University of Melbourne
Faculty of Architecture, Building and Planning
Master of Urban Planning
Autonomous Vehicles in Suburban Melbourne Studio

Project Title:

Kerbside Management and Automated Vehicles

Oakleigh Train Station

Presented by:
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Executive Summary

This project explores kerbside management strategies for future transport changes, particularly shared mobility and automated vehicles. Findings inform what kerbside management strategies are needed to allow transport innovations whilst protecting sustainable and active transport modes. Limitations and opportunities to integrate kerbside management in strategic planning practices in Victoria are also studied. To understand the existing conditions of kerbside management, Oakleigh Train Station was used as a case study.

Introduction

Objective of the Studio

The Autonomous Vehicles in Suburban Melbourne Studio is an interdisciplinary studio for Master of Urban Planning students and Master of Architecture students. The objective of the studio is to test the extent to which Autonomous Vehicles (AVs) can meet expectations for better use of the public realm, by practical testing of space requirements in real locations in suburban Melbourne.

Methodology

This project intents to address the objective of the studio in four main parts. First, automated vehicles as a technological innovation and as a transport challenged are studied. Secondly, the role of urban planning in the deployment of automated vehicles is explored. Third, kerbside management is introduced as a strategic tool to respond and anticipate for future transport challenges.

Finally, current use and management of the kerb is studied in a suburban train station and potential applications of kerbside management strategies are explored.

Content

1. Automated Vehicles

Automated vehicles, also known as driverless or autonomous vehicles, are vehicles equipped with hardware and software capable of performing all the operational and tactical functions required to operate a vehicle without the need of a conventional driver
(SAE 2016). This definition does not exclude remote driving, which means, a vehicle that is remotely driven by a human is also considered an automated vehicle.

Levels of automation have been defined to allocate car manufacturing innovations to the market into 5 levels. Lower levels of automation (1-3), imply a lower role of humans performing the operation and tactical functions of vehicles whilst higher levels of automation refer to a software and hardware capable of performing these functions in sustainable basis. While level 0 corresponds to no driving automation, levels 1 and 2 include driver assistance and partial driving automation such as cruise control. On the other hand, levels 3, 4 and 5 are more complex. To understand the implications of these automation levels, two concepts need to be introduced, DDT fallback and operational design domain (ODD).

First, a DDT fallback is the response by the user or by the automated vehicle to perform the operation of a vehicle or to achieve a minimal risk condition when a system failure occurs.

A DDT fallback can also be needed when a vehicle is exiting its ODD.

Secondly, an ODD or operational design domain, perhaps one of the most important elements of automated vehicles, are is the specific conditions required for an automated vehicle to function.
Operational design domains can include geographic, environmental, speed, traffic or temporal limitations (SAE 2016). For instance, a vehicle may only be automated in daylight conditions, under 30km/h within Greater Melbourne Boundaries or within controlled roadways with heavy-traffic and no pedestrians.
Table 1 presents key differences between automation levels 3, 4 and 5.

Level 3 – Conditional Driving Automation	Level 4 – High Driving Automation	Level 5 – Full Driving
Ready user performs DDT-fallback	DDT performs DDT-fallback	DDT performs DDT-fallback
Limited ODD	Limited ODD	Unlimited ODD

Table 1

Whilst in level 3, the ready user, whether it is a human driver inside the vehicle or a remote human driver, performs the DDT fallback. In levels 4 and 5 the operational and tactical functions within the vehicle are capable of performing it. However, a remote driver performing this DDT fallback will upgrade an automated vehicle level 3 into an AV level 4, therefore, it is expected that car manufactures would include remote driving services to introduce vehicles under automation level 4. The remaining difference between a level 4 vehicle and a fully automated vehicles that a fully automated vehicle has an unlimited ODD. An unlimited ODD means that a vehicle is able to function on any road, at any time, under all geographical, temporal and traffic conditions. In other words, car manufactures would have to replicate the human driver without replicating human mistakes. According to Nikolaj Stache (head of the Artificial Intelligence Centre at Continental): *"this vision falls into the substitution of the human brain through artificial intelligence (which) is still a long way away (…)" (Stache 2016)*

If the success of artificial intelligence is set aside, along with the potential for some interesting science fiction realities, the limitations of automated vehicles become more relevant, particularly, those of ODDs. Therefore, a future is suggested where introductions and deployment of automated vehicles will only be under an automation level 4.

