian crossings cross a wide traffic lane (13m and 10m) so the pedestrian refuges need to be retained in the Reference Design.

The existing pedestrian crossings on Oxford Terrace includes pedestrian refuge islands and the intention is to retain those, noting that the dog leg / staggered crossing will be converted to a two-stage straight across crossing. Raising the crossings will further slow vehicles and visually prioritise pedestrian movements across access roads. It is noted Oxford Terrace and Cambridge Terrace are both bus routes, the raised crossings will be design in accordance with NZTA's Pedestrian Network Guidance[2].

Please see **Appendix B** (Waterloo Station – Pedestrian Crossings Design Note) for further detail on pedestrian crossing facilities.

5.3 PUDO Arrangements

The new PUDO bays on the northwestern side of the station are in close proximity to the two pedestrian crossings in the same area. Westbound vehicles traveling along Oxford Terrace to access these bays risk queuing back into the second pedestrian crossing if pedestrians are present at the westernmost crossing.

This situation also complicates right-turn movements from Knights Road onto Oxford Terrace when vehicles are already queued between the two crossings. Consequently, this may cause additional queuing along Knights Road for those waiting to turn right so further refinement is needed during the next stage of design development to optimise the PUDO facility.

To address these issues, further refinement of the northwestern PUDO bay location and the pedestrian crossing layout is necessary. One potential solution is to reduce the width of the first pedestrian crossing encountered

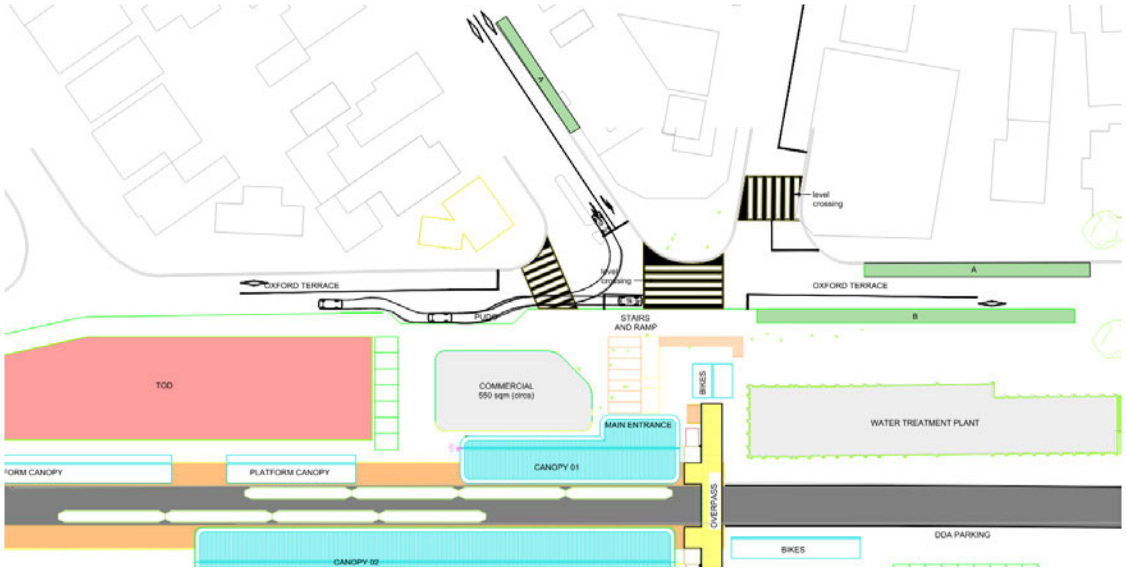

Figure 5-4: Oxford Terrace pedestrian crossing and PUDO interface

[2] 3. Design – 3.4. Crossings Pedestrian Network Guidance, NZTA, February 2025 V1.1

when traveling southbound, to increase the distance between the first and second crossings and improve traffic flow.

The PUDO facility on the northeast side of the station operates as a one-way circulation system. Due to its design and accessibility constraints, right-turn movements into the PUDO from Cambridge Terrace are either restricted or prohibited; therefore, it is recommended that access be limited to left turns only.

The introduction of the proposed pedestrian crossings will remove the existing southbound drop-off bays, which may create safety concerns related to on-street pick-ups and drop-offs.

Additional analysis and design refinement will be necessary to finalise the PUDO operations and explore potential options for accommodating southbound PUDO facilities.

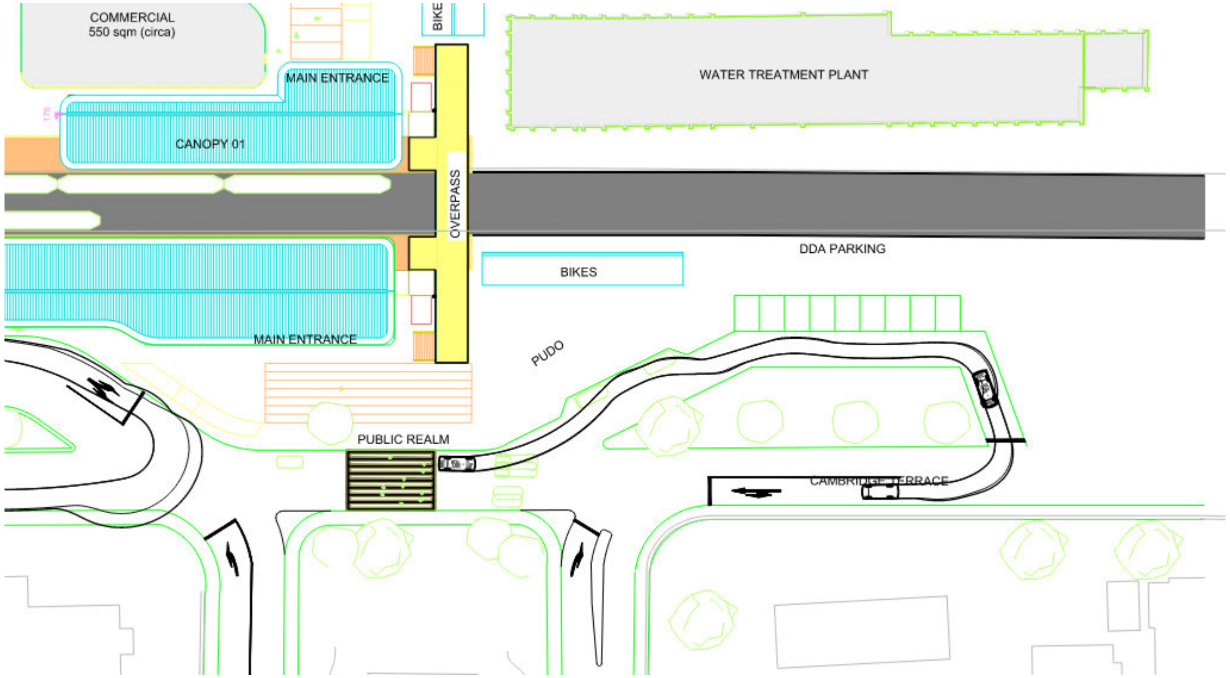

Figure 5-5: Cambridge Terrace PUDO arrangement

5.4 Wider Network / Local Road Impacts

Further assessment of local road and network impacts will be required in the next design stage to ensure the station integrates effectively with its wider context. Key areas of investigation include:

- **Network Assessment** – Review of surrounding street functions and access arrangements, including implications for Waterloo and Cambridge Terraces.

- **Modelling** – Local traffic modelling to test access scenarios, intersection performance, and multimodal demand under future growth.
- **Signal Phasing Design** – Assessment of traffic signal timing changes, particularly at Cambridge Terrace, to support increased pedestrian flows and safe crossing.
- **Network Impact Assessment** – Identification of wider network effects, including safety, congestion, and operational risks, to inform mitigation strategies.

These investigations will support a balanced and resilient multimodal network as the precinct intensifies.

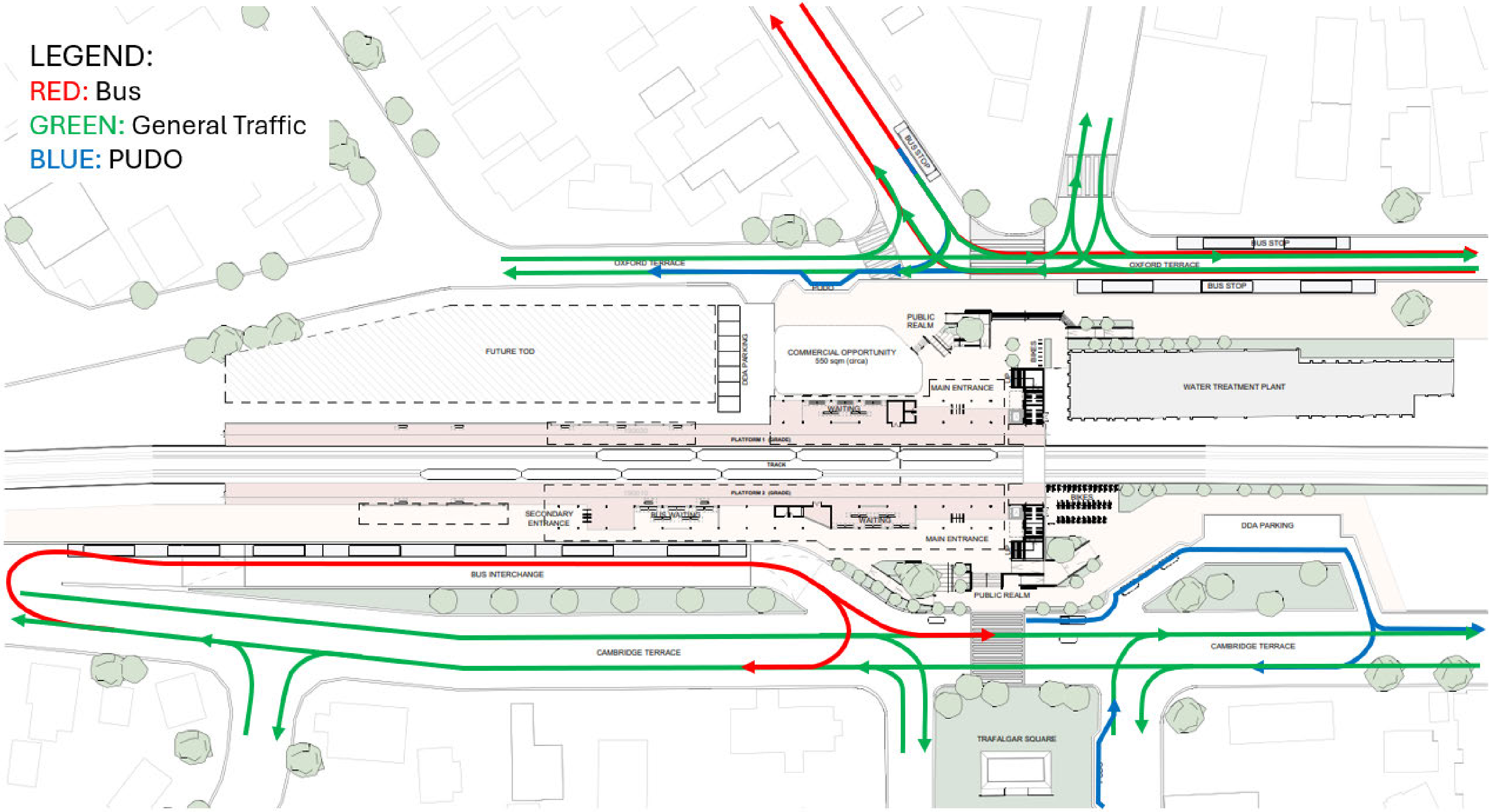

Figure 5-6: Required bus / general traffic / PUDO movements

6 Accessibility, Safety and Customer Experience

The Reference Design embeds accessibility and legibility as foundational design principles, ensuring Waterloo Station functions as an inclusive public space that supports people of all ages, abilities, and journey purposes. The station is designed to be easy to use - not just compliant - with a focus on creating intuitive, safe, and dignified journeys across all access modes.

The approach reflects the values of universal design and responds directly to Wellington region priorities for equitable access, social inclusion, and customer experience uplift. By combining robust technical standards with human-centred thinking, The Reference Design positions accessibility not as a constraint but as a driver of quality and performance.

Key elements of the design include:

- **Universal access across all station elements**
  All entries, platforms, vertical circulation elements, and bus interchange facilities are designed to meet or exceed the requirements of NZS4121 and international universal design best practice. Step-free access is provided throughout, supported by lifts, tactile surfaces, and gentle gradients to support people using wheelchairs, mobility aids, or prams.
- **High-quality lighting and clear sightlines**
  Lighting design ensures uniform coverage and minimises shadows and glare, enhancing perceptions of personal safety during early morning, evening, and off-peak travel. Visual transparency and open sightlines improve navigation and comfort, particularly for women, older people, and those travelling alone.
- **Consistent and intuitive wayfinding**
  Wayfinding is integrated into the architecture and landscape, using Metlink brand standards to create a coherent, user-friendly experience across the precinct. Signage placement and language are designed for clarity and ease of comprehension, reducing reliance on prior knowledge or staff assistance.
- **Real-time information across modes**
  Digital displays and audible announcements provide timely, reliable information for both rail and bus services. Information is positioned for easy viewing from key waiting areas and pedestrian paths, supporting seamless decision-making and reducing anxiety for users unfamiliar with the network or travelling under time pressure.
- **Well-located amenities for comfort and dignity**
  Weather protection, seating, and public toilets (including accessible facilities) are placed where they are most needed - adjacent to platforms, entries, and bus stops. These elements support longer dwell times, enable rest for those who need it, and ensure the station is usable by all, regardless of physical condition or trip purpose.

The Reference Design transforms Waterloo Station into an interchange that is not only functional but welcoming, legible and inclusive. By embedding accessibility into every part of the design, it delivers a station experience that is easy to navigate, safe to use, and universally supportive - reflecting the values of equity, dignity, and customer focus that underpin a truly future-ready public transport network.

7 Constraints and Risk Management

7.1 Physical and Network Constraints

a. Platform Geometry and Alignment Constraints
The alignment of platforms (particularly in The Reference Design) requires physical realignment of Platform 2 to be consistent with Platform 1. While this improves wayfinding and station legibility, it imposes challenges related to:

- Impacts on the existing signal box and rail infrastructure.
- Potential disruption to rail operations during construction.
- Confined corridor geometry limiting flexibility for overpass design and pedestrian landing zones.

b. Vertical Level Changes
Cambridge Terrace presents a notable level change (~9 metres) to the rail corridor, complicating direct pedestrian connections. Risk exists that without sensitive design integration, vertical circulation elements (e.g. lifts, stairs) could become inaccessible or act as barriers to multimodal transfer.

c. Rail Corridor Operating Environment
The station is located on a live rail corridor serving both the Hutt Valley and Wairarapa Lines. Risks include:

- Operational disruption during construction, especially where works interface with track, OLE (overhead line equipment), and signalling systems.
- Constrained construction windows due to network availability.
- Health and safety risks associated with working adjacent to operating rail infrastructure.

7.2 Demand Forecasting and Capacity Risks

a. Demand Uncertainty
Passenger demand is projected to grow significantly (up to 180% to 2061 under Sense Partners high growth scenario)

- Over or under-sizing of facilities leading to operational and investment inefficiencies.
- Mismatch between future service levels and platform or vertical circulation capacity.
- Sensitivity to growth assumptions including TOD uptake, mode shift success, and macroeconomic factors.

b. Station Sizing Constraints
Static pedestrian modelling has identified minimum clear widths for platforms (5.0 m), stairs, and passageways. Risks include:

- Constraints in achieving these dimensions due to site boundaries, spatial competition with bus interchange and commercial elements.
- Potential congestion at key vertical circulation points (e.g. lifts, stairs), particularly in peak 15-minute periods. Dynamic pedestrian modelling can be undertaken at the next stage of design development to better understand this risk.
- Should overpass stair clear width be increased beyond 4.0 m a central handrail will be required which will further increase the overall stair width.
- Impact of non-rail pedestrian demand not included in the overpass sizing assessment.

8 Rail Standards and Operations

The Reference Design features aligned, upgraded platforms with level boarding. Platform realignment enhances operational efficiency, improves passenger distribution, and enables phased construction.

8.1 Systems Engineering and Safety Assurance

The Waterloo Station project intends to make significant changes to the existing station and adjoining infrastructure through which this becomes a multifaceted and significant endeavour that integrates infrastructure, technology, services, and human interaction. A project-specific requirements set is recommended to be prepared for project.

A project requirements set serves as the foundational blueprint for any successful project, transforming initial ideas into a structured, actionable plan. It defines the “what,” “why,” and “how” of a project - outlining deliverables, establishing boundaries, and setting criteria for success. By clearly articulating both the scope and exclusions, it prevents scope creep and ensures a shared understanding among stakeholders. This alignment fosters consensus and purposeful work by tying project activities directly to strategic objectives. As a guiding document, the requirements set informs every aspect of design and development, reducing ambiguity and guesswork while enabling deliberate, traceable decisions. It also underpins effective planning and risk management by providing the basis for cost estimates, scheduling, and milestone tracking.

It defines success in measurable terms, forming the foundation for testing, quality assurance, and final acceptance. By capturing needs early and precisely, the requirements set helps prevent costly rework, uncovers issues early, and ultimately ensures that the delivered solution meets expectations. In short, it is the single most important tool for bringing clarity, alignment, and control to a project.

The project requirements set should be a part of a wider systems engineering effort to demonstrate compliance for operating intent and safety.

8.2 Rail-Corridor Impacts

At its core, the primary purpose of a train station is to serve as a gateway and interface between the railway system and the public, facilitating the movement of people. The scope of the project is primarily aimed at undertaking the significant modification of the existing station. The scope and level of the imposition of the changes to the core railway infrastructure must be determined such that adequate design and project management can be applied.

To assist with the imposition, a System Breakdown Structure (SBS) has been prepared (refer to section 8.6) which provides a categorisation of major station and station adjacent elements. Applicable elements are identified and form the preliminary basis upon which the details of this report are structured.

8.3 Impact on Rail Safety Case Impact

Both KiwiRail and the train operator (GWRC) will have a Safety Case in place. The proposed changes to the station will need to be assessed by the respective Safety Case holders for their impact on the assumptions and dependencies that underly these safety cases.

This consultation should be carried out at early in the design phase.

8.4 Transport Authority Standards & Guides

The Wellington regional transport authority, GWRC, were not identified to have a transport infrastructure guide for use in the design of the station.

For reference, Auckland Transport publish Technical Design Manual (TDM), and specifically, the engineering design code for Public Transport – Rail Infrastructure which applies specifically to Auckland Metro commuter railways. There may be an opportunity to leverage this TDM for design aspects of Waterloo Station.

8.5 KiwiRail Standards

Where the project interfaces or interacts with the rail corridor, the project will be required to undertake works commensurate with KiwiRail requirements.

The identification of applicable KiwiRail standards is proposed based on the proposed project SBS. The applicable standards should be agreed with KiwiRail.

The proposed applicable standards are described in section 8.6.

8.6 System Breakdown Structure

A System Breakdown Structure (SBS) is a hierarchical decomposition of a complex system into smaller, more manageable components, sub-systems, and individual elements. It visually represents the entire scope of a project, breaking down high-level functionalities into increasingly detailed and definable parts. Each level of the SBS typically represents a deliverable or a work package, providing a clear and comprehensive overview of all the elements required to complete the system.

An SBS is particularly useful to establish during the Reference Design stage as it facilitates a systematic and structured approach to planning and design. In terms of Waterloo Station, it serves two purposes, it supports with the structuring and allocation of requirement to station elements which in turn, assists with managing systems engineering processes and assurance activities. Secondly, it enables project teams to identify all necessary components, allocate responsibilities, estimate costs more accurately, and manage risks effectively. By providing a common framework for understanding the system, the SBS ensures that all stakeholders have a shared vision of the project's scope, preventing omissions and promoting efficient communication and coordination among various disciplines like civil engineering, electrical systems, signalling, and architectural design. This structured approach helps in defining interfaces between different sub-systems early on, streamlining the design process and laying a solid foundation for subsequent project phases.

Railway stations are complex systems with numerous interacting elements which must adequately perform in order to achieve the operating intent and safety. To support the development approach, an SBS for the Waterloo Station project has been prepared and as shown in Table 8-1.

When the project progresses, the SBS will be the basis for apportioning of requirements to system elements, this in turn will provide a means for undertaking verification and validation activities at the later stages of design and construction.

8.7 Track Alignment

In the first instance, the station modifications should endeavour to avoid impacting or need to modify the existing track alignment. The rationale being that process to move can be time and resource intensive. It is also not expected to be a significant amount of track alignment that would be required to achieve an improved alignment for the station redesign. However, the alignment at the southern end of the proposed station platforms is an issue. The added length places them into the track existing track radius. Whilst it is minimal, it will lead to a separation between the train vehicle and the platform edge for this region as the vehicle navigates the curve.

KiwiRail have a requirement within C-ST-PL-4109, section 6.4, that curved platforms should be avoided.

"*New platforms should be constructed on straight track. Where conditions/service requirements necessitate platforms on curves, the design of each new curved platform must be developed in conjunction with the Operator and design approval sought from KiwiRail*".

The rationale being largely related to the PTI issues, and exposure to collision from derailed trains. The lower limit for platforms on the outside of track curves is 1350m, which the expectation is that this curve radius exceeds this value by a significant amount, though yet to be formally determined. Clarification should be sought from KiwiRail as to their willingness accept a curved platform end (noting that only a part of the platform would need to be a curve) within the design.

If this agreement is not able to be reached, the project will need to coordinate and liaise with KiwiRail to agree to the design for realignment of track at the southern end, in order to achieve a straight alignment.

8.8 Traction Power Impact

An overhead line equipment (OLE) designer, Ralph Moulang (Aurecon) was consulted in order to provide early design input into what needs to be considered early in the design. A variable, as identified in section 8.7, is whether the track alignment will need to be modified through the station. The Traction OLE system needs to follow the track alignment and maintain stagger arrangements accordingly.

If the track alignment remains as is, the imposition on the OLE is minimised. However, if the track is realigned, then the OLE will ned to be adjusted. The OLE designer advised that the current OLE masts were installed circa 2015/16 and have the ability to accommodate movement of the OLE wire without needing to change or upgrade the supporting structures, though this will be assessed and confirmed in concept design.

Regardless of whether the OLE is modified, is the clearance requirements of the OLE structures with overhead structures. KiwiRail standards, require install heights to be at 4800mm, and a 300mm clearance margin. The caveat with this however, is that the as-built current OLE arrangements at the site need to be confirmed. KiwiRail have been approached to provide the current as-built information, so that the pedestrian overbridge design can be adequately informed.

Please note that the Wellington Electrified Area (WEA) uses a DC electrical system for traction power. This does have an influence on the electrical design of railway structures, particularly around the earthing and bonding arrangement that are adopted within the structures.

8.9 Signalling Design

Within the station, and within the scope of works is an existing signalling hut. This will need to be moved to alternative point. This will need to be agreed with KiwiRail.

Where the signalling hut is relocated, the interconnections and routing for the signalling will need to be modified. The impact and scope of this should be assessed early and must be done in consultation with KiwiRail who will in turn, should consult Siemens who are the contracted party for the signalling design.

The repositioning of the platforms will modify the stopping locations for train at the station. The signalling design will need to be updated regardless of whether the alignment is modified or not. Siemens, as contracted by KiwiRail will be responsible for implementing the final changes into the signalling control system, noting the distinction between the physical equipment and the software-based control systems and software. The Signal Sighting Committee must be consulted early to confirm suitability of wayside signal locations.

There is a possibility that derogations exist at the site for the underground signalling routings. Caution should be applied to review whether a difference exists between the 'as-built' information and actual physical install location.

8.10 Platforms

According to the KiwiRail Property GIS, the existing platforms are owned by KiwiRail. Any modifications to these platforms should be with the permission of KiwiRail. In addition, the eventual ownership of the completed platforms should be agreed.

The proposed platform design is the result of a necessity to avoid conflict between the existing water treatment plant, which is located at the north. The proposed platform design is also the result of a necessity to balance the spatial requirements on either side of the alignment, and the functions the station is expected to provide (e.g., intermodal connections, etc.).

As discussed in section 8.7, due to the platform lengths being proposed, the platforms will encroach into the track curve at the southern end. As previously mentioned, agreement from KiwiRail to implement partial platform curves should be received.

The platform coping edges are an important aspect of the platform design as they are the direct interface between the train vehicle and the platform. The current intent is to comply with the requirements provided in C-ST-PL-4109, which identifies the clearance requirements, and the layout of edge markings, which comprises a 300mm wide white painted line along the platform edge, with TGSI, at a minimum of 1200mm from platform edge; and printed in yellow "Wait behind this line until train has stopped". This edge arrangement should be confirmed with KiwiRail. Note also that the coping edge design should be consistent with other stations along the network to ensure familiarity by rail users.

8.11 Pedestrian Bridge

The proposed pedestrian bridge will need to comply with the KiwiRail clearance requirements for structures next to the rail corridor.

Per section 8.8, the pedestrian bridge will also need to comply with the traction power system requirements.

8.12 Existing Underpass

Under the proposed design, the existing underpass which provides a grade separated means for getting across the rail corridor, would be replaced by the pedestrian bridge.

A decision will need to be made around what is to happen to the structure. There is an opportunity to repurpose it to be an undertrack crossing for station services. If this opportunity is not availed, a decision would need to be made around whether it would be to sustain it as is though without general access, or whether it is abandoned. If the decision is to abandon it, a decision would need to be made as to whether to backfill it or to remove it. An unmaintained subterranean asset poses a structural failure hazard to the track formation above. This decision should be made in consultation with KiwiRail.

Table 8-1: Proposed Station SBS

SBS L1 ID	SBS L1	SBS L2 ID	SBS L2	App.	Description	KiwiRail Standards
SBS-1	Rail Vehicles			N/A		N/A
SBS-1	Rail Vehicles	SBS-1.1	Commuter & Passenger Trains	N/A		N/A
SBS-1	Rail Vehicles	SBS-1.2	Freight Train	N/A		N/A
SBS-1	Rail Vehicles	SBS-1.3	Trailer Vehicle Subsystems	N/A		N/A
SBS-1	Rail Vehicles	SBS-1.4	Engineering Vehicle Subsystems (EVSs)	N/A		N/A
SBS-2	Railway Operations, Management, & Control			N/A		N/A
SBS-2	Railway Operations, Management, & Control	SBS-2.1	Automatic Train Protection	N/A		N/A
SBS-2	Railway Operations, Management, & Control	SBS-2.2	Automatic Train Operation	N/A		N/A
SBS-2	Railway Operations, Management, & Control	SBS-2.3	Automatic Train Supervision	N/A		N/A
SBS-2	Railway Operations, Management, & Control	SBS-2.4	Automatic Despatch	N/A		N/A
SBS-2	Railway Operations, Management, & Control	SBS-2.5	Operations and Management	N/A		N/A
SBS-3	Railway Infrastructure			N/A		
SBS-3	Railway Infrastructure	SBS-3.1	Ground System (including track substructures)	App.	Applicable to track formation, track drainage etc.	C-ST-FO-4110 Formation
SBS-3	Railway Infrastructure	SBS-3.2	Track System (including Trackwork Equipment)	App.	Applicable to all track superstructure.	T-ST-DE-5200 Track Design T-ST-AM-5400 T200 Network Engineering Track Handbook T-ST-DE-5212 Clearances C-ST-CD-4102 Corridor Drainage
SBS-3	Railway Infrastructure	SBS-3.3	Signalling Systems & Infrastructure	App.	Applicable to signal equipment, structures and routing	T-ST-DE-5212 Clearances
SBS-3	Railway Infrastructure	SBS-3.4	Traction Power Systems Overhead Lines Equipment	App.	Applicable to OLE structures, Catenary wire system, power distribution networks.	E-SP-WE-61330 WEA Traction Overhead Design Specification E-ST-WE-0137 WEA DC Protection E-ST-WE-0115 WEA Earthing _ Bonding Design E-ST-WE-0114 WEA Asset Manual T-ST-DE-5212 Clearances
SBS-3	Railway Infrastructure	SBS-3.5	Rail Level Crossings	N/A		

SBS L1 ID	SBS L1	SBS L2 ID	SBS L2	App.	Description	KiwiRail Standards	
SBS-3	Railway Infrastructure	SBS-3.6	Tunnels (train)	N/A			
SBS-3	Railway Infrastructure	SBS-3.7	Tunnels (Road-Under-Rail)	N/A			
SBS-3	Railway Infrastructure	SBS-3.8	Underpass (Pedestrian)	App.	Applicable to the existing pedestrian underpass	B-PR-GE-3011 Structure Principles	
SBS-3	Railway Infrastructure	SBS-3.9	Pedestrian Bridges	App.		Applicable if an above-grade pedestrian crossing is introduced.	T-ST-DE-5212 Clearances B-PR-GE-3011 Structure Principles
SBS-3	Railway Infrastructure	SBS-3.10	Road-over-Rail Bridges	N/A			
SBS-3	Railway Infrastructure	SBS-3.11	Rail-under-Road Bridge (Underpass)	N/A			
SBS-3	Railway Infrastructure	SBS-3.12	Rail Bridges	N/A			
SBS-3	Railway Infrastructure	SBS-3.13	Barriers (Protective), Barriers (Noise), Fencing,	N/A			
SBS-3	Railway Infrastructure	SBS-3.14	Earth Retention Systems	N/A			
SBS-3	Railway Infrastructure	SBS-3.15	Wayside Structures (Including Natural Features, Formations, and Urban Realm)	App.		Applicable to fences and hedges. (no additional wayside structures identified.	T-ST-DE-5212 Clearances
SBS-3	Railway Infrastructure	SBS-3.16	Ventilation and Environmental Control Structures	N/A			
SBS-3	Railway Infrastructure	SBS-3.17	Networks, Services and Utilities (Traction/ Non-Traction) (Including Support Buildings and Structures)	App.		Nothing identified.	S-ST-CW-2140 Construction of Cable Duct Routes C-ST-CD-4102 Corridor Drainage C-SP-AE-64322 Installation of Utility Structures on Railway Land

SBS L1 ID	SBS L1	SBS L2 ID	SBS L2	App.	Description	KiwiRail Standards
SBS-4	Railway Stations			APPL.	Applicable to station operational requirements (CONOPS, OPSCON etc.).	
SBS-4	Railway Stations	SBS-4.1	Station Buildings	N/A		
SBS-4	Railway Stations	SBS-4.2	Concourse	N/A		
SBS-4	Railway Stations	SBS-4.3	Platforms	App.	Applicable to platforms	C-ST-PL-4109 Passenger Platforms B-PR-GE-3011 Structure Principles T-ST-DE-5212 Clearances
SBS-4	Railway Stations	SBS-4.4	Retail & Commercial buildings	App.	Applicable to concession stands, leased building space within the station area.	None.
SBS-4	Railway Stations	SBS-4.5	Intermodal Facilities - Bus Stations/ Terminals	App.	Applicable to the bus stops provided at the station.	None.
SBS-4	Railway Stations	SBS-4.6	Intermodal Facilities - Train Terminals (Other)	N/A		
SBS-4	Railway Stations	SBS-4.7	Intermodal Facilities - Parking Facilities	App.	Applicable to the public car parking space provided at the site.	None.
SBS-4	Railway Stations	SBS-4.8	Intermodal Facilities - Personal Mobility Systems	N/A		
SBS-5	Railway Facilities			N/A		
SBS-5	Railway Facilities	SBS-5.1	Yards	N/A		
SBS-5	Railway Facilities	SBS-5.2	Depots	N/A		
SBS-5	Railway Facilities	SBS-5.3	Freight Terminals (including Sidings)	N/A		
SBS-5	Railway Facilities	SBS-5.4	Train Control Operations Centre	N/A		
SBS-6	Civil Networks, Services, & Utilities			N/A		
SBS-6	Civil Networks, Services, & Utilities	SBS-6.1	Electrical Infrastructure (Utility) (including Structures)	N/A		
SBS-6	Civil Networks, Services, & Utilities	SBS-6.2	Gas Utilities	N/A		

SBS L1 ID	SBS L1	SBS L2 ID	SBS L2	App.	Description	KiwiRail Standards
SBS-6	Civil Networks, Services, & Utilities	SBS-6.3	Lighting Installations	N/A		
SBS-6	Civil Networks, Services, & Utilities	SBS-6.4	Wastewater Utilities & Systems (including Structures)	N/A		
SBS-6	Civil Networks, Services, & Utilities	SBS-6.5	Stormwater Utilities & Systems (including Structures)	N/A		
SBS-6	Civil Networks, Services, & Utilities	SBS-6.6	Potable Water Utilities (including Structures)	App.	Applicable to Waterloo Water Treatment Plant.	None. Note: Should comply wit the clearance requirements T-ST-DE-5212 Clearances
SBS-6	Civil Networks, Services, & Utilities	SBS-6.7	Telecommunications Networks and Services (including Structures)	App.	Mobile service operators have existing infrastructure installed at the site.	None.
SBS-6	Civil Networks, Services, & Utilities	SBS-6.8	Services, Networks, Utilities & Routing (including Structures)	App.	Applicable to underground power, water, telephony services. (Note: to confirm what is present)	None.
SBS-7	Civil Infrastructure			N/A		
SBS-7	Civil Infrastructure	SBS-7.1	Ground System	App.	Applicable to ground structures for non-rail corridor aspects.	N/A
SBS-7	Civil Infrastructure	SBS-7.2	Ground Improvement System	N/A		
SBS-7	Civil Infrastructure	SBS-7.3	Earth Retention Systems	N/A		
SBS-7	Civil Infrastructure	SBS-7.4	Tunnels (Vehicle)	N/A		
SBS-7	Civil Infrastructure	SBS-7.5	Underpasses	N/A		
SBS-7	Civil Infrastructure	SBS-7.6	Pedestrian Bridges	N/A	The pedestrian bridge being included in design is considered as a rail pedestrian bridge due to its primary purpose being a grade separated crossing of the railway.	
SBS-7	Civil Infrastructure	SBS-7.7	Road Bridges (Road over Road, Road over Ground etc.)	N/A		
SBS-7	Civil Infrastructure	SBS-7.8	Barriers (protective), Barriers (noise), Fencing,	N/A		
SBS-7	Civil Infrastructure	SBS-7.9	Parks and Recreational Areas	N/A		
SBS-7	Civil Infrastructure	SBS-7.10	Landscaping and Urban Realm features	App.	Applicable to station area and interfaced area.	None.
SBS-8	Roads and Accessways			N/A		
SBS-8	Roads and Accessways	SBS-8.1	Accessways	App.	Applicable to the road vehicle movement routes within the station boundary.	
SBS-8	Roads and Accessways	SBS-8.2	Highways & Roadways	N/A		

SBS L1 ID	SBS L1	SBS L2 ID	SBS L2	App.	Description	KiwiRail Standards
SBS-8	Roads and Accessways	SBS-8.3	Public Transport Systems	N/A		
SBS-8	Roads and Accessways	SBS-8.4	Pedestrian and Cycle Infrastructure	N/A		
SBS-10	Railside Civil Assets (non-rail or civil infrastructure-related)	N/A				
SBS-10	Railside Civil Assets (non-rail or civil infrastructure-related)	SBS-10.1	Building Structures - Large Commercial	N/A		
SBS-10	Railside Civil Assets (non-rail or civil infrastructure-related)	SBS-10.2	Buildings - Small Commercial	App.	Applicable to the station	None.
SBS-10	Railside Civil Assets (non-rail or civil infrastructure-related)	SBS-10.3	Buildings - Small Residential	N/A		
SBS-10	Railside Civil Assets (non-rail or civil infrastructure-related)	SBS-10.4	Buildings - Large Residential	N/A		
SBS-10	Railside Civil Assets (non-rail or civil infrastructure-related)	SBS-10.5	Building Structures - Utilities	N/A		
SBS-10	Railside Civil Assets (non-rail or civil infrastructure-related)	SBS-10.6	Open Area - Car Parking facilities (excluding multi-storey parking structures)	N/A	Covered by SBS-4.7 Intermodal Facilities - Parking Facilities	None.
SBS-10	Railside Civil Assets (non-rail or civil infrastructure-related)	SBS-10.7	Open area - Storage Area/ Facility	N/A		
SBS-10	Railside Civil Assets (non-rail or civil infrastructure-related)	SBS-10.8	Open area - Parkland	N/A		
SBS-10	Railside Civil Assets (non-rail or civil infrastructure-related)	SBS-10.9	Open Area - Other	N/A		
SBS-10	Railside Civil Assets (non-rail or civil infrastructure-related)	SBS-10.10	Other	N/A		

9 Summary of Key Findings

The Reference Design represents the optimal outcome for Waterloo Station when assessed through a multimodal, integrated network lens. It performs most strongly against the project's strategic objectives by enabling mode shift, enhancing network legibility and accessibility, and supporting future urban form through Transit Oriented Development (TOD).

A Seamless, Legible Multimodal Interchange

From a network planning perspective, the Reference Design delivers the highest level of service for passengers through an aligned platform configuration, enabling intuitive and legible movement through the station. The simplification of vertical circulation elements - via a short overbridge and surface-level pedestrian crossing - creates clear desire-line alignment between bus stops, entrances and platforms. These connections minimise interchange times and reduce system friction for transfers between bus and rail modes, directly supporting patronage growth.

The design is structured to accommodate growing complexity in user journeys, including those involving walking, cycling, micromobility, and on-demand services. The Reference Design supports Metlink's station hierarchy and Greater Wellington's access prioritisation framework, positioning Waterloo as a true modal hub for Lower Hutt.

Supports Mode Shift and Urban Integration

The Reference Design supports mode shift objectives by co-locating upgraded bus facilities directly adjacent to the primary station entrance, reducing first/last mile barriers and enabling fast, convenient transfers. The eastern interchange is fully integrated into the station forecourt, while the western interchange is retained and enhanced to maintain operational flexibility. By reducing physical and cognitive effort associated with mode changes, The Reference Design reinforces public transport's competitiveness with private car travel - particularly for passengers from Wainuiomata, Naenae and Kelson, where seamless transfers are essential to viable network journeys.

Future-Ready and Scalable

The Reference Design is demand-led and appropriately futureproofed. Station sizing reflects high-growth scenarios informed by Sense Partners projections and tested through detailed static pedestrian modelling. The platform widths, vertical circulation, and validation infrastructure are specified to accommodate projected patronage in 2046 and 2061, while allowing for future upgrade pathways without major rebuild. This option preserves flexibility to accommodate changes in network operating patterns - such as Bus Replacing Train (BRT) operations or demand-responsive feeder services - providing resilience for future service models and changes in the way people travel.

Aligning Design with Rail Standards and Operational Requirements

The Reference Design for Waterloo Station establishes a robust foundation for implementation, balancing operational efficiency, rail integration, and system assurance requirements. While the design achieves key outcomes such as aligned platforms and compact interchange layout, it also introduces significant interface complexities with the rail corridor. A suite of further technical work is clearly understood, including the development of a project-specific requirements set, systems engineering processes, and early consultation with KiwiRail on signalling, safety case variation, track alignment, traction power, and platform geometry. These activities will be critical to managing delivery risks, ensuring compliance, and progressing confidently toward a buildable, consentable and certifiable design solution.

The Next Steps are Well Understood

Several aspects of the station access and interchange design require further refinement in collaboration with Hutt City Council, particularly where proposed changes affect the local road network. This includes the final location and configuration of on road bus stops. Similarly, the design of pedestrian crossings will be refined to align with council and NZTA standards.

In parallel, more detailed assessment is needed to confirm the wider traffic and network effects of the proposed changes. This includes signal phasing design (especially at Cambridge Terrace), and a network impact assessment to test safety, congestion, and multimodal integration to inform design refinement.

Appendix A
Forecast Demand Technical Memo

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Memorandum

To	s7(2)(a) [redacted]	From	s7(2)(a) [redacted]
Copy	**Emmet McElhatton**	Reference	**528886**
Date	**2025-07-17**	Pages (including this page)	**37**
Subject	**Waterloo Station Pedestrian Modelling Memo**		

1 Introduction

To support the Waterloo Station feasibility study, static pedestrian modelling has been undertaken to inform initial station sizing and planning.

This memo details the sources of data, assumptions, limitations and exclusions, future year passenger demands development, the equations used, and the results of the static pedestrian modelling.

Static pedestrian modelling has been undertaken using passenger demand forecasts for a Design Year of 2046 (representing an indicative Rail Day One plus 15-years) and an Ultimate Design Year of 2061 (representing an indicative Rail Day One plus 30-years).

The memo includes an assessment of the preferred design option, Option 17, in terms of Level of Service performance of the proposed station element provisions over time (from Rail Day One to Rail Day One plus 30-years).

Note, numbers in this memo may not sum to the totals due to rounding.

2 Sources

Static pedestrian modelling has been informed by the reference documents and standards in Table 2.1.

Table 2.1 Reference documents

Document	Revision
Waterloo Transit Oriented Development – Public Transport Minimum Requirements	First Issue (10/04/2025)
Auckland Transport – Transport Design Manual – Engineering Design Code – Public Transport – Rail Infrastructure	Version 2
Design for Access and Mobility – Buildings and Associated Facilities	NZS 4121:2001
Metro Trains Melbourne – Stations and Public Precincts Standards – A1530	Version 5.0
Transport for New South Wales – Functional Spaces – Part 2 Stations – TS 04951.2:1.0	Version 1.0
Hong Kong MTR Corporation – New Works Design Standards Manual – Section 5 – Architecture and Station Planning	Revision A9
Waterloo B&A.xlsx	Version 1
Waterloo-Station-TOTO-15min_2024-03-11-to-2024-03-17 FIXED.xlsx	Version 2

3 Station layout

While the station layout has not been finalised, for the purpose of static pedestrian modelling a side platform arrangement has been assessed, with an indicative arrangement shown in Figure 3-1.