Without undermining the uncertainty of a technological innovation of this magnitude, it is fair to predict that automated vehicles will be deployed under major operational limitations, particularly compared to conventional vehicles. Understanding what these limitations are will provide a clearer idea of what transport challenges automated vehicles will introduce to cities.

Two main scenarios are expected for the deployment of AVs. The first is a scenario where AVs are a privately-owned mode of transport. The second is where AVs are part of a shared fleet of vehicles which could be competing or integrated with existing public transport services (UITP 2017). The second is a preferred scenario as it results in better mobility. Furthermore, if AV fleets are integrated with public transport services its deployment will not only result in better mobility but also likely in more equitable and sustainable transport modes.

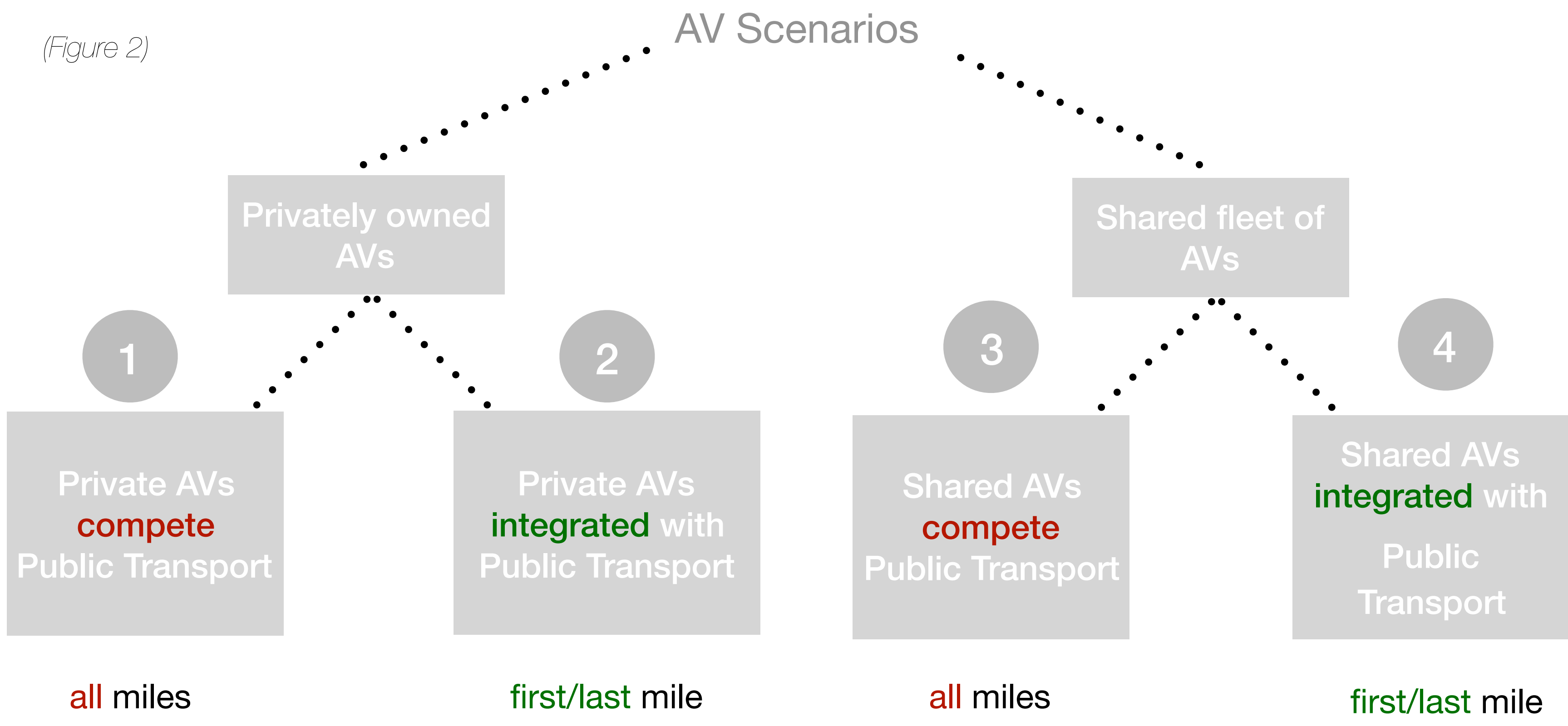
Space requirements can be explored under four main scenarios, particularly when differentiated by on-peak and off-peak hours. As illustrated in figure 3, space requirements during peak hours for all scenarios could be similar. For instance, they would all be using the road network and loading zones to deliver or pick-up and drop-off passengers. However, these spatial requirements become more complex and uncertain during off-peak hours.