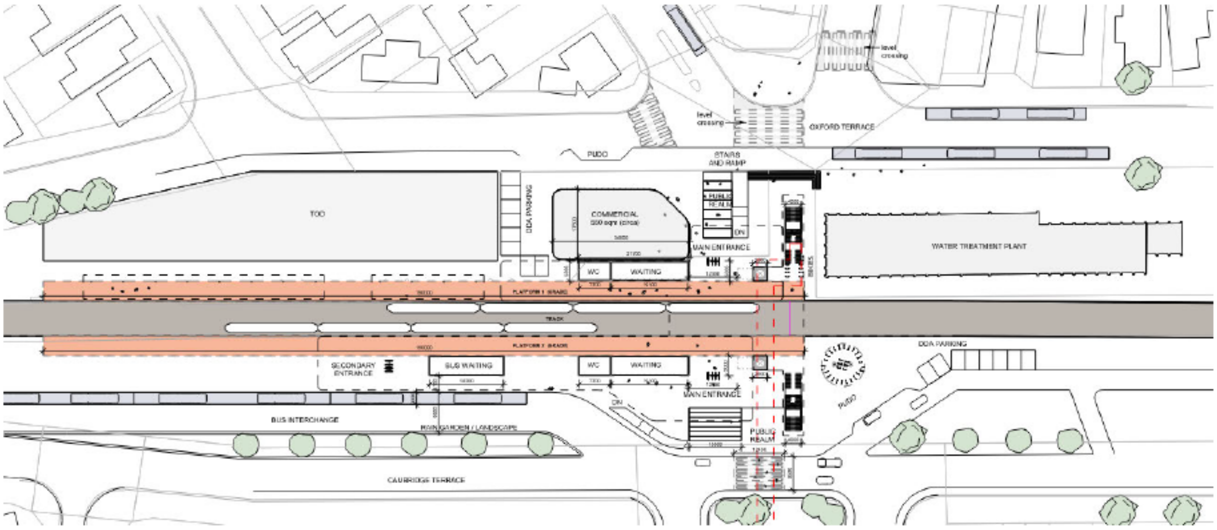


Figure 3-1 Indicative Waterloo Station side platform arrangement (Option 17)

4 Assumptions and data inputs

4.1 Assumptions

Assumptions adopted to undertake the static pedestrian modelling are provided in Table 4.1.

Table 4.1 Assumptions

Assumption	Value	Unit	Source
Peak 5-minute factor	0.4		Section 13 - Auckland Transport – Transport Design Manual – Engineering Design Code – Public Transport – Rail Infrastructure
Peak minute boarding factor	0.2		Section 2.2 - Waterloo Transit Oriented Development – Public Transport Minimum Requirements
Morning peak hour Hutt Valley Line train services	8	trains / hour / direction	Waterloo B&A
	7.5	minutes	
Morning peak hour Wairarapa Line train services	2	trains / hour / direction	Waterloo B&A
	30	minutes	
Evening peak hour Hutt Valley Line train services	8	trains / hour / direction	Waterloo B&A
	7.5	minutes	
	2	trains / hour / direction	Waterloo B&A

Assumption	Value	Unit	Source
Evening peak hour Wairarapa Line train services	30	minutes	
Hutt Valley Line alighting peak concentration	80	per cent	Section 2.2 - Waterloo Transit Oriented Development – Public Transport Minimum Requirements
Wairarapa Line alighting peak concentration	60	per cent	Section 2.2 - Waterloo Transit Oriented Development – Public Transport Minimum Requirements
Delayed service factor[1]	125	per cent	Section 2.2 - Waterloo Transit Oriented Development – Public Transport Minimum Requirements
Normal operation staircase flow rate	28	people / minute / metre	Table 15 - Auckland Transport – Transport Design Manual – Engineering Design Code – Public Transport – Rail Infrastructure
Degraded operation staircase flow rate	35	people / minute / metre	Table 15 - Auckland Transport – Transport Design Manual – Engineering Design Code – Public Transport – Rail Infrastructure
Staircase minimum clear width	1.2	m	Table 5 - Auckland Transport – Transport Design Manual – Engineering Design Code – Public Transport – Rail Infrastructure
Normal operation passageway flow rate	40	people / minute / metre	Table 15 - Auckland Transport – Transport Design Manual – Engineering Design Code – Public Transport – Rail Infrastructure
Degraded operation passageway flow rate	50	people / minute / metre	Table 15 - Auckland Transport – Transport Design Manual – Engineering Design Code – Public Transport – Rail Infrastructure
Passageway minimum clear width	1.8	m	Figure D10 – Design for Access and Mobility – Buildings and Associated Facilities – NZS 4121:2001
Snapper card gate flow rate	25	people / minute / scanner	Table 9 - Metro Trains Melbourne – Stations and Public Precincts Standards – A1530 Section 6.2.5 - Transport for New South Wales – Functional Spaces – Part 2 Stations – TS 04951.2:1.0
Snapper card gate redundancy	1	scanner (if less equal to or less than ten gates)	Section 14 - Auckland Transport – Transport Design Manual – Engineering Design Code – Public Transport – Rail Infrastructure
	2	scanner (if greater than ten gates)	
Minimum Snapper card gate provision	3	Gates (per access point to the paid area)	Section 14 - Auckland Transport – Transport Design Manual – Engineering Design Code – Public Transport – Rail Infrastructure
Normal operation platform density	0.8	m^2 / person	Table 15 - Auckland Transport – Transport Design Manual – Engineering Design Code – Public Transport – Rail Infrastructure
Degraded operation platform density	0.45	m^2 / person	Table 15 - Auckland Transport – Transport Design Manual – Engineering Design Code – Public Transport – Rail Infrastructure

Assumption	Value	Unit	Source
Platform length	190	m	Section 2.6 - Waterloo Transit Oriented Development – Public Transport Minimum Requirements
Minimum platform width	5.0	m	Section 2.6 - Waterloo Transit Oriented Development – Public Transport Minimum Requirements
Platform distribution (Busiest quarter of platform)	35	per cent	Section 13 - Auckland Transport – Transport Design Manual – Engineering Design Code – Public Transport – Rail Infrastructure
Platform edge effect	1.0	m	Section 13 - Auckland Transport – Transport Design Manual – Engineering Design Code – Public Transport – Rail Infrastructure
Passageway edge effect	0.6	m	Section 14 - Auckland Transport – Transport Design Manual – Engineering Design Code – Public Transport – Rail Infrastructure
Cambridge Terrace (inbound) Station Forecourt Entrance split	17	per cent	Assumption
Cambridge Terrace (inbound) Entrance split	17	per cent	Assumption
Oxford Terrace (outbound) Entrance split	67	per cent	Assumption
Station entrance split uncertainty design factor	75	per cent	Clause 5.1.4.2 Hong Kong MTR Corporation – New Works Design Standards Manual – Section 5 – Architecture and Station Planning
1. The station elements have been designed to achieve the target flows rates for normal operation (i.e. achieving pedestrian level of service C) which does not account for a delayed service. The delayed services has been assessed based on the resultant widths for normal operation and checked against flow rates for degraded operation (i.e. achieving pedestrian level of service D).			

The station entrance split assumptions from Table 4.1 are show illustratively in Figure 4-1.

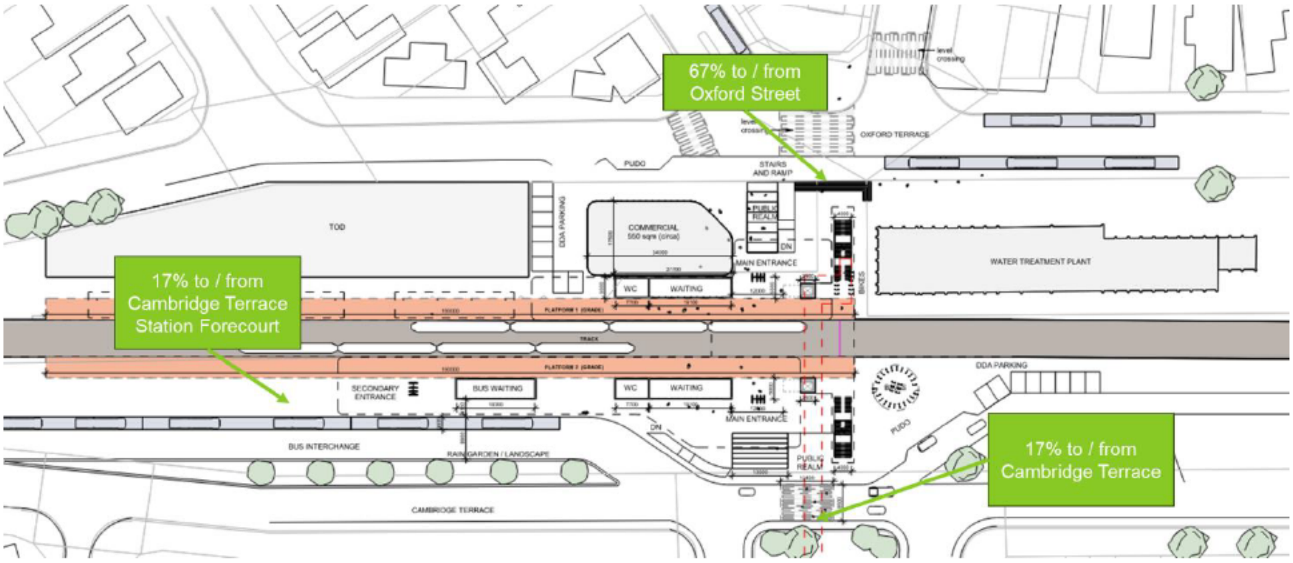


Figure 4-1 Waterloo Station assumed entrance splits

4.2 Existing passenger demand

Snapper data for 11 March to 17 March 2024 was analysed for the morning peak (06:00 to 09:00) and evening peak (15:00 to 18:00) to understand existing rail passenger demands and arrival / departure profiles for Waterloo Station.

March was adopted for the assessment as it represents the 'busy' month as shown in Figure 4-2 and is the month commonly used for Metlink service and investment planning

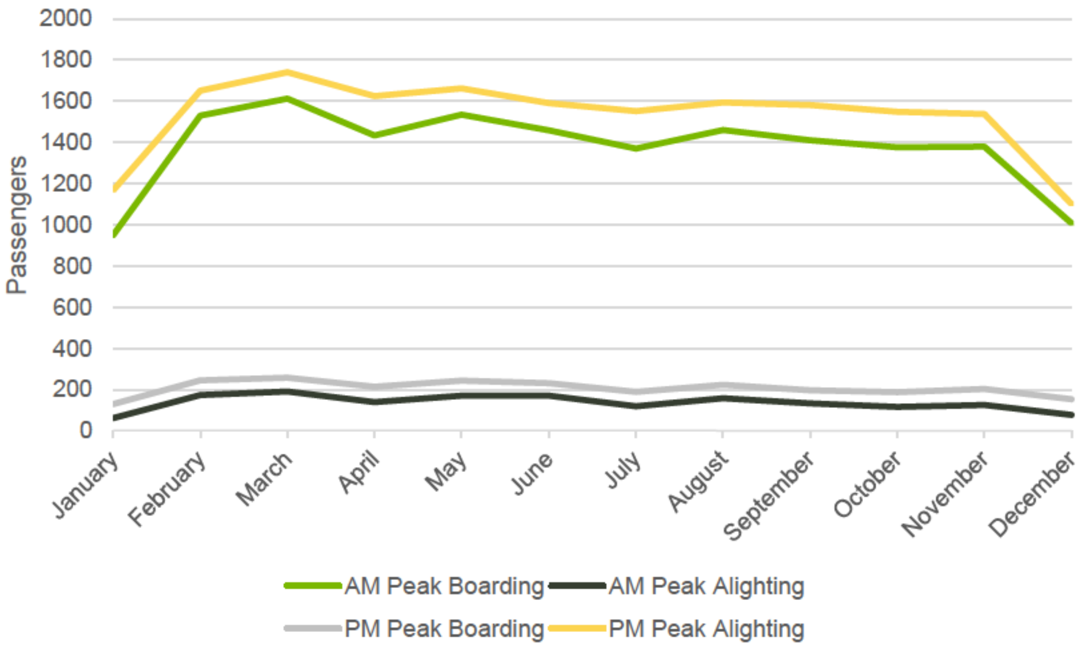


Figure 4-2 Waterloo Station year 2024 weekday daily average boarding and alighting volumes per month

Due to work from home behaviours, data for Monday and Friday was excluded from the assessment as the passenger demands were notably lower than other weekdays. In addition, weekend data was also excluded from the assessment due to lower passengers demands.

The average passenger boarding and alighting demands were therefore based on the data for Tuesday, Wednesday, and Thursday and separated by the Hutt Valley Line (HVL) and Wairarapa Line (WRL).

Passenger demands for the HVL are shown in Figure 4-3 and Figure 4-4, and passenger demands for the WRL are shown in Figure 4-5 and Figure 4-6. The data shows tidal passenger flows, with high inbound (towards Wellington CBD) in the morning and high outbound flows (away from Wellington CBD) in the evening. In addition, with the higher train frequency of the HVL (versus the WRL), the HVL receives most of the passenger demand.

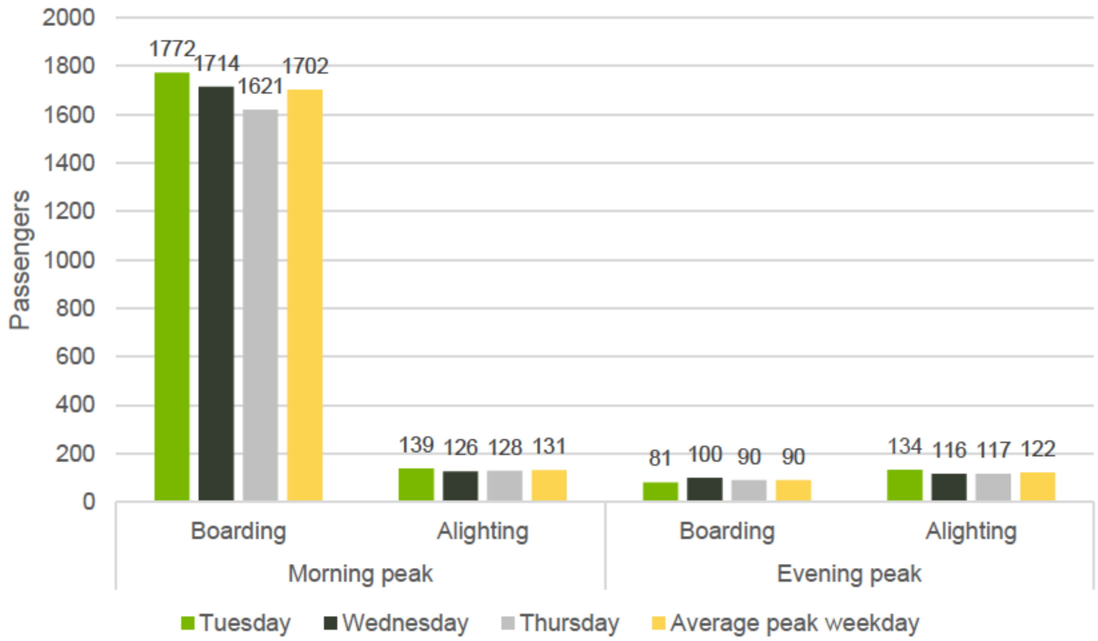


Figure 4-3 Hutt Valley Line (inbound) existing morning and evening 3-hour peak passenger demands

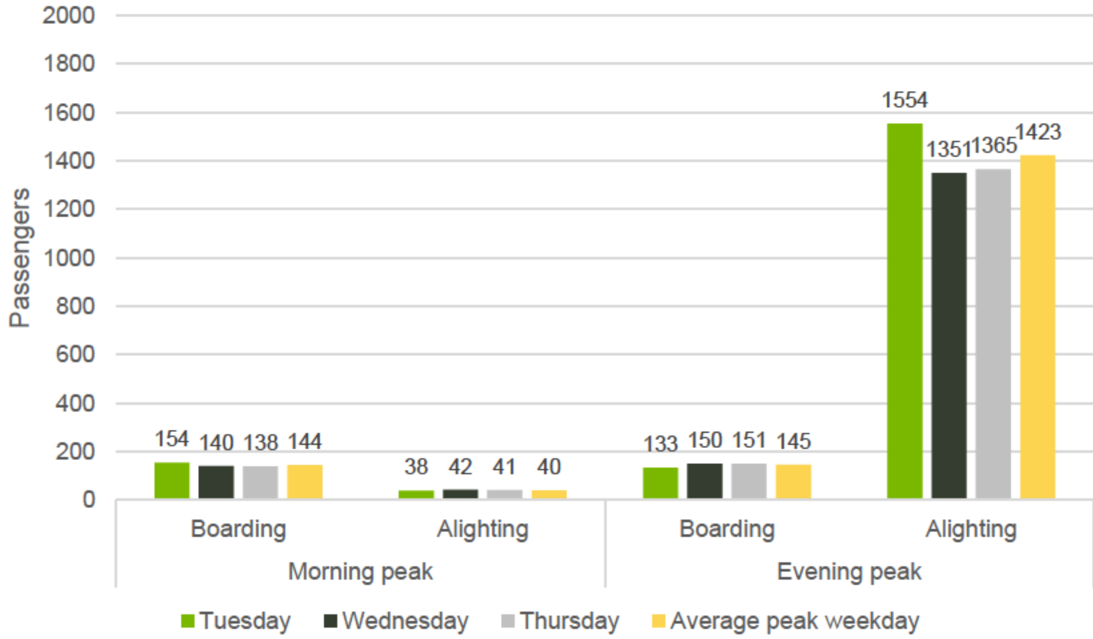


Figure 4-4 Hutt Valley Line (outbound) existing morning and evening 3-hour peak passenger demands

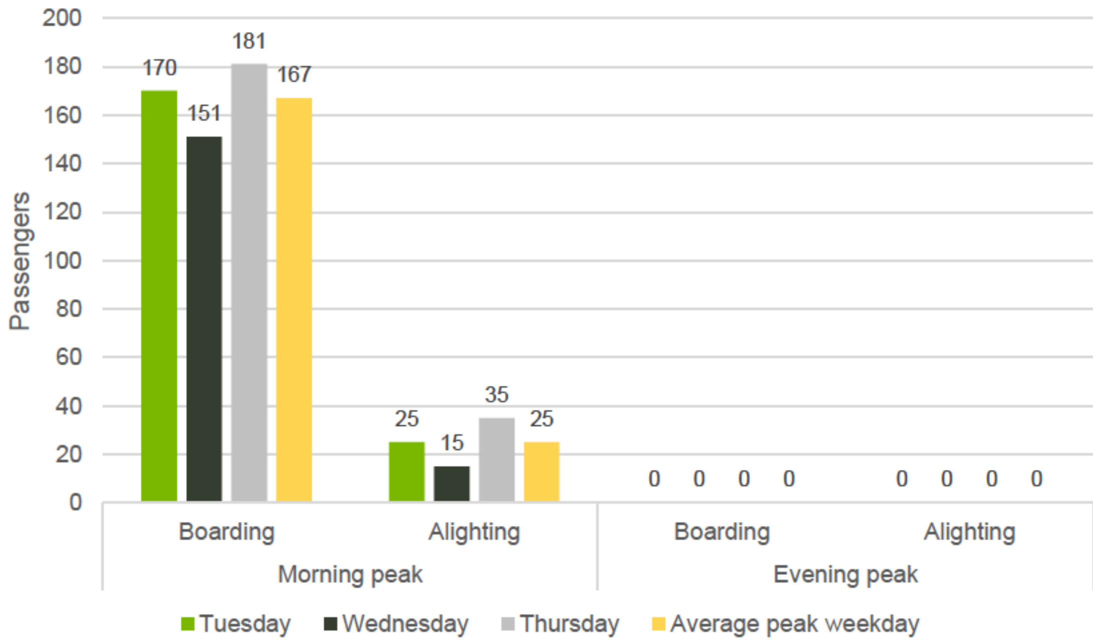


Figure 4-5 Wairarapa Line (inbound) existing morning and evening 3-hour peak passenger demands