For the case of a suburban train station such as Oakleigh, the promises of AVs freeing up space previously used for vehicle storage, such as on-street and off-street parking, are challenged. For instance, under scenario 1, private AVs will need to either use the road network to return to its “owner” parking space at home, long-term parking at destination (if technology does not allow AVs to drive without a ready user) or the use of the road network waiting for peak hours to come back again (if technology allows AVs to drive without a ready user). Even when predicting space requirements for shared AVs integrated with public transport and covering the first and last mile, AVs will require short-term and long-term parking space during off-peak hours or space on the road network.

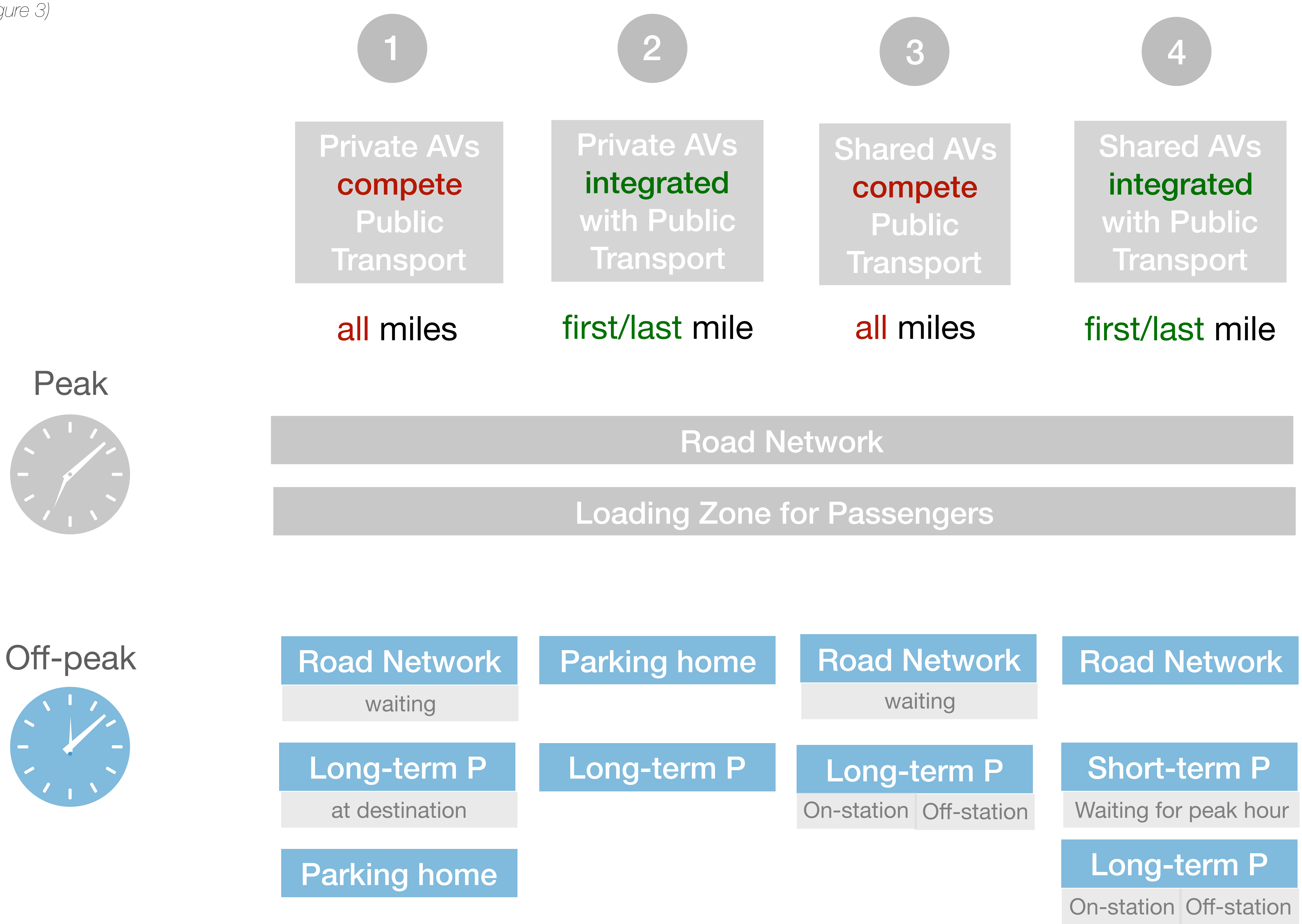
The fact that AVs can provide transport services in shared fleets, of which could potentially be integrated with public transport, does not mean that they do not require parking space when transport demand diminishes while passengers are at destinations during off-peak hours.