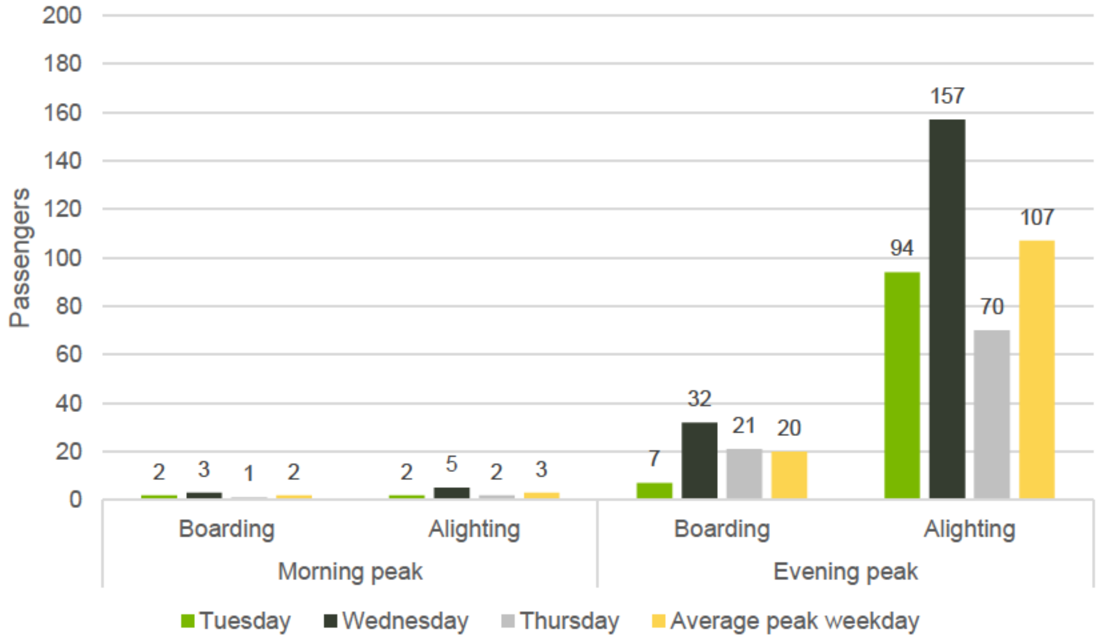


Figure 4-6 Wairarapa Line (outbound) existing morning and evening 3-hour peak passenger demands

4.2.1 Passenger demand distributions

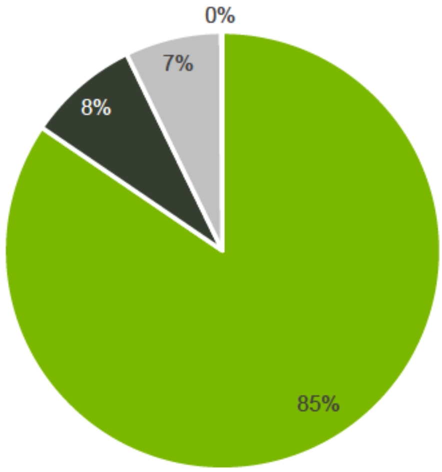
The existing passenger demand distributions between the HVL and WRL for inbound and outbound services are shown in Table 4.2 and Table 4.3 for the morning and evening peaks respectively. The results show the majority of boarding and alighting in the morning peak to be to/from HVL inbound services. While for the evening peak the majority of boarding and alighting is to/from HVL outbound services.

These existing distributions were applied to the future passengers demands (see Section 4.2.2) due to the observed data being more suitable than using the modelled spits.

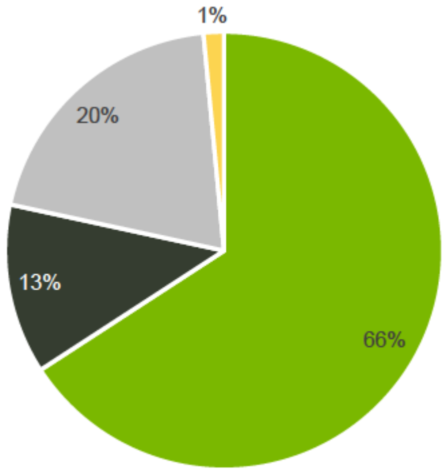
Table 4.2 Morning 3-hour peak passenger demand distributions

Boarding	Alighting

Boarding

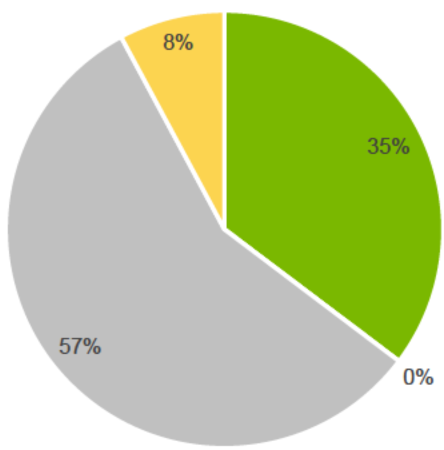


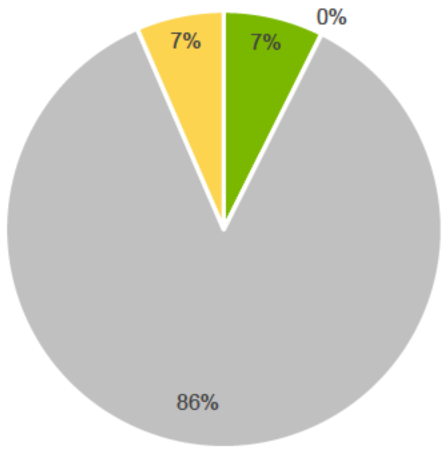
Alighting



Hutt Valley Line (Inbound)
Wairarapa Line (Inbound)
Hutt Valley Line (Outbound)
Wairarapa Line (Outbound)

Table 4.3 Evening 3-hour peak passenger demand distributions

<table>
<tr><th>Boarding</th><th>Alighting</th></tr>
<tr><td>


</td><td>


</td></tr>
<tr><td colspan="2">
Hutt Valley Line (Inbound)
Wairarapa Line (Inbound)
Hutt Valley Line (Outbound)
Wairarapa Line (Outbound)
</td></tr>
</table>

4.2.2 Passenger demand profiles

Passenger demand profiles were obtained from the existing Snapper data to understand the proportion of passengers across the morning and evening 3-hour time periods boarding and alighting train services in 15-minute intervals.

The existing profile was then applied to the future year data to identify the peak 15-minute boarding and alighting demands to undertake the static pedestrian modelling.

Hutt Valley Line

The HVL shows relatively even distribution of boarding demand throughout the morning and evening 3-hour periods with the typical peak 15-minute boarding demand representing approximately 18 per cent of the total 3-hour demand (see Figure 4-7 and Figure 4-9).

For alighting passenger profile, both the morning and evening peaks show clear spikes, likely correlating with the train timetable. The morning peak 15-minutes represents 36 per cent of the 3-hour alighting demand and the evening peak 15-minutes represents 23 per cent (see Figure 4-8 and Figure 4-10).

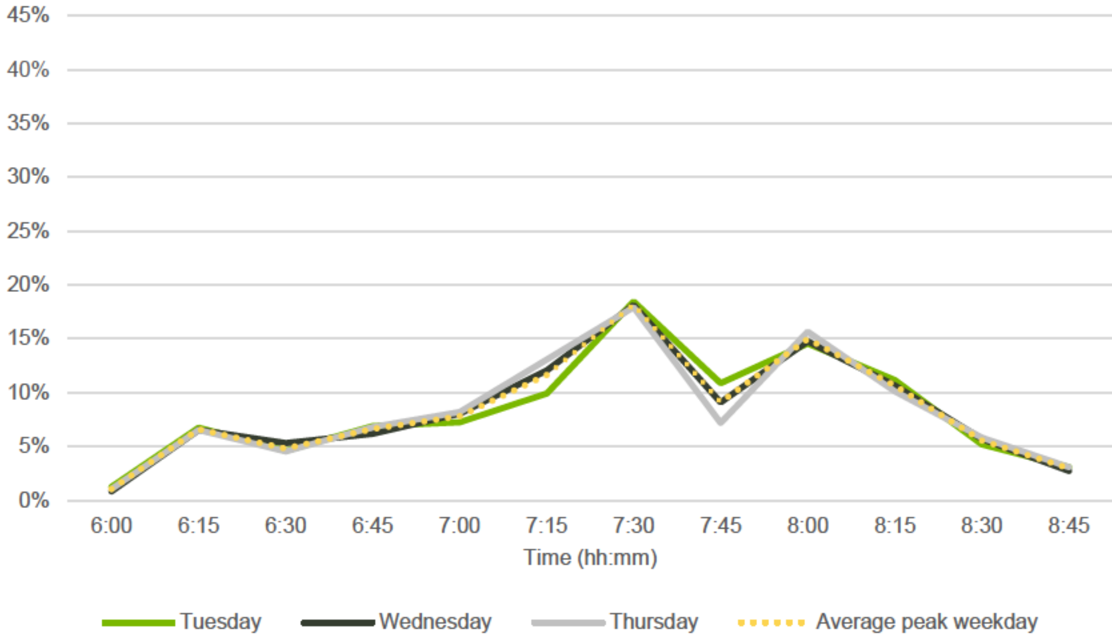


Figure 4-7 Hutt Valley Line morning peak passenger boarding profile

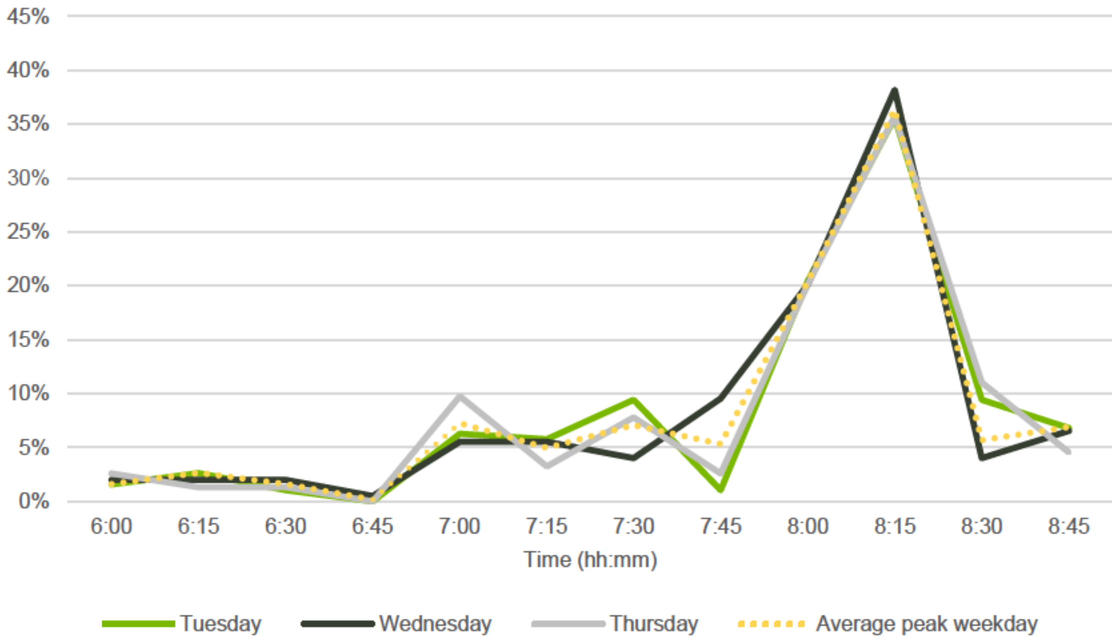


Figure 4-8 Hutt Valley Line morning peak passenger alighting profile

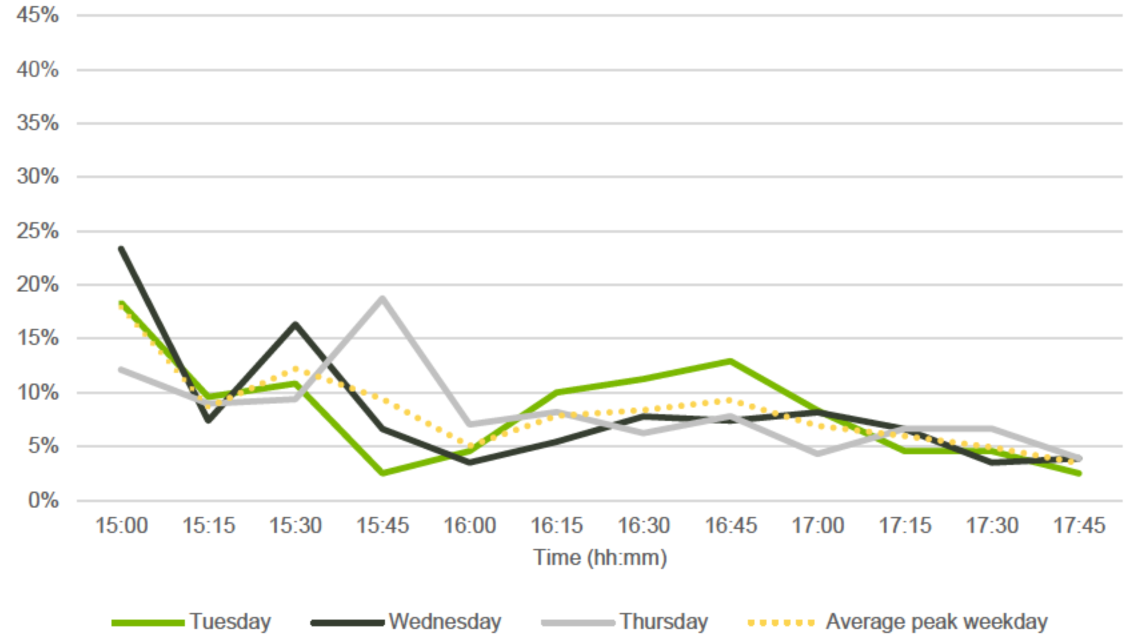


Figure 4-9 Hutt Valley Line evening peak passenger boarding profile

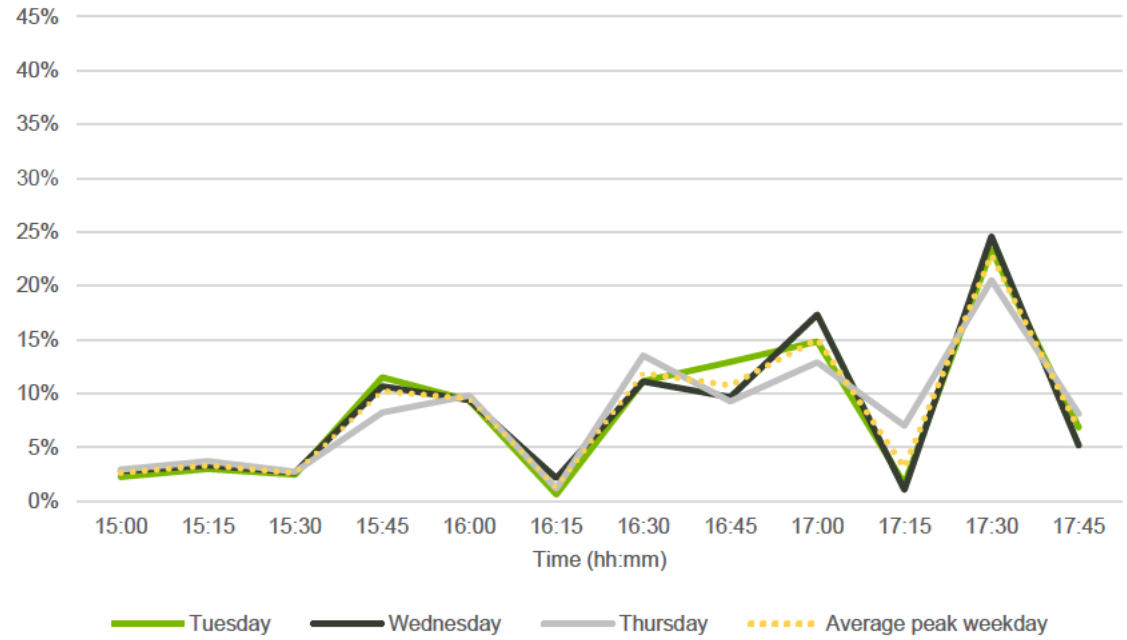


Figure 4-10 Hutt Valley Line evening peak passenger alighting profile

Wairarapa Line

The WRL shows peaks in boarding demand likely coinciding with timetabled train arrivals (with trains approximately every 30 minutes. The morning peak 15-minutes represents 62 per cent of the 3-hour alighting demand and the evening peak 15-minutes represents 46 per cent (see Figure 4-11 and Figure 4-13).

The alighting passenger profile also shows clear spikes, likely correlating with the train timetable. The morning peak 15-minutes represents 43 per cent of the 3-hour alighting demand and the evening peak 15-minutes represents 50 per cent (see Figure 4-12 and Figure 4-14).