Despite uncertainty of future transport challenges arising from automated vehicles, space requirements of AVs are likely to follow patterns of conventional and traditional modes of transport, particularly those of existing for-hire shared services. Recent research has suggested that automated vehicles are likely to replace short distance trips in feeder services covering the first and last mile (ITF 2018).

(Figure 2)



(Figure 3)



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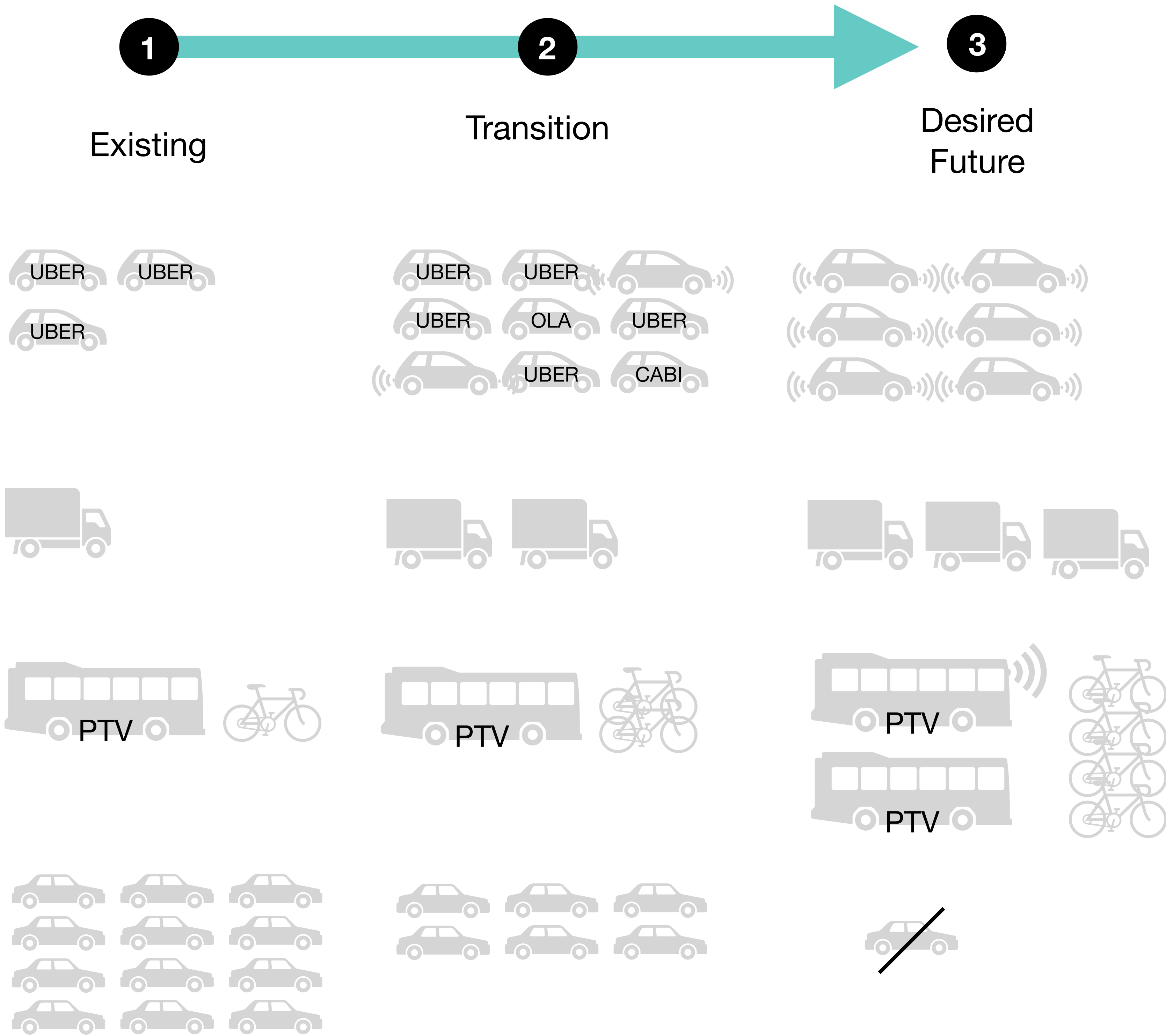
2
3
4
Private AVs compete Public Transport
Private AVs integrated with Public Transport
Shared AVs compete Public Transport
Shared AVs integrated with Public Transport
all miles
first/last mile
all miles
first/last mile
Peak
Road Network
Loading Zone for Passengers
Off-peak
Road Network
waiting
Long-term P
at destination
Parking home
Parking home
Long-term P
Road Network
waiting
Long-term P
On-station
Off-station
Road Network
Short-term P
Waiting for peak hour
Long-term P
On-station
Off-station

2. Urban Planning and future transport challenges

2.1 Future Transport challenges in Australia

Like many other countries, Australia is facing an urban transport revolution due to the more than 10% uptake of door-to-door hire-car ride services now being taken up in Uber vehicles and not taxis (Grattan Institute 2018). The Use of ridesharing services is increasing alongside the emergence of new TNCs such as Uber pool, Taxify and Olacabs. TNCs are regulated under the Road Safety Act (1986) and the Transport Integration Act (year) by the Taxi Services Commission. Victoria has a total of 9,757 taxi licences compared with 31,974 hire car licences mostly representing new entrants to the market in January 2008 (TSC 2018).

Ride-sharing particularly during off-peak hours provides lower prices compared to taxis, whilst also offering additional convenience through on-demand supply via mobile applications. Following statistics from the United States, most ridesharing occurs on weekends in the late afternoon and early evening, which is suggestive of demand for leisure trips.,. A second peak corresponds to the morning rush, suggesting that ride services are being used for commuting trips as feeders to public transport hubs or door-to-door trips.



Short trips under 5 kilometres currently dominate ride services and the length of trips is positively correlated with low density and low public transport availability and frequency (ITF 2018).

As identified, automated vehicles are expected to be deployed as for-hire share services. Therefore, in addition to existing for-hire share services, this will put additional pressure into the kerb. Particularly, the number of kerbside passenger pick-up and drop-off is expected to increase. Furthermore, not only will this shift towards ride-sharing require more space at the kerb. Additionally, the online revolution that has transformed shopping behaviour through such sites as eBay, Amazon, and Alibaba, has changed the number of goods being delivered to households and has therefore place more pressure on kerbside demand (NACTO 2017b).

2.2 The role of Urban Planning

Current planning practices are already being challenged by changes in economic, political, populational and geographical spheres. These shifts are making it more difficult to predict future mobility demands, and result in limited capacity to provide adequate regulation on time. Automated vehicles are not an exception, AVs are a technological-driven disruption with uncertain promises and perils and are only one of many future transport challenges.