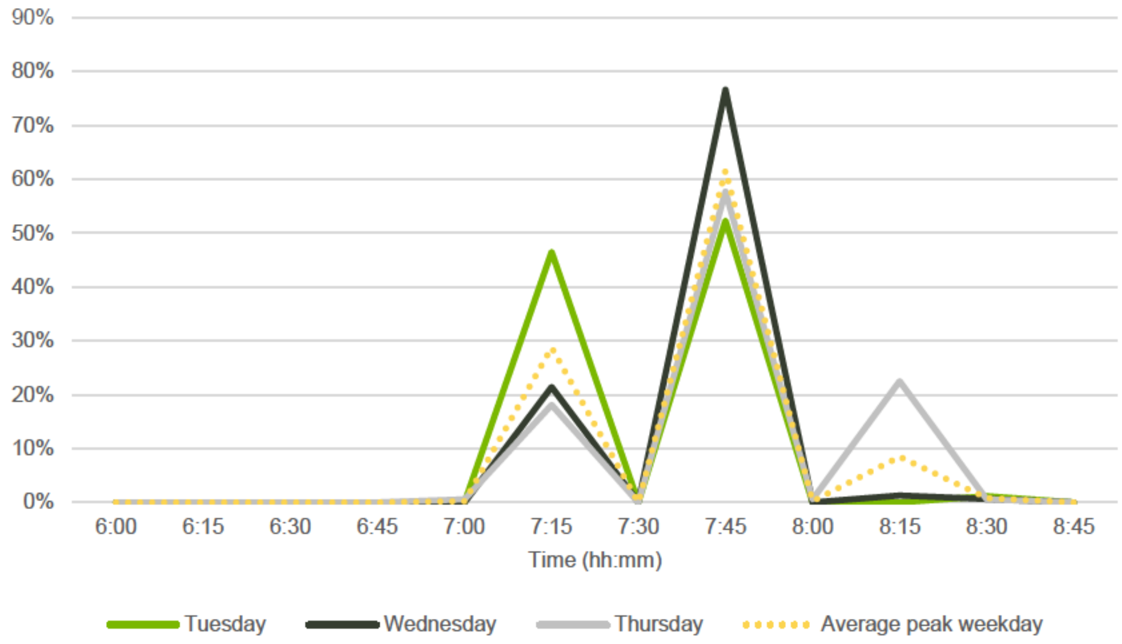


Figure 4-11 Wairarapa Line morning peak passenger boarding profile

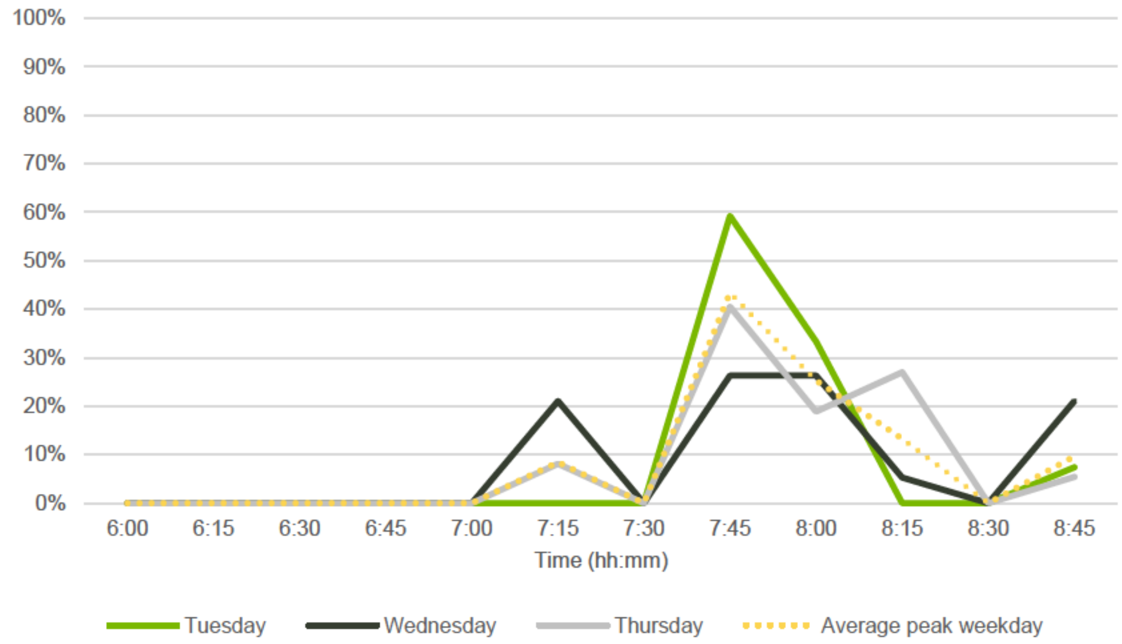


Figure 4-12 Wairarapa Line morning peak passenger alighting profile

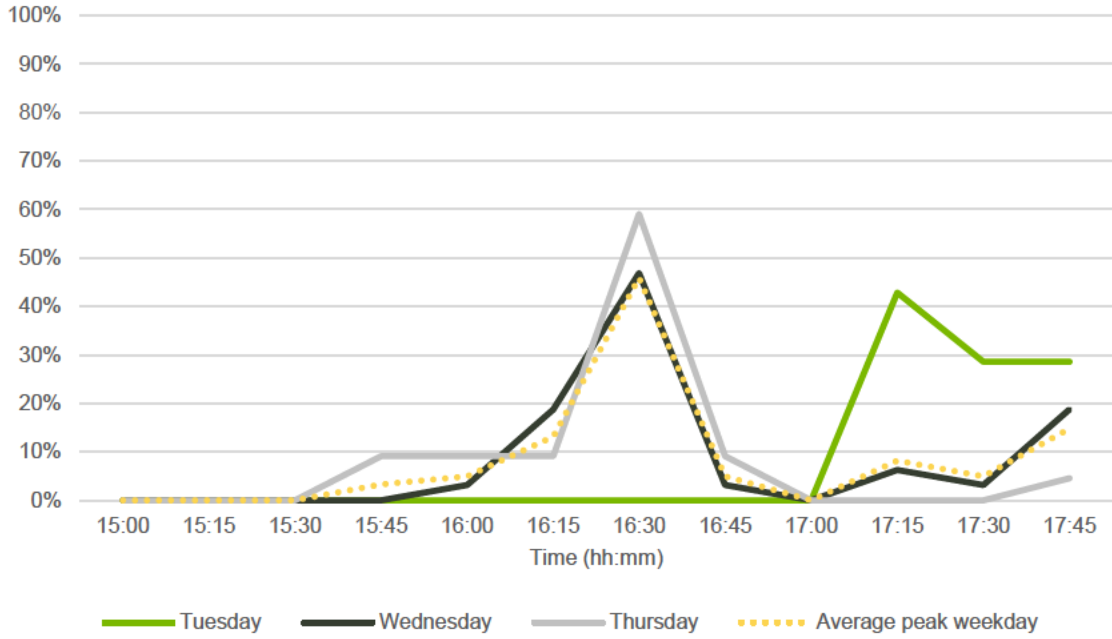


Figure 4-13 Wairarapa Line evening peak passenger boarding profile

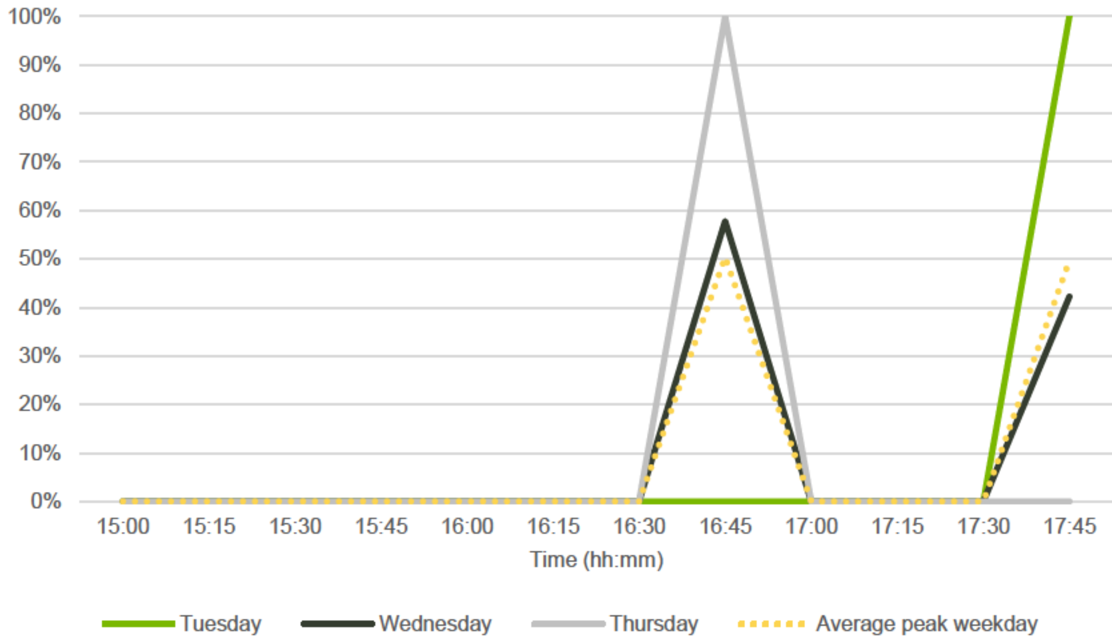


Figure 4-14 Wairarapa Line evening peak passenger alighting profile

4.3 Future passenger demand

Future passenger demand forecasts for the year 2053 were obtained from the Wellington Strategic Demand Model based on population and employment growth rates developed by Sense Partners. The demand forecasts for the morning and evening 3-hour peaks are shown in Table 4.4.

Table 4.4 Modelled morning and evening 3-hour peak passenger demands

Peak	2018		2053		Per annum growth rate (2018 to 2053)	
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting
Morning	2073	431	3495	834	1.50%	1.90%
Evening	609	2019	1124	3175	1.77%	1.30%

The morning and evening 3-hour peak demands were distributed by line and direction based on the existing demand distributions shown in Table 4.2 and the outputs are shown in Table 4.5 and Table 4.6.

Table 4.5 Modelled morning 3-hour peak passenger demands by line and direction

Line	2018		2053	
	Boarding	Alighting	Boarding	Alighting
HVL (Inbound)	1751	283	2952	548
WRL (Inbound)	172	54	290	105
Inbound Total	1923	337	3242	653
HVL (Outbound)	148	87	250	169
WRL (Outbound)	2	6	3	13
Outbound Total	150	94	253	181

Table 4.6 Modelled evening 3-hour peak passenger demands by line and direction

Line	2018		2053	
	Boarding	Alighting	Boarding	Alighting
HVL (Inbound)	216	149	398	235
WRL (Inbound)	0	0	0	0
Inbound Total	216	149	398	235
HVL (Outbound)	345	1739	638	2734
WRL (Outbound)	48	131	88	206
Outbound Total	393	1870	726	2940

To account for travel behaviour changes between 2018 and 2024, due to covid and increased work-from-home, rather than using passenger demand numbers from the Wellington Strategic Demand Model, growth rates were obtained from the model which were than applied to the existing 2024 Snapper data. Therefore, better reflecting existing rail passenger demands which are anticipated to continue into the future.

The per annum growth rates from Table 4.5 and Table 4.6 were used to interpolate the growth for the 2046 Design Year and extrapolate the 2061 Ultimate Design Year. As growth rates for the modelled data were applied to the existing Snapper data, growth was re-based to the year 2024 rather than the 2018 model base year.

The resultant growth rates are shown in Figure 4-15 and Table 4.7, and show the highest growth rates for alighting in the morning peak and boarding in the evening peak which correlate with the aspiration of Waterloo becoming a growing destination.

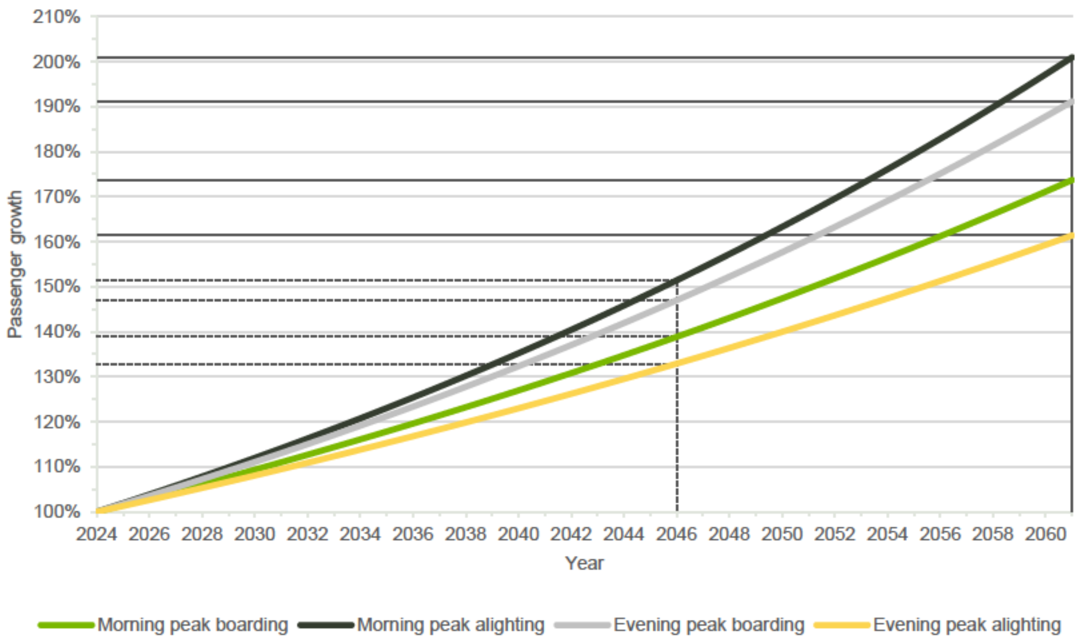


Figure 4-15 Waterloo Station passenger growth rates

Table 4.7 Waterloo Station passenger growth rates from the year 2024

Peak	2046		2061	
	Boarding	Alighting	Boarding	Alighting
Morning	139%	151%	174%	201%
Evening	147%	133%	191%	161%

Applying the growth rates from Table 4.7 and the passenger demand distributions from Table 4.2 and Table 4.3 to the existing Snapper data for the average peak weekday, results in the Design Year and Ultimate Design Year passenger demands in Table 4.8 and Table 4.9.

Table 4.8 Design Year and Ultimate Design Year morning 3-hour peak passenger demands by line and direction

Line	2024		2046		2061	
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting
HVL (Inbound)	1702	131	2364	198	2957	263

Line	2024		2046		2061	
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting
WRL (Inbound)	167	25	232	38	291	50
Inbound Total	1869	156	2596	236	3248	313
HVL (Outbound)	144	40	200	61	250	81
WRL (Outbound)	2	3	3	5	3	6
Outbound Total	146	43	203	66	253	87

Table 4.9 Design Year and Ultimate Design Year evening 3-hour peak passenger demands by line and direction

Line	2024		2046		2061	
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting
HVL (Inbound)	90	122	133	163	173	197
WRL (Inbound)	0	0	0	0	0	0
Inbound Total	90	122	133	163	179	197
HVL (Outbound)	145	1423	213	1892	277	2297
WRL (Outbound)	20	107	29	142	38	173
Outbound Total	165	1530	242	2034	315	2470

5 Limitations and exclusions

The static pedestrian modelling included in this memo includes the following limitations:

- Detailed station entry and exit split information was unavailable and therefore to de-risk elements of the station impacted by the adopted assumptions a 75% reduction in flow rates was applied to station elements at station entrances (as per Hong Kong MTRC approach [see Table 4.1]).
- Passenger demand forecasts were produced for the year 2053, the Ultimate Design Year (2061) forecasts are based on extrapolation with assumes continuation of the modelled annual growth between 2018 and 2053.

The static pedestrian modelling included in this memo excludes the following items:

- Non-rail passengers' usage of the station (e.g. the usage of the proposed overpass to travel between Oxford Terrace and Cambridge Terrace)
- Emergency egress performance
- Back of House areas
- Public toilets
- Usage of ticket offices
- Public precinct

6 Methodology

6.1 Passenger demand

Passenger demand forecasts from Section 4.3 were used to develop peak train boarding and alighting volumes and peak minute volumes for the purposes of determining the minimum provision of passenger station elements. The process to develop these volumes generally followed the process outlined in Section 2.2 of the Waterloo Transit Oriented Development – Public Transport Minimum Requirements, with the exception of the application of the 125% uplift to account for a delayed service (see Table 4.1 for further details).

An overview of passenger demand methodology is provided in Figure 6-1.

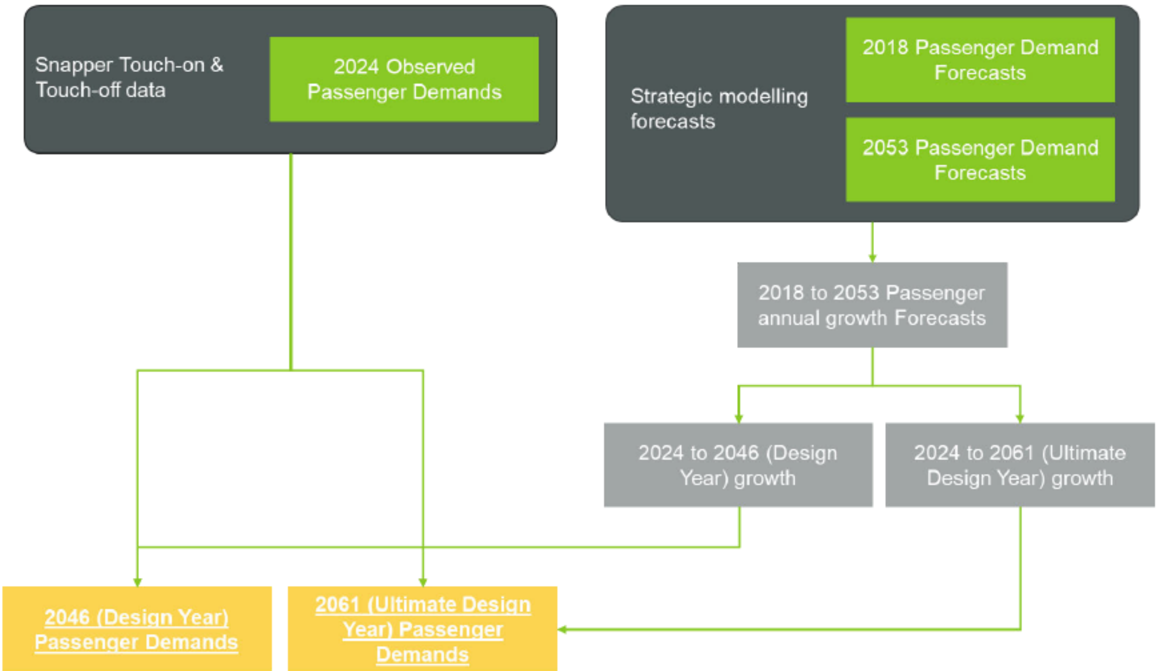


Figure 6-1 Passenger demand methodology overview

6.1.1 Design Year

Morning peak

Applying the existing passenger demand profiles to the adopted Design Year (2046) passenger demand forecasts shows the morning peak 15-minute period for the inbound platform to be 07:30 to 07:45, with a total of 445 passengers boarding and alighting train services (see Table 6.1).

Table 6.1 Design Year (2046) morning peak inbound passenger demands 15-minute intervals

Time period	Hutt Valley Line		Wairarapa Line		Total		
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting	Total
06:00 – 06:15	25	3	0	0	25	3	28
06:15 – 06:30	156	5	0	0	156	5	161
06:30 – 06:45	114	3	0	0	114	3	117

Time period	Hutt Valley Line		Wairarapa Line		Total		
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting	Total
06:45 – 07:00	156	0	0	0	156	0	157
07:00 – 07:15	185	14	0	0	185	14	199
07:15 – 07:30	275	10	67	3	342	13	355
07:30 – 07:45	**430**	**15**	**0**	**0**	**430**	**15**	**445**
07:45 – 08:00	216	11	143	16	359	27	386
08:00 – 08:15	354	40	0	10	355	50	405
08:15 – 08:30	252	72	20	5	272	77	349
08:30 – 08:45	131	11	2	0	133	11	114
08:45 – 09:00	70	14	0	4	70	17	88
Total	**2364**	**198**	**232**	**38**	**2596**	**236**	**2833**

The morning peak 15-minute period for the outbound platform is 08:15 to 08:30 with a total of 44 passengers boarding and alighting train services (see Table 6.2).

Table 6.2 Design Year (2046) morning peak outbound passenger demands 15-minute intervals

Time period	Hutt Valley Line		Wairarapa Line		Total		
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting	Total
06:00 – 06:15	2	1	0	0	2	1	3
06:15 – 06:30	13	2	0	0	13	2	15
06:30 – 06:45	10	1	0	0	10	1	11
06:45 – 07:00	13	0	0	0	13	0	13
07:00 – 07:15	16	4	0	0	16	4	20
07:15 – 07:30	23	3	1	0	24	3	27
07:30 – 07:45	36	4	0	0	36	4	41
07:45 – 08:00	18	3	2	2	20	5	25
08:00 – 08:15	30	12	0	1	30	14	44
08:15 – 08:30	**22**	**22**	**0**	**1**	**22**	**23**	**44**
08:30 – 08:45	11	3	0	0	11	3	15
08:45 – 09:00	6	4	0	0	6	5	11
Total	**200**	**61**	**3**	**5**	**203**	**66**	**268**

Evening peak

Applying the existing passenger demand profiles to the adopted Design Year (2046) passenger demand forecasts shows the evening peak 15-minute period for the inbound platform to be 17:30 to 17:45, with a total of 45 passengers boarding and alighting train services (see Table 6.3).

Table 6.3 Design Year (2046) evening peak inbound passenger demands 15-minute intervals

Time period	Hutt Valley Line		Wairarapa Line		Total		
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting	Total
15:00 – 15:15	24	4	0	0	24	4	28
15:15 – 15:30	11	5	0	0	11	5	17
15:30 – 15:45	16	4	0	0	16	4	20
15:45 – 16:00	13	17	0	0	13	17	29
16:00 – 16:15	7	15	0	0	7	15	22
16:15 – 16:30	10	2	0	0	10	2	12
16:30 – 16:45	11	19	0	0	11	19	30
16:45 – 17:00	12	17	0	0	12	17	30
17:00 – 17:15	9	24	0	0	9	24	34
17:15 – 17:30	8	5	0	0	8	5	13
17:30 – 17:45	**7**	**38**	**0**	**0**	**7**	**38**	**45**
17:45 – 18:00	5	11	0	0	5	11	16
Total	**133**	**163**	0	0	**133**	**163**	**295**

The evening peak 15-minute period for the outbound platform is 17:30 to 17:45 with a total of 445 passengers boarding and alighting train services (see Table 6.4).

Table 6.4 Design Year (2046) evening peak outbound passenger demands 15-minute intervals

Time period	Hutt Valley Line		Wairarapa Line		Total		
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting	Total
15:00 – 15:15	38	50	0	0	38	50	88
15:15 – 15:30	18	63	0	0	18	63	81
15:30 – 15:45	26	50	0	0	26	50	76
15:45 – 16:00	20	193	1	0	21	193	214
16:00 – 16:15	11	180	1	0	12	180	192
16:15 – 16:30	17	24	4	0	21	24	45
16:30 – 16:45	18	225	13	0	31	225	256

Time period	Hutt Valley Line		Wairarapa Line		Total		
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting	Total
16:45 – 17:00	20	203	1	72	21	275	296
17:00 – 17:15	15	285	0	0	15	285	299
17:15 – 17:30	13	59	2	0	15	59	74
17:30 – 17:45	**10**	**433**	**1**	**0**	**12**	**433**	**445**
17:45 – 18:00	7	127	4	71	12	198	209
Total	**213**	**1892**	**29**	**142**	**242**	**2034**	**2276**

6.1.2 Ultimate Design Year

Morning peak

Applying the existing passenger demand profiles to the adopted Ultimate Design Year (2061) passenger demand forecasts shows the morning peak 15-minute period for the inbound platform to be 07:30 to 07:45, with a total of 556 passengers boarding and alighting train services (see Table 6.5).