The Victorian State government has recently introduced amendments to the Road Safety Act (1986) to establish a regime for the trialling of automated vehicles on highways. A permit system has been established that enables VicRoads to determine if a permit should be issued to conduct Automated Driving System (ADS) trials. The requirement for a vehicle supervisor to be in the AV is set out as a condition of the permit, and therefore it is up to VicRoads discretion to condition trials to include vehicles supervisors or not.

Transport agencies in Australia at Metropolitan levels of governance are taking a passive role in this transition due to the unpredictability of new forms of transport (Stone, et al. 2018). If governments continue to follow this trend, the future of our cities will follow self-governance styles entirely governed by independent private enterprises. This is contrary to a bureaucratic model were transport agencies are the lead organization managing deployment of new transport technologies (Rodriguez 2015).

It has become crucial to not only respond to, but to also anticipate the deployment of new technologies such as automated vehicles. It is critical to identify key elements expected during this transition and for planning to have a role during transition periods where not only new transport innovations are introduced, but where existing transport introductions are likely to increase, such as for-hire ride services.

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3. Kerbside Management

> *"Cities that prioritize transit in kerbside regulation will be one step closer to incentivize transit and shared-automated vehicles rather than single-occupancy or zero-occupancy vehicle travel"* (NACTO 2017a).

The introduction of automated vehicles and demand increased for shared-fleet of for-hire ride services have one thing in common: they will increase the number of kerbside passenger pick-up and drop-off. Furthermore, if for-hire vehicle travel becomes more affordable than other modes of transport, kerbsides will be under significant pressure (ITF 2018). Kerbside management is a combination of kerbspace assignment, time limits and meter rates that reflect changes in transport demand. Management of the kerb is expected to allocate space where it is most needed, reduce time spent by vehicles cruising near destinations or at the kerb. More importantly, kerbside management has the potential of shifting trips to public transport modes and to anticipate and adapt to new transport technologies (NACTO 2017a).

Despite the fact that the language used by transport strategies in Victoria in regard to automated vehicles is not conclusive, State, metropolitan and local strategic plans do establish a vision for a future where sustainable and active transport modes are dominant.

These strategic visions further imagine a future where car dependency diminishes, and shared fleets of AVs could potentially be supported under a scheme where they cover first/last mile trips integrated with public transport. This project uses this common vision to guide kerbside management as a strategic tool to anticipate, respond and adapt to future transport challenges.

Today, kerbside management has been devoted to short-term and medium-term parking in most urban areas. In the near future, kerbside management, if done successfully, will anticipate and respond to these challenges and consider allocating kerbside space based on demand, integrating the broad principles established within existing planning doctrine, and prioritising the allocation of space for high-capacity and active modes of transit.

Kerbside inventories and data collection processes are a fundamental starting point for kerbside management. Within Victoria, data on kerb use is significantly fragmented and poor. For instance, City of Melbourne is the only local government with on-street parking data available online. This includes parking sensors updating information every two minutes on current available parking spaces and their restrictions (City of Melbourne 2018). Other localities such as the City of Monash do have up to date information of the kerb and its use.

Four main documents were studied as they constitute the most updated blueprints and guidelines for kerbside management. These considered future transport challenges, such as shared mobility services and automated vehicles. Table 2 introduces these four documents:

Title	Author	Year
Curb Appeal – Curbside Management Strategies for improving transit reliability	The National Association of City Transportation Officials (NACTO)	2017
Blueprint for Autonomous Urbanism	NACTO	2017
Boston Complete Streets – Design Guidelines	City of Boston	2013
The Shared-use city: Managing the Curb	International Transport Forum (ITF)	2018

Table 2

In Boston Complete Streets, the City of Boston includes a chapter on Smart Kerbsides. This acknowledges the existing pressure as a result of passenger cars, delivery vehicles, and buses competing for this limited and valuable space. On the other hand, NACTO and the ITF recently released guidelines and strategies that emerge as a response to the on-going demand for kerb access reflecting the uptake of platform-based ride services and changing patterns of online shopping. NACTO and the ITF also identify the importance of kerbside management as anticipated planning and future instrument for automated vehicles, primarily as they are likely to be deployed as platform-based share ride services.

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As expected, these strategies complement each other and therefore provide the starting point for city authorities to anticipate, consider, test and to implement up to date kerbside management. This section of the report intends to aggregate and organize strategies and guidelines for kerbside management.