Table 6.5 Ultimate Design Year (2061) morning peak inbound passenger demands 15-minute intervals

Time period	Hutt Valley Line		Wairarapa Line		Total		
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting	Total
06:00 – 06:15	31	4	0	0	31	4	35
06:15 – 06:30	195	7	0	0	195	7	202
06:30 – 06:45	143	4	0	0	143	4	147
06:45 – 07:00	196	0	0	0	196	0	196
07:00 – 07:15	231	19	1	0	231	19	251
07:15 – 07:30	344	13	84	4	427	17	445
07:30 – 07:45	**538**	**19**	**0**	**0**	**538**	**19**	**556**
07:45 – 08:00	270	14	179	22	449	36	484
08:00 – 08:15	443	54	1	13	444	66	510
08:15 – 08:30	316	96	25	7	340	102	442
08:30 – 08:45	164	15	2	0	167	15	181
08:45 – 09:00	88	18	0	5	88	23	111
Total	**2957**	**263**	**291**	**50**	**3248**	**313**	**3561**

The morning peak 15-minute period for the outbound platform is 08:15 to 08:30 with a total of 58 passengers boarding and alighting train services (see Table 6.6).

Table 6.6 Ultimate Design Year (2061) morning peak outbound passenger demands 15-minute intervals

Time period	Hutt Valley Line		Wairarapa Line		Total		
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting	Total
06:00 – 06:15	3	1	0	0	3	1	4
06:15 – 06:30	17	2	0	0	17	2	19
06:30 – 06:45	12	1	0	0	12	1	13
06:45 – 07:00	17	0	0	0	17	0	17
07:00 – 07:15	20	6	0	0	20	6	25
07:15 – 07:30	29	4	1	1	30	5	35
07:30 – 07:45	45	6	0	0	45	6	51
07:45 – 08:00	23	4	2	3	25	7	32
08:00 – 08:15	37	17	0	2	37	18	56
08:15 – 08:30	**27**	**30**	**0**	**1**	**27**	**31**	**58**
08:30 – 08:45	14	5	0	0	14	5	19
08:45 – 09:00	7	6	0	1	7	6	14
Total	**250**	**81**	**3**	**6**	**254**	**87**	**341**

Evening peak

Applying the existing passenger demand profiles to the adopted Ultimate Design Year (2061) passenger demand forecasts shows the evening peak 15-minute period for the inbound platform to be 17:30 to 17:45, with a total of 55 passengers boarding and alighting train services (see Table 6.7).

Table 6.7 Ultimate Design Year (2061) evening peak inbound passenger demands 15-minute intervals

Time period	Hutt Valley Line		Wairarapa Line		Total		
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting	Total
15:00 – 15:15	31	5	0	0	31	5	36
15:15 – 15:30	15	7	0	0	15	7	21
15:30 – 15:45	21	5	0	0	21	5	26
15:45 – 16:00	16	20	0	0	16	20	36
16:00 – 16:15	9	19	0	0	9	19	27
16:15 – 16:30	14	3	0	0	14	3	16
16:30 – 16:45	14	23	0	0	14	23	38
16:45 – 17:00	16	21	0	0	16	21	37

Time period	Hutt Valley Line		Wairarapa Line		Total		
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting	Total
17:00 – 17:15	12	30	0	0	12	30	42
17:15 – 17:30	10	6	0	0	10	6	16
17:30 – 17:45	**9**	**46**	**0**	**0**	**9**	**46**	**55**
17:45 – 18:00	6	13	0	0	6	13	19
Total	**173**	**197**	**0**	**0**	**173**	**197**	**370**

The evening peak 15-minute period for the outbound platform is 17:30 to 17:45 with a total of 542 passengers boarding and alighting train services (see Table 6.8).

Table 6.8 Design Year (2046) evening peak outbound passenger demands 15-minute intervals

Time period	Hutt Valley Line		Wairarapa Line		Total		
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting	Total
15:00 – 15:15	50	61	0	0	50	61	110
15:15 – 15:30	24	76	0	0	24	76	100
15:30 – 15:45	34	60	0	0	34	60	94
15:45 – 16:00	26	235	1	0	27	235	262
16:00 – 16:15	14	219	2	0	16	219	234
16:15 – 16:30	22	29	5	0	27	29	56
16:30 – 16:45	23	273	18	0	41	273	314
16:45 – 17:00	26	247	2	87	28	334	361
17:00 – 17:15	19	345	0	0	19	345	365
17:15 – 17:30	17	72	3	0	20	72	91
17:30 – 17:45	**14**	**526**	**2**	**0**	**16**	**526**	**542**
17:45 – 18:00	10	154	6	86	15	240	255
Total	**277**	**2297**	**38**	**173**	**315**	**2470**	**2784**

6.1.3 Passenger demand summary

The peak 15-minute demand was then converted into peak train service demand based on the train frequencies in Table 4.1. Peak minute boarding demand was calculated using the factors in Table 4.1 and the alighting peak minute was determined based on the HVL and WRL peak concentration percentages in Table 4.1. The resultant peak demands for sizing the station elements for the morning and evening peaks are shown in Table 6.9 and Table 6.10.

Table 6.9 Morning peak demand summary

	Design Year 2046				Ultimate Design Year 2061			
	Inbound		Outbound		Inbound		Outbound	
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting
Peak 15-minutes	430	15	22	23	538	19	27	31
Peak train service	215	8	11	12	269	10	14	15
Peak minute	35	6	2	9	44	8	3	12

Table 6.10 Evening peak demand summary

	Design Year 2046				Ultimate Design Year 2061			
	Inbound		Outbound		Inbound		Outbound	
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting
Peak 15-minutes	7	38	12	433	9	46	16	526
Peak train service	4	19	6	217	5	23	7	263
Peak minute	1	15	1	174	1	19	2	211

6.2 Assessment equations

The equations used to undertake the static pedestrian modelling assessment are detailed in Section 6.2.1 to Section 6.2.4.

6.2.1 Platform width

$$Platform\ width = \frac{platform\ load\ per\ headway\ \times platform\ distribution\ \ [35\%] \times platform\ density\ [0.8m^2/person]}{platform\ length \times 25\%} + platform\ edge\ effect\ [1m]$$

Equation 6-1 Platform width

6.2.2 Snapper card gates

$$roundup\frac{peak\ minute\ boarrding\ flow}{Snapper\ card\ gate\ flow\ rate\ [25\ people\ /\ minute]} + roundup\frac{peak\ minute\ alighting\ flow}{Snapper\ card\ gate\ flow\ rate\ [25\ people\ /\ minute]}$$

Equation 6-2 Snapper card gates

6.2.3 Staircase width

$$\frac{peak\ minute\ flow}{staircase\ flow\ rate\ [28\ people\ /\ minute/\ metre]}$$

Equation 6-3 Staircase width

6.2.4 Passageway width

$$\frac{peak\ minute\ flow}{passageway\ flow\ rate\ [40\ people\ /\ minute/\ metre]} + passageway\ edge\ effect\ [0.6m]$$

Equation 6-4 Passageway width

7 Results

Based on the assumptions in Section 4.1 and methodology detailed in Section 5, the minimum station elements are provided in Table 7.1 for a side platform arrangement and illustrated in Figure 7-1 for the Design Year.

All widths are clear widths (i.e. width between handrails).

Section 7.1 to 7.3 provides details of the calculations used to determine the minimum provisions.

Table 7.1 Side platform arrangement minimum station elements provision

Station element	Minimum provision		Delta (Ultimate Design Year – Design Year
	Design Year	Ultimate Design Year	
Inbound platform width	5.0 m	5.0 m	+0.0 m
Outbound platform width	5.0 m	5.0 m	+0.0 m
Inbound platform Snapper card gates	4 gates	4 gates	+0 gates
Outbound platform Snapper card gates	9 gates	11 gates	+2 gates
Overpass width	3.0 m	3.6 m	+0.6 m
Overpass staircase	3.4 m	4.2 m	+0.8 m
Oxford Terrace Station Forecourt staircase	6.1 m	7.5 m	+1.4 m
Cambridge Terrace Station Forecourt staircase	3.3 m	4.0 m	+0.7 m

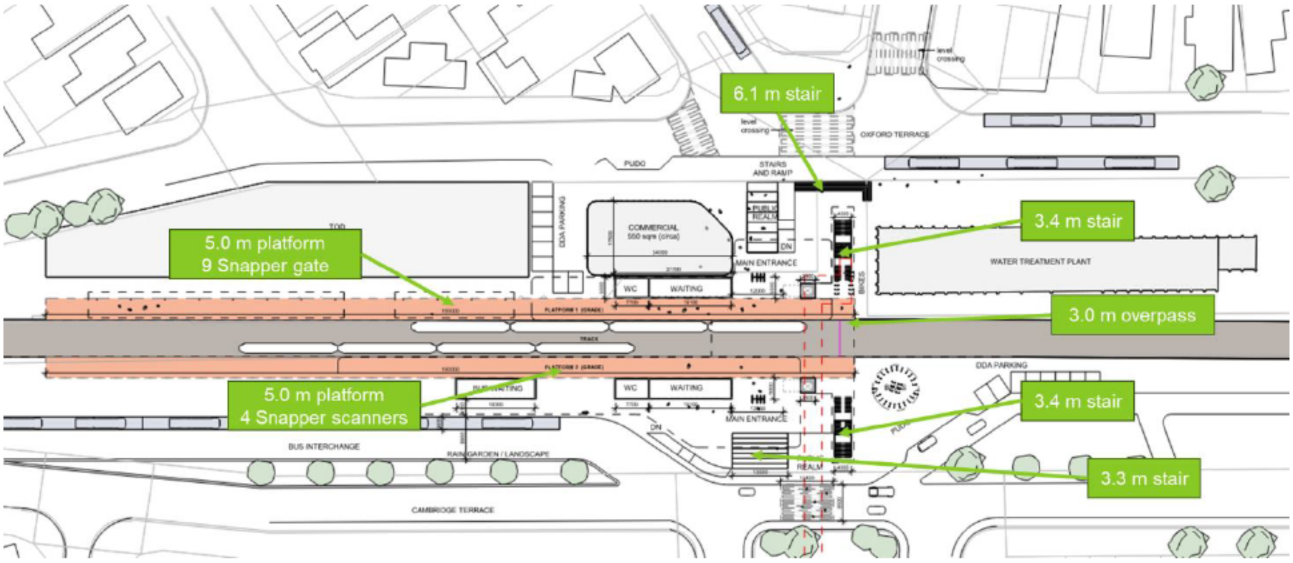


Figure 7-1 Waterloo Station Design Year (2046) minimum station elements provision

7.1 Platform width

Table 7.2 Design Year (2046) minimum platform width

Step		Morning peak				Evening peak			
		Inbound platform		Outbound platform		Inbound platform		Outbound platform	
		Value	Unit	Value	Unit	Value	Unit	Value	Unit
1	Peak train boarding demand	215	people	11	people	4	people	6	people
2	Peak train alighting demand	8	people	12	people	19	people	217	people
3	Platform load per headway (Step 1 plus Step 2)	223	people	23	people	23	people	223	people
4	Busiest platform quarter (Step 3 multiplied by 35%)	79	people	9	people	9	people	79	people
5	Platform area (Step 4 multiplied by 0.8)	63.2	m^2	7.2	m^2	7.2	m^2	63.2	m^2
6	Platform width (Step 5 divided by 190 multiplied by 25% plus 1m)	2.4	m	1.2	m	1.2	m	2.4	m
7	**Minimum platform width (GWRC Minimum Requirements)**	**5.0**	**m**	**5.0**	**m**	**5.0**	**m**	**5.0**	**m**

Table 7.3 Ultimate Design Year (2061) minimum platform width

Step		Morning peak				Evening peak			
		Inbound platform		Outbound platform		Inbound platform		Outbound platform	
		Value	Unit	Value	Unit	Value	Unit	Value	Unit
1	Peak train boarding demand	269	people	14	people	5	people	7	people
2	Peak train alighting demand	10	people	15	people	23	people	263	people
3	Platform load per headway (Step 1 plus Step 2)	279	people	29	people	28	people	270	people
4	Busiest platform quarter (Step 3 multiplied by 35%)	98	people	11	people	10	people	95	people
5	Platform area (Step 4 multiplied by 0.8)	78.4	m²	8.8	m²	8.0	m²	76.0	m²
6	Platform width (Step 5 divided by 190 multiplied by 25% plus 1m)	2.7	m	1.2	m	1.2	m	2.6	m
7	**Minimum platform width (GWRC Minimum Requirements)**	**5.0**	**m**	**5.0**	**m**	**5.0**	**m**	**5.0**	**m**

7.2 Snapper card gates

Table 7.4 Design Year (2046) minimum Snapper card gate provision

Step		Morning peak				Evening peak			
		Inbound platform		Outbound platform		Inbound platform		Outbound platform	
		Value	Unit	Value	Unit	Value	Unit	Value	Unit
1	Peak minute boarding demand	35	people	2	people	1	people	1	people
2	Peak minute alighting demand	6	people	9	people	15	people	174	people
3	Required boarding Snapper card gates (roundup Step 1 divided by 25)	2	gates	1	gates	1	gates	1	gates
4	Required Snapper card gates (roundup Step 2 divided by 25)	1	gates	1	gates	1	gates	7	gates
5	Snapper card gate redundancy provision	1	gates	1	gates	1	gates	1	gates
6	Total Snapper card gate provision (Step 3 plus Step 4 plus Step 5)	4	gates	3	gates	3	gates	9	gates
7	**Minimum Snapper card gate provision**	**4**	**gates**	**3**	**gates**	**3**	**gates**	**9**	**gates**

Table 7.5 Ultimate Design Year (2061) minimum Snapper card gate provision

Step		Morning peak				Evening peak			
		Inbound platform		Outbound platform		Inbound platform		Outbound platform	
		Value	Unit	Value	Unit	Value	Unit	Value	Unit
1	Peak minute boarding demand	44	people	3	people	1	people	2	people
2	Peak minute alighting demand	8	people	12	people	19	people	211	people
3	Required boarding Snapper card gates (roundup Step 1 divided by 25)	2	gates	1	gates	1	gates	1	gates
4	Required Snapper card gates (roundup Step 2 divided by 25)	1	gates	1	gates	1	gates	9	gates
5	Snapper card gate redundancy provision	1	gates	1	gates	1	gates	1	gates
6	Total Snapper card gate provision (Step 3 plus Step 4 plus Step 5)	4	gates	3	gates	3	gates	11	gates
7	**Minimum Snapper card gate provision**	**4**	**gates**	**3**	**gates**	**3**	**gates**	**11**	**gates**

7.3 Overpass width

Table 7.6 Design Year (2046) station overpass minimum width

Step		Morning peak		Evening peak	
		Value	Unit	Value	Unit
1	Inbound peak minute boarding demand	35	people	1	people
2	Inbound peak minute boarding demand from Oxford Terrace (Step 1 multiplied by 67%)	24	people	1	people
3	Inbound peak minute alighting demand	6	people	15	people
4	Inbound peak minute alighting demand to Oxford Terrace (Step 3 multiplied by 67%)	4	people	10	people
5	Outbound peak minute boarding demand	2	people	1	people
6	Outbound peak minute boarding demand from Cambridge Terrace (Step 5 multiplied by 34%)	2	people	1	people
7	Outbound peak minute alighting demand	9	people	174	people
8	Outbound peak minute alighting demand from Cambridge Terrace (Step 7 multiplied by 34%)	4	people	58	people
9	Peak minute demand (summation of Steps 2, 4, 6, and 8)	34	people	70	people

Step		Morning peak		Evening peak	
		Value	Unit	Value	Unit
10	Overpass width (Step 9 divided by 40 multiplied by 75% [entrance split uncertainty factor]) plus 0.6)	1.8	m	3.0	m
11	**Minimum overpass width**	**1.8**	**m**	**3.0**	**m**

Table 7.7 Ultimate Design Year (2061) station overpass minimum width

Step		Inbound platform			
		Morning peak		Evening peak	
		Value	Unit	Value	Unit
1	Peak minute inbound boarding demand	44	people	1	people
2	Inbound peak minute boarding demand from Oxford Terrace (Step 1 multiplied by 67%)	30	people	1	people
3	Peak minute inbound alighting demand	8	people	19	people
4	Inbound peak minute alighting demand to Oxford Terrace (Step 3 multiplied by 67%)	6	people	13	people
5	Peak minute outbound boarding demand	3	people	2	people
6	Outbound peak minute boarding demand from Cambridge Terrace (Step 5 multiplied by 34%)	2	people	2	people
7	Peak minute outbound alighting demand	12	people	211	people
8	Outbound peak minute alighting demand to Cambridge Terrace (Step 7 multiplied by 34%)	4	people	72	people
9	Peak minute demand (summation of Steps 2, 4, 6, and 8)	42	people	88	people
10	Overpass width (Step 9 divided by 40 multiplied by 75% [entrance split uncertainty factor]) plus 0.6)	2.0	m	3.6	m
11	**Minimum overpass width**	**2.0**	**m**	**3.6**	**m**

7.4 Overpass staircase widths

Table 7.8 Design Year (2046) overpass minimum staircase widths

Step		Inbound platform			
		Morning peak		Evening peak	
		Value	Unit	Value	Unit
1	Peak minute inbound boarding demand	35	people	1	people
2	Inbound peak minute boarding demand from Oxford Terrace (Step 1 multiplied by 67%)	24	people	1	people

Step		Inbound platform			
		Morning peak		Evening peak	
		Value	Unit	Value	Unit
3	Peak minute inbound alighting demand	6	people	15	people
4	Inbound peak minute alighting demand to Oxford Terrace (Step 3 multiplied by 67%)	4	people	10	people
5	Peak minute outbound boarding demand	2	people	2	people
6	Outbound peak minute boarding demand from Cambridge Terrace (Step 5 multiplied by 34%)	2	people	2	people
7	Peak minute outbound alighting demand	9	people	174	people
8	Outbound peak minute alighting demand to Cambridge Terrace (Step 7 multiplied by 34%)	2	people	58	people
9	Peak minute demand (summation of Steps 2, 4, 6, and 8)	34	people	71	people
10	Staircase width (Step 9 divided by 28 multiplied by 75% [entrance split uncertainty factor])	1.7	m	3.4	m
11	**Minimum staircase width**	**1.7**	**m**	**3.4**	**m**

Table 7.9 Design Year (2061) inbound platform overpass minimum staircase width

Step		Morning peak		Evening peak	
		Value	Unit	Value	Unit
1	Peak minute inbound boarding demand	44	people	1	people
2	Inbound peak minute boarding demand from Oxford Terrace (Step 1 multiplied by 67%)	30	people	1	people
3	Peak minute inbound alighting demand	8	people	19	people
4	Inbound peak minute alighting demand to Oxford Terrace (Step 3 multiplied by 67%)	6	people	13	people
5	Peak minute outbound boarding demand	3	people	2	people
6	Outbound peak minute boarding demand from Cambridge Terrace (Step 5 multiplied by 34%)	2	people	2	people
7	Peak minute outbound alighting demand	12	people	211	people
8	Outbound peak minute alighting demand to Cambridge Terrace (Step 7 multiplied by 34%)	4	people	72	people
9	Peak minute demand (summation of Steps 2, 4, 6, and 8)	42	people	88	people
12	Staircase width (Step 9 divided by 28 multiplied by 75% [entrance split uncertainty factor])	2.0	m	4.2	m
13	**Minimum staircase width**	**2.0**	**m**	**4.2**	**m**

7.5 Oxford Terrace Station Forecourt staircase

Table 7.10 Design Year (2046) Oxford Terrace Station Forecourt minimum staircase width

Step		Oxford Terrace			
		Morning peak		Evening peak	
		Value	Unit	Value	Unit
1	Inbound peak minute boarding demand	35	people	1	people
2	Inbound peak minute boarding demand from Oxford Terrace (Step 1 multiplied by 67%)	24	people	1	people
3	Inbound peak minute alighting demand	6	people	15	people
4	Inbound peak minute alighting demand to Oxford Terrace (Step 3 multiplied by 67%)	4	people	10	people
5	Outbound peak minute boarding demand	2	people	1	people
6	Outbound peak minute boarding demand from Oxford Terrace (Step 5 multiplied by 67%)	2	people	1	people
7	Outbound peak minute alighting demand	9	people	174	people
8	Outbound peak minute alighting demand to Oxford Terrace (Step 7 multiplied by 67%)	6	people	116	people
9	Peak minute demand (summation of Steps 2, 4, 6, and 8)	36	people	128	people
10	Staircase width (Step 9 divided by 28 multiplied by 75% [entrance split uncertainty factor])	1.8	m	6.1	m
11	**Minimum staircase width**	**1.8**	**m**	**6.1**	**m**

Table 7.11 Ultimate Design Year (2061) Oxford Terrace Station Forecourt minimum staircase width

Step		Oxford Terrace			
		Morning peak		Evening peak	
		Value	Unit	Value	Unit
1	Inbound peak minute boarding demand	44	people	1	people
2	Inbound peak minute boarding demand from Oxford Terrace (Step 1 multiplied by 67%)	30	people	1	people
3	Inbound peak minute alighting demand	8	people	19	people
4	Inbound peak minute alighting demand to Oxford Terrace (Step 3 multiplied by 67%)	6	people	13	people
5	Outbound peak minute boarding demand	3	people	2	people
6	Outbound peak minute boarding demand from Oxford Terrace (Step 5 multiplied by 67%)	2	people	2	people
7	Outbound peak minute alighting demand	12	people	211	people

Step		Oxford Terrace			
		Morning peak		Evening peak	
		Value	Unit	Value	Unit
8	Outbound peak minute alighting demand to Oxford Terrace (Step 7 multiplied by 67%)	8	people	141	people
9	Peak minute demand (summation of Steps 2, 4, 6, and 8)	46	people	157	people
10	Staircase width (Step 9 divided by 28 multiplied by 75% [entrance split uncertainty factor])	2.2	m	7.5	m
11	**Minimum staircase width**	**2.2**	**m**	**7.5**	**m**

7.6 Cambridge Terrace Station Forecourt staircase

Table 7.12 Design Year (2046) Cambridge Terrace Station Forecourt minimum staircase width

Step		Cambridge Terrace			
		Morning peak		Evening peak	
		Value	Unit	Value	Unit
1	Inbound peak minute boarding demand	35	people	1	people
2	Inbound peak minute boarding demand from Cambridge Terrace (Step 1 multiplied by 34%)	12	people	1	people
3	Inbound peak minute alighting demand	6	people	15	people
4	Inbound peak minute alighting demand to Cambridge Terrace (Step 3 multiplied by 34%)	2	people	6	people
5	Outbound peak minute boarding demand	2	people	1	people
6	Outbound peak minute boarding demand from Cambridge Terrace (Step 5 multiplied by 34%)	2	people	1	people
7	Outbound peak minute alighting demand	9	people	174	people
8	Outbound peak minute alighting demand to Cambridge Terrace (Step 7 multiplied by 34%)	4	people	58	people
9	Peak minute demand (summation of Steps 2, 4, 6, and 8)	20	people	66	people
10	Staircase width (Step 9 divided by 28 multiplied by 75% [entrance split uncertainty factor])	1.0	m	3.3	m
11	**Minimum staircase width**	**1.2**	**m**	**3.3**	**m**

Table 7.13 Ultimate Design Year (2061) Cambridge Terrace Station Forecourt minimum staircase width

Step		Cambridge Terrace			
		Morning peak		Evening peak	
		Value	Unit	Value	Unit
1	Inbound peak minute boarding demand	44	people	1	people
2	Inbound peak minute boarding demand from Cambridge Terrace (Step 1 multiplied by 34%)	16	people	1	people
3	Inbound peak minute alighting demand	8	people	19	people
4	Inbound peak minute alighting demand to Cambridge Terrace (Step 3 multiplied by 34%)	4	people	8	people
5	Outbound peak minute boarding demand	3	people	2	people
6	Outbound peak minute boarding demand from Cambridge Terrace (Step 5 multiplied by 34%)	2	people	2	people
7	Outbound peak minute alighting demand	12	people	211	people
8	Outbound peak minute alighting demand to Cambridge Terrace (Step 7 multiplied by 34%)	4	people	72	people
9	Peak minute demand (summation of Steps 2, 4, 6, and 8)	26	people	83	people
10	Inbound peak minute boarding demand	1.3	m	4.0	m
11	**Minimum staircase width**	**1.3**	**m**	**4.0**	**m**

8 Option 17 station elements level of service performance

Station sizing assessment of Option 17 highlights the following:

- Platform circulation and vertical access elements provide sufficient space to meet LoS C during peak periods under normal operations and meet LoS D during delayed services in peak conditions for the years 2046 and 2061.
- Additional Snapper gates required on the outbound platform to cater to the alighting passenger demand in the evening peak (six additional gates required for year 2046, and a further three for 2061).
- Lack of alternative (or redundant) step-free access to and from the overpass in the event of a lift failure.

The provided provisions in Option 17 generally meet or exceed the minimum provisions required to meet the years 2046 and 2061 passenger demand forecasts, with the exception of the outbound platform Snapper card gate and the overpass staircase. The outbound platform would require an additional six gates to meet the year 2046 demand, with a further two gates to meet the year 2046 demands. There appears to be sufficient spatial provision for these additional gates to be added as the station passenger demand grows. The overpass staircase has a minor shortfall in width (0.2 m) by the year 2061 however, the width is still sufficient to meet LoS C (with a maximum flow rate of 29.3 people per minute per meter, which slightly exceeds the target flow rate of 28 people per minute per meter) and is deemed acceptable.

Table 8.1 Option 17 provided provision versus years 2046 and 2061 minimum provisions

Station Element	Option 17 provided provision	Year 2046 minimum provision	Year 2061 minimum provision
Inbound platform width	5.0 m	5.0 m	5.0 m
Outbound platform width	5.0 m	5.0 m	5.0 m
Inbound platform Snapper card gates	6 gates	4 gates	4 gates
Outbound platform Snapper card gates	3 gates	9 gates	11 gates
Overpass width	4.8 m	3.0 m	3.6 m
Overpass staircase	4.0 m	3.4 m	4.2 m
Oxford Terrace Station Forecourt staircase	18.0 m	6.1 m	7.5 m
Cambridge Terrace Station Forecourt staircase	13.0 m	3.3 m	4.0 m

The pedestrian level of service performance of the station elements over time (with the exception of platforms, which provide sufficient width for the 2061 design year) are provided in Figure 8-1 to Figure 8-4 based on the widths provided in Option 17.

The figures provide an indication of potential level of service performance from Rail Day One to the 2061 design year for both normal and degraded operations. In general, the figures show that the target level of service performance for normal and degraded operations can be met, with a slight exceedance at the overpass stairs for beyond the year 2058.

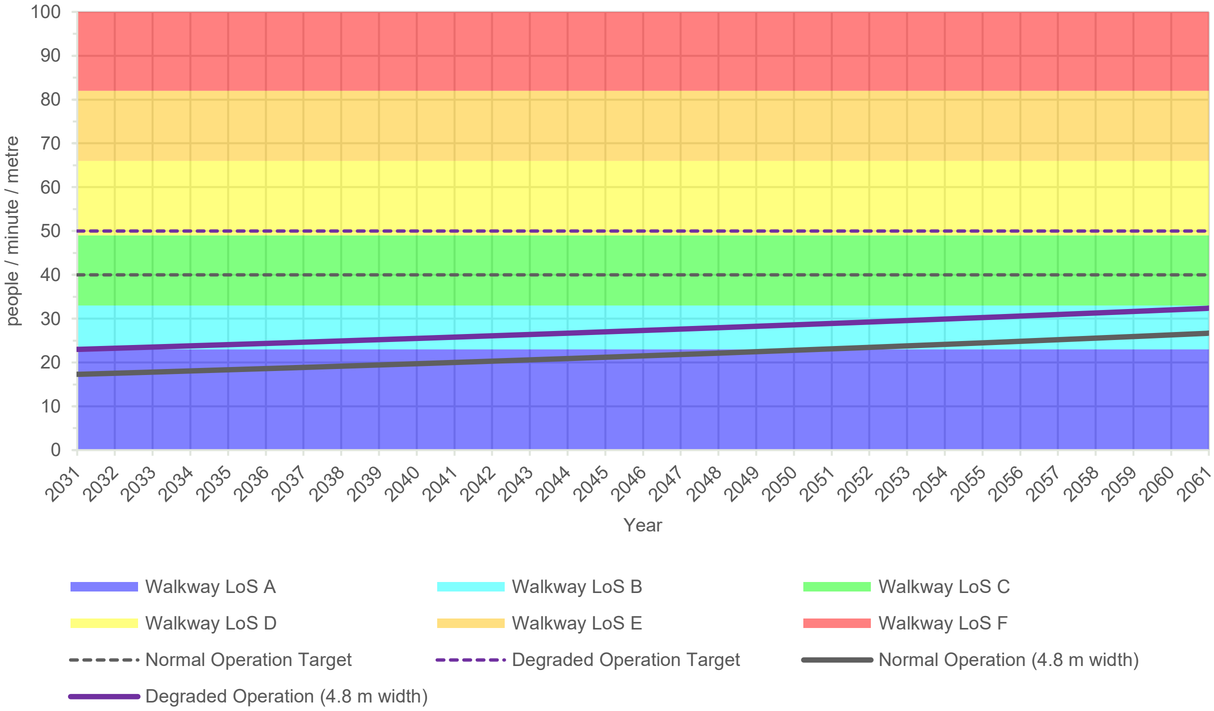


Figure 8-1 Overpass evening peak walkway Level of Service performance

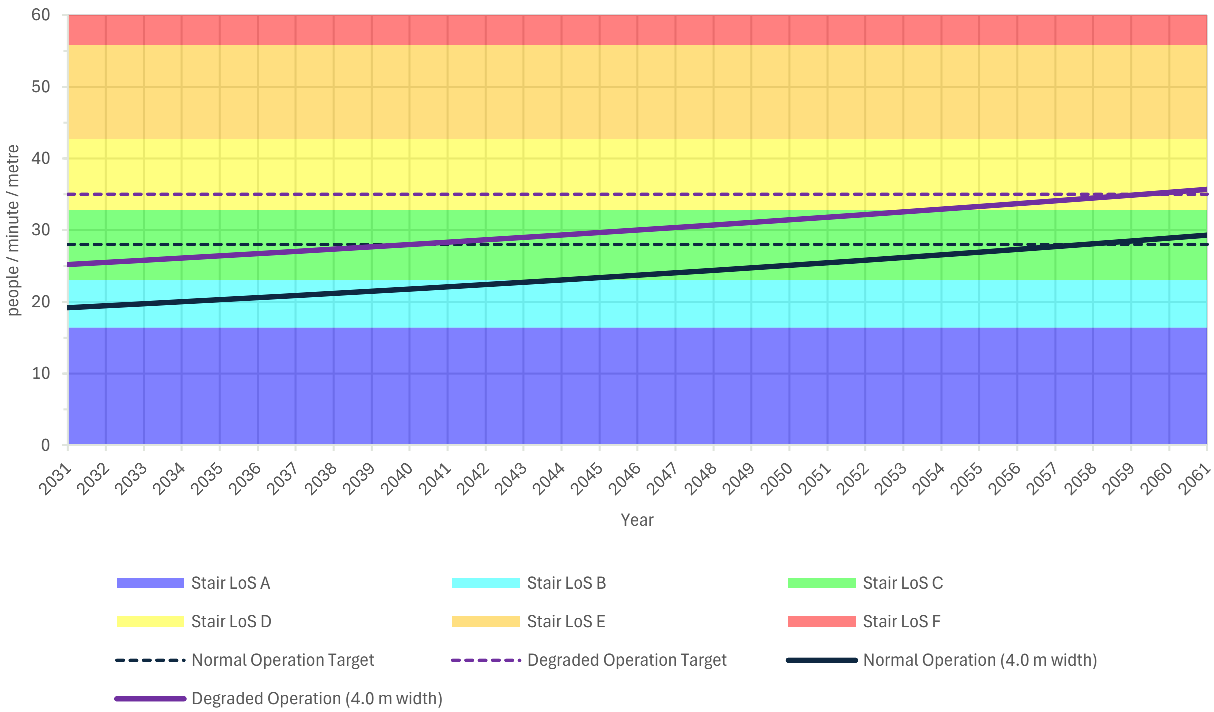


Figure 8-2 Overpass staircase evening peak stair Level of Service performance

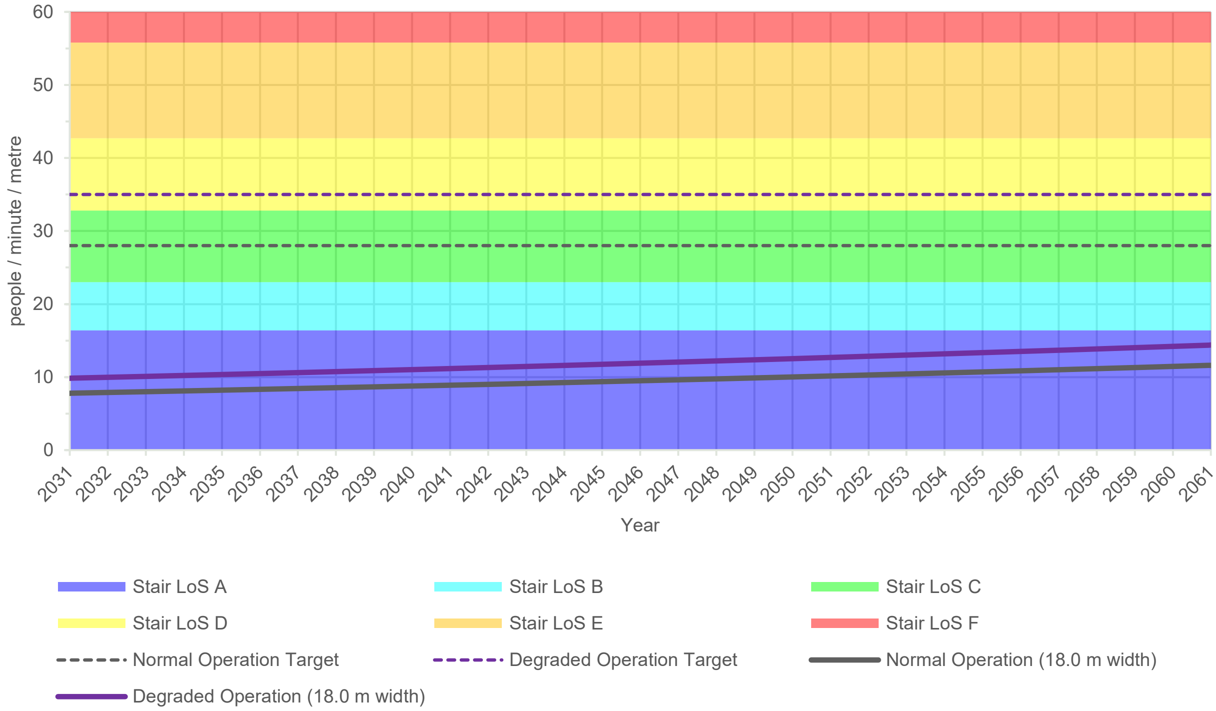


Figure 8-3 Oxford Terrace staircase evening peak stair Level of Service performance

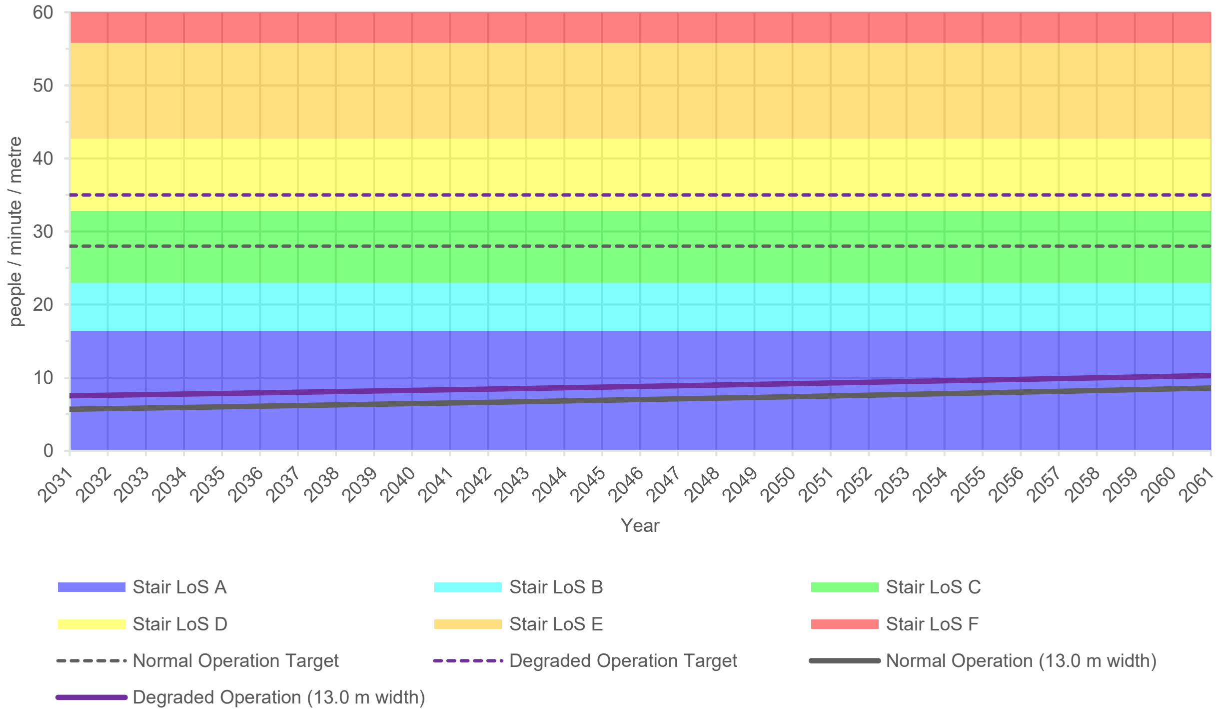


Figure 8-4 Cambridge Terrace staircase evening peak stair Level of Service performance

9 Sizing based on delayed service

In addition to the station element widths provided in Section 7, the required widths to achieve pedestrian Level of Service C for a delayed train service in the Design Year and the Ultimate Design Year are provided in Table 9.1 for information.

Table 9.1 Side platform arrangement minimum station elements provision not accounting for versus accounting for delayed service

Station element	2046 Design Year		2061 Ultimate Design Year	
	Not accounting for delayed service	Accounting for delayed service	Not accounting for delayed service	Accounting for delayed service
Inbound platform width	5.0 m	5.0 m (+0.0 m)	5.0 m (+0.0 m)	5.0 m (+0.0 m)
Outbound platform width	5.0 m	5.0 m (+0.0 m)	5.0 m (+0.0 m)	5.0 m (+0.0 m)
Inbound platform Snapper card gates	4 gates	4 scanners (+0 gates)	4 gates (+0 gates)	4 scanners (+0 gates)
Outbound platform Snapper card gates	9 gates	11 scanners (+2 scanners)	11 gates (+2 gates)	14 scanners (+5 gates)
Overpass width	3.0 m	3.6 m (+0.6 m)	3.6 m (+0.6 m)	4.2 m (+1.2 m)
Overpass staircase	3.4 m	4.3 m (+0.9 m)	4.2 m (+0.8 m)	5.1 m (+1.7 m)
Oxford Terrace Station Forecourt staircase	6.1 m	7.7 m (+1.6 m)	7.5 m (+1.4 m)	9.3 m (+3.2 m)
Cambridge Terrace Station Forecourt staircase	3.3 m	4.1 m (+0.8 m)	4.0 m (+0.7 m)	4.8 m (+1.5 m)

Appendix B
Waterloo Station – Pedestrian Crossings Design Note

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Memorandum

To	[redacted] – **Boffa Miskell**	From	[redacted]
Copy	[redacted]	Reference	**P528886**
Date	**2025-07-16**	Pages (including this page)	**10**
Subject	**Waterloo Station – Pedestrian Crossings DRAFT Design Note**		

1 Background

This memorandum is a discussion of existing and proposed pedestrian facilities immediately north and south of Waterloo Station in Lower Hutt for the Waterloo Station Feasibility Study and Reference Design.

The proposals being evaluated are:

North of Waterloo Station

1. Zebra crossings on Oxford Terrace, Pohutukawa Street and Birch Street – on single raised platforms or one raised platform for the intersection.

South of Waterloo Station

2. Pedestrian signals on Cambridge Terrace
3. Raised Safety Platforms on Trafalgar Square at Cambridge Terrace.

There are no pedestrian volumes available to use in the evaluation, however road volumes and characteristics are appended.

2 Recommendations

Retain the existing pedestrian facilities on the north side of the station in approximately the same locations as they best match pedestrian desire lines. Raise each one on a single platform to highlight the pedestrians to approaching traffic, provide traffic calming to lower speeds and create a traffic calmed precinct on the northern approach to the station to support the change in movement and place function.

Raising the entire intersection would provide speed reduction benefits at the edges of the platform and provide an easier transition through the intersection for heavy vehicles and emergency services, however it would not provide the maximum speed reduction benefit at the conflict points with pedestrians and would encourage pedestrians to cross the corridor away from the pedestrian crossing facilities.

Install a signalised pedestrian crossing on the southern side of the station on a raised platform to provided managed pedestrian priority in a higher volume, higher speed environment. Consider adding raised safety platforms on Telegraph Road as 'courtesy crossings' to provide a continuous accessible path of travel to the station from PUDO and bus stop areas and emphasise the change in priority to active modes access to the station. Where shoulder width is available and cycle routes are not affected, include side islands at crossing points to shorten crossing width and provide locations for poles and signs out of footpath areas.

2.1 General

- Future design stages should review crossing storage capacity and existing safety issues at crossing locations/desire lines to determine if any additional improvements should be made and finalise crossing widths.
- Future design stages should review cycle facilities provision and determine whether cycle facilities should be included in pedestrian crossings or if cycle lanes are included on street how they should be included in the crossings designs.
- Pedestrian crossings at intersections should be in a low speed environment – raised platforms will assist in lowering speeds at the conflict points.
- Pedestrian crossing markings should not be excessively wide as this affects limit line locations, intervisibility and extends queueing across adjacent intersections affecting pedestrian access and safety
- Pedestrian crossing lengths – for any road width greater than 10m a median island refuge is recommended to allow crossings to operate as 2 separate legal crossings and is required for widths 15m or greater. A single stage zebra or signalised crossing will require all traffic to stop for all pedestrians. Two stage crossings improve safety by limiting pedestrian exposure to traffic to one direction at a time, shorten the crossing distance and reduce congestion with each lane operating separately.
- Side islands – these are recommended where there are marked shoulders to provide additional protection kerbside and shorten the distance pedestrians are exposed to traffic. These are an obstruction for cyclists so are not recommended on a cycle route.
- Oxford Terrace Zebra Crossing – maintain a two stage pedestrian crossing. This can be via a wide central refuge with or without a stagger. The stagger is a safety measure to turn pedestrians towards oncoming traffic. If the stagger is retained, it should be reversed so pedestrians face oncoming traffic when walking in the median. Installation on a raised platform would reduce speeds at the conflict points.
- Consider emergency services access when designing raised platforms – Wellington Free Ambulance is immediately northeast of the station on Oxford Terrace

3 Design Proposals

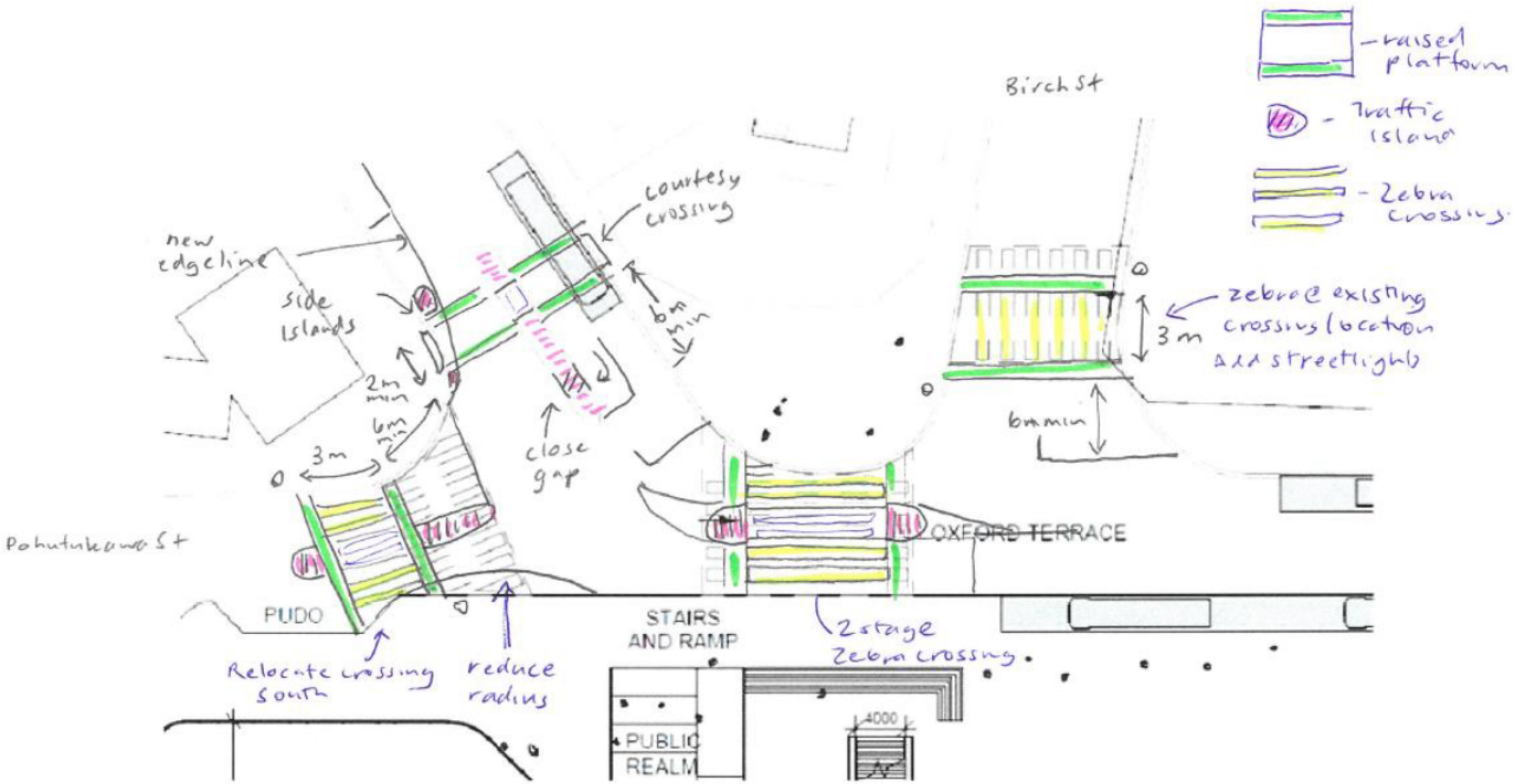

Figure No. 1: North of Waterloo Station

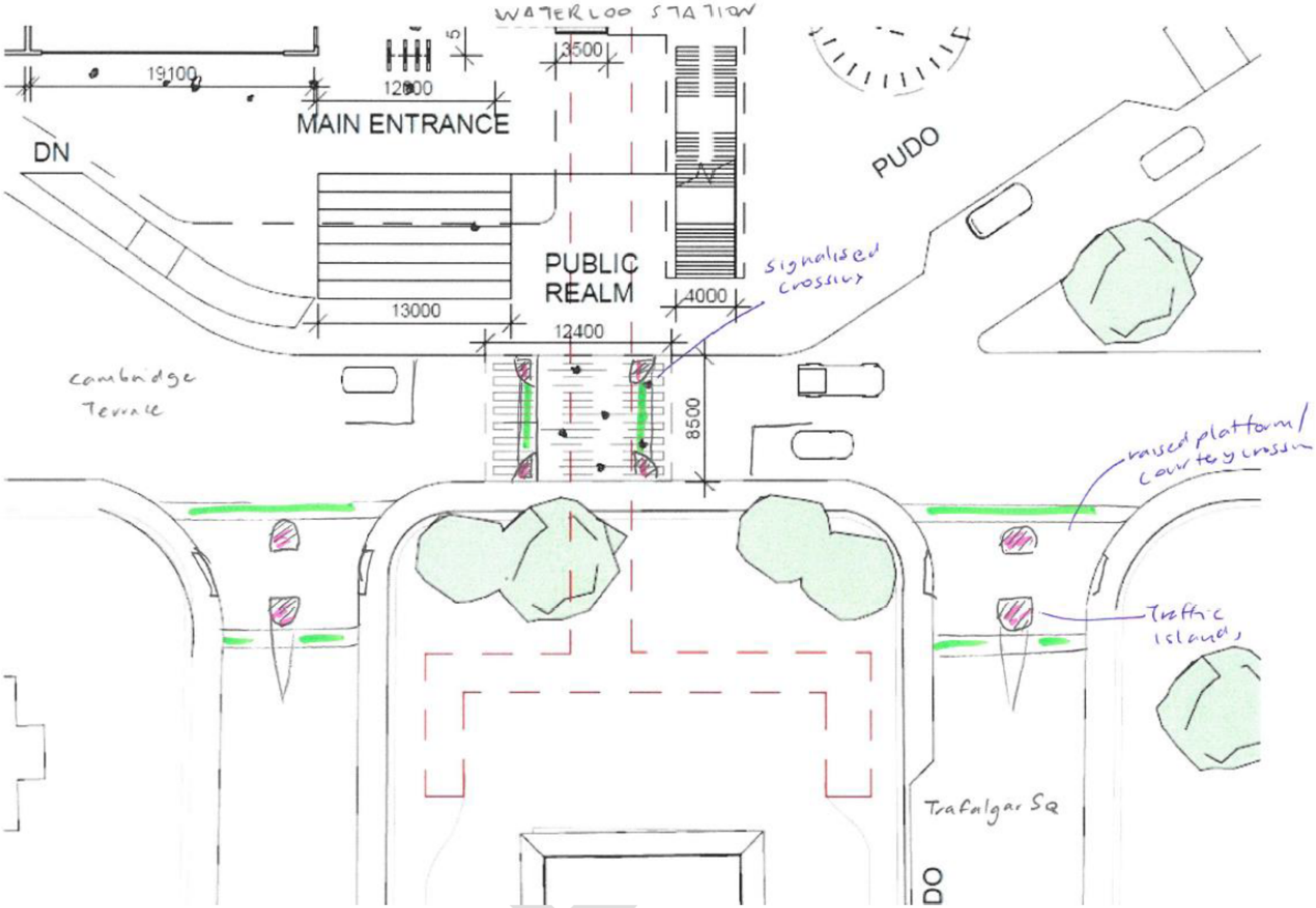

Figure No. 2: **South of Waterloo Station**

4 Options Evaluation

4.1 North of Waterloo Station

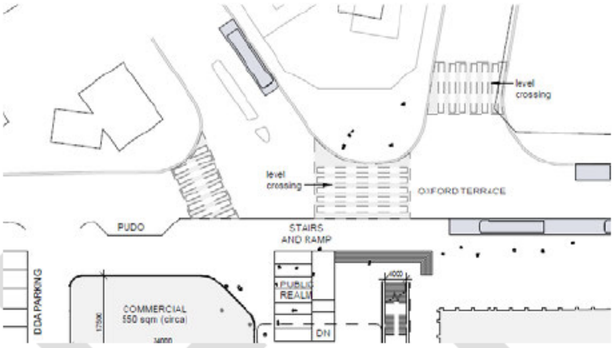

Figure No. 3: Existing Pedestrian Facilities

Figure No. 4: Proposed Pedestrian Facilities

4.1.1 Oxford Terrace

- Existing: at grade 2 stage staggered pedestrian zebra crossing with fenced median refuge (with red surfacing under the zebra bars) and streetlighting.
- Proposed: at grade 1 stage wide pedestrian zebra crossing

The existing pedestrian zebra crossing manages priority on each side of the carriageway separately as two separate legal pedestrian crossings. This means one side of the road can continue to operate while pedestrians are crossing on the other side. There is storage kerbside and in the median for pedestrians and the refuge fencing provides protection and channels pedestrians through the crossing. The total crossing distance is approximately 14 metres. For any distance over 10m a refuge is recommended and required at 15m width.

The existing stagger direction is the opposite recommended. It is more appropriate to have a right left stagger in the median so pedestrians enter then walk and look towards the direction traffic is approaching. The red markings under the zebra bars are not recommended as they do not provide sufficient contrast between the bars and the road surfacing for visually impaired road users. NZTA guidance is to apply red surfacing on the vehicle approaches.

The current proposal widens the crossing and shows it as a 1-stage crossing. This means all traffic has to stop for all pedestrians. The limit lines to show drivers where to stop are not shown but are required to be 5m in advance of the zebra stripes. Widening the crossing would also move the limit lines further from the existing crossing location and potentially affect sightlines between pedestrians and drivers. Depending on their location, the limit line position may affect the safety of pedestrians using the refuge island on Knights Road with traffic queueing back from the Oxford Terrace crossing. The proposal for a single stage crossing would reduce pedestrian safety, increase congestion at the intersection and affect the operation of the adjacent intersections.

Raising the crossing onto a platform would highlight pedestrians and reduce speeds at the point of conflict.

Raising the whole intersection on a platform would reduce speeds through the whole intersection and improve driver reaction time and reduce crash severity, however this would cover a large area and the immediate effect of the platform on speeds would be at the entry/exit points rather than at the conflict locations.

Recommendation:

- Zebra – maintain two stage pedestrian crossing in the same location. This can be a wide central refuge or if the stagger is retained, it can be reversed so pedestrians face oncoming traffic when walking in the median. Installation on a raised platform would reduce speeds at the conflict points. Staggered pedestrian crossings can stay as 4m wide zebra crossings or a total width of 8m subject to volume calculations for refuge storage if the sight distance for the current crossing layout meets requirements.

Figure No. 5: **Example – zebra crossing on a raised platform with a central refuge**

- An alternative is to signalise the two stage pedestrian crossing if volumes are sufficient to warrant this. The stagger is recommended to be retained in this situation to support crossing operation with a change to a right-left stagger. This would need to be modelled to evaluate the impact and confirm whether the whole intersection should be signalised. A signalised crossing would manage priority and create gaps in traffic for other crossing locations and for the side road intersections. A zebra crossing gives priority to pedestrians based on demand where with a signalised crossing you can share priority based on pedestrian and vehicle demand. If you are expecting high volumes of pedestrians or high volumes at specific times signals can better manage priority and congestion. This is subject to road and pedestrian volumes being sufficient.

4.1.2 Pohutukawa Street

- Existing: at grade 2 stage single pedestrian zebra crossing with median refuge island (with red surfacing under the zebra bars) safe hit posts to adjust the edgeline entry taper from Oxford Terrace, streetlighting.
- Proposed: at grade 1 stage pedestrian zebra crossing

The existing crossing is a 2-stage crossing as the road width at the intersection is approximately 15m. For any crossing distance over 10m a staged crossing is recommended (and required at 15m) to provide protection and a location for pedestrians to pause in the median. Single stage crossings increase congestion as drivers are required to stop for all pedestrians rather than for pedestrians crossing on their side of the road.

NZTA recommends crossings close to intersections are in low speed areas and the crossing is set back to provide space for a turning vehicle to yield to pedestrians out of the stream of through traffic.

Recommendation – change kerbline for entry (east) to reduce radius, move crossing south to provide storage space for 1 vehicle at the intersection. Raise crossing on a platform. Retain median refuge if crossing width exceeds 10m at new location.

4.1.3 Knights Road

- Existing: refuge island through Right Turn Bay with speed cushions on both west approach lanes
- Proposed: no change

The existing pedestrian refuge is within the head of the right turn bay. Pedestrians using the refuge would conflict with a vehicle waiting to turn. There is no kerb ramp on the southern side of the crossing and pedestrians cross into the Pohutukawa Street intersection where they are in conflict with left turning traffic. There are speed cushions immediately in advance of the crossing on the western approach. We can assume the zebra crossing on Oxford Terrace provides speed management for westbound traffic on occasion

Recommend – move the median gap west to ensure it is at least 1 car width behind the right turn bay limit line and allows establishment of kerb ramps on both sides of the intersection. Raise the crossing on a platform and sign as a courtesy crossing. Relocation – may require parking space removal to provide sightlines. Add side islands to reduce crossing distance. Mark the edgeline from Pohutukawa Street west to the parking bays on Knights Road to guide turning traffic and provide space for the side islands.

4.1.4 Birch Street

- Existing: pram ramps
- Proposed: Wide pedestrian zebra crossing

There is an existing build-out on the eastern side of Birch Street which shortens the pedestrian crossing distance. The existing crossing point is approximately 8 metres from Oxford Terrace and should be retained as it is an existing desire line and meets safety guidance.

NZTA recommends crossings close to intersections are low speed areas and the crossing is set back to provide space for a turning vehicle to yield to pedestrians out of the stream of through traffic.

A wide zebra crossing is not recommended as it increases the sighting distance between drivers and pedestrians and encourages pedestrians to cross diagonally, reducing their visibility to traffic and safety.

Recommendation – use existing pram ramps location for the proposed zebra crossing, raise on a platform, add streetlighting. Shorten crossing length proposed.

4.2 South of Waterloo Station

Figure No. 6: Existing

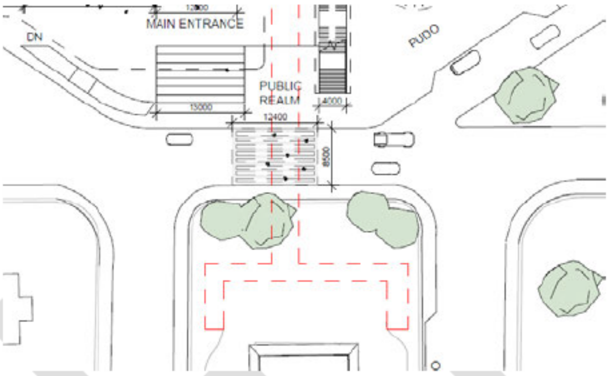

Figure No. 7: Proposed

4.2.1 Cambridge Terrace:

- Existing: underpass
- Proposed: Signalised Pedestrian Crossing

Cambridge Terrace is <10m wide and carries over 12000 vpd. Pedestrian volumes have not been specified, however this will be a main entrance so a signalised pedestrian crossing is a suitable crossing type to manage safety and priority for pedestrians and traffic. To manage speeds, it is recommended the crossing be on a raised platform and side islands be included to reduce the distance pedestrians are exposed to traffic and provide locations for traffic signal poles out of the footpath if possible.

The crossing width should not be excessive as this increases the total crossing footprint, reduces intervisibility between pedestrians and drivers, potentially increases the distance pedestrians need to travel to access a pushbutton and affects the visibility of signal displays to approaching traffic.

4.2.2 Trafalgar Square

- Existing: Refuge islands and Give Way controls
- Proposed: Raised Safety Platform

Trafalgar Square has a 30km/h speed limit and a measured operating speed of 21km/h. The road widths are 13.3m which is a long distance for pedestrians to cross without support. At both intersections there is an existing refuge island to support pedestrians and Give Way markings.

To help define the pedestrian route to the station, raise the profile of pedestrians and support lower traffic speeds a raised safety platform or courtesy crossing is proposed at the intersection. This should include refuge islands to guide traffic and provide support for pedestrians. Side islands would also support slower entry/exit speeds at the intersection and shorten the crossing distance. Ideally this should provide at least 6m of space between the Give Way limit line and the refuge to allow vehicles to enter and exit without blocking the pedestrian desire line.

Courtesy crossing	Pedestrian platform
	
Courtesy crossings are intended to facilitate eye contact between pedestrians and drivers resulting in a mutually negotiated position over who goes first.	On their own pedestrian platforms provide a focus for pedestrians to cross, however pedestrians must still give way to vehicles.

Figure No. 8: NZTA Pedestrian Network Guidance – non priority crossing aids

5 Background Data

Speeds from Mega Maps, ONF, width and volumes from Mobile Road

Table No. 1: Road Characteristics

Road	Posted Speed Limit (km/h)	Operating Speed (km/h)	ONF	Width (m)	Traffic Volume (vpd) 2025 estimate
Knights Road	50	46	Primary Collector	14.9	25531 2% HCV
Birch Street	50	30	Secondary Collector	13.3	1078, 0% HCV
Oxford Terrace	50	41	Primary Collector	8.6	7880, 5% HCV
Pohutukawa Street	50	42	Primary Collector	8.7	391 5% HCV
Cambridge Terrace	50	49	Primary Collector	10.7	12317 2% HCV
Trafalgar Square	30	21	Secondary Collector	13.3	3323 3% HCV

Figure No. 9: Crash History 2019-2023 (Mega Maps)

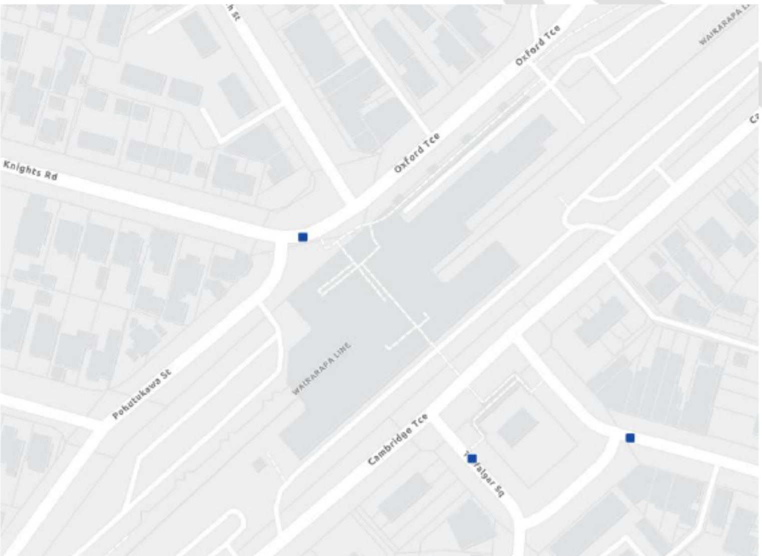

Table No. 2: Crash Details

Oxford Terrace

Rear End Crash, Minor Injury, Sept 2022 11:20am

Factors - alcohol test below limit, failed to notice vehicle slowing, stopping or stationary in front

Trafalgar Square

Manoeuvring Crash, Minor Injury, March 2023, 5:59pm

Factors - Drugs Suspected, Other inappropriate speed conditions, Intentional Collision

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