3.1 Kerbside Management Strategies

City authorities should establish strategies to guide future technology development and deployment and respond to the likely increase prevalence of for-hire ride services and automated vehicles. Strategies suggested by the documents studied are similar and can be divided in broad planning strategies and kerbside management strategies. Broad planning strategies are necessary when managing the kerb. For instance, policies that incentivize compact, accessible and sustainable cities lead to prioritizing walking, cycling, public transport and shared mobility whilst discouraging cars, vehicles and for-hire services with zero or single passengers. Community engagement in the decision-making process to re-allocate and implement kerb spaces is crucial to transition into future of shared and zero-emission services. Particular strategies for kerbside management are aggregated into 7 strategies and identified actions.

Strategy 1 – Broad Planning Vision

Integrate the broad planning vision by incentivizing compact, accessible and sustainable cities prioritizing walking, cycling, public transport and shared mobility whilst discouraging cars, vehicles and for-hire services with zero or single passengers.

- Provide space at the kerb for the most efficient uses that fit strategic priorities.
- Use of the kerbside should be possible and affordable regardless of age, gender, income and abilities. Grant queue-cutting priority, longer hours for people with mobility or cognitive disabilities.
- Gradually introduce changes such as removal of on-street parking and kerb access rates along with community engagement practices.
- Allow kerbsides to be flexible to adapt to future transport outcomes.
- Kerbside zones should be flexible and able to adapt to implications of future transport outcomes. They could change use over the course of the year, week, or even the day. Morning, mid-day, evening and late-night.
- For instance, if the uptake of ride services proves to work efficiently and reduces congestion improving transport options to all users, authorities should allocate more kerb space for these services, if they result in inefficient services, re-allocation of kerbside uses to other services should be flexible enough to allow a smooth management.
- Only support automated vehicles in shared zero-emission fleets.
- Allow transition to zero-emission vehicles by providing electric grids and electric vehicle charging.

Strategy 2 – Efficiency

Kerb access should be prioritized for transport modes that move more people in fewer vehicles and use less space at the kerb.

- Clear the way for public transport by prioritising its access to critical locations and repurposing sections of the kerb, such as only-bus lanes.
- Use street and kerb design to clear the way for Public Transport:

- Removing on-street parking and using space for left-turn pockets to reduce delays.
- Using space for left-turn only except buses lane where a phase is activated when buses are near to clear left-turning vehicles.
- Allocating queue jump lanes in peak hours and parking and loading in off-peak hours

Strategy 3 – Data and Connectivity

Open data, data infrastructure and monitoring supporting shared transport services enables interoperability, competition and innovation. City authorities should work towards the integration and connectivity of people, vehicles and networks. For instance, bicycle and car-share stations and transit route information can be enhanced with real-time information allowing transport nodes and transfers between services to be more efficient and reliable. Real-time parking availability information reduces time spent by vehicles cruising for parking. Re-evaluation of physical and digital infrastructure.

- Develop common standards to encode information about the kerb that can be shared freely among private and public bodies to allow data collection, monitoring and enforcement processes.
- Provide information infrastructure such as traffic cameras, multi-space meters, parking sensors, occupants monitoring, variable pricing, digital tags, slot reservation.
- Provide information regarding parking availability to decrease cruising for parking and double-parking.

Strategy 4 – Pricing models

Consider the introduction of a pricing model where every vehicle pays their share for road use, congestion, pollution and for the use of the kerb taking into account operating, maintenance and social costs.

Experiment pricing in critical areas where and when is most needed.
Some models are:

- To avoid empty travel examine introducing price time in service differentiated by in-use and non-passenger transport time.
- Per-hour rates for commercial and delivery trucks at peak hours to incentivise delivery activities at different times of the day.
- Progressive parking charges, for instance, lower rate the first 15min and higher rate for additional minutes.
- Aim for a demand responsible system and self-adjusting kerb spaces that consider the use of the street, traffic flow and public transport routes.

Strategy 5 – Governance

Create bodies to manage the kerb or integrate its management to existing planning and transport bodies where its more suitable.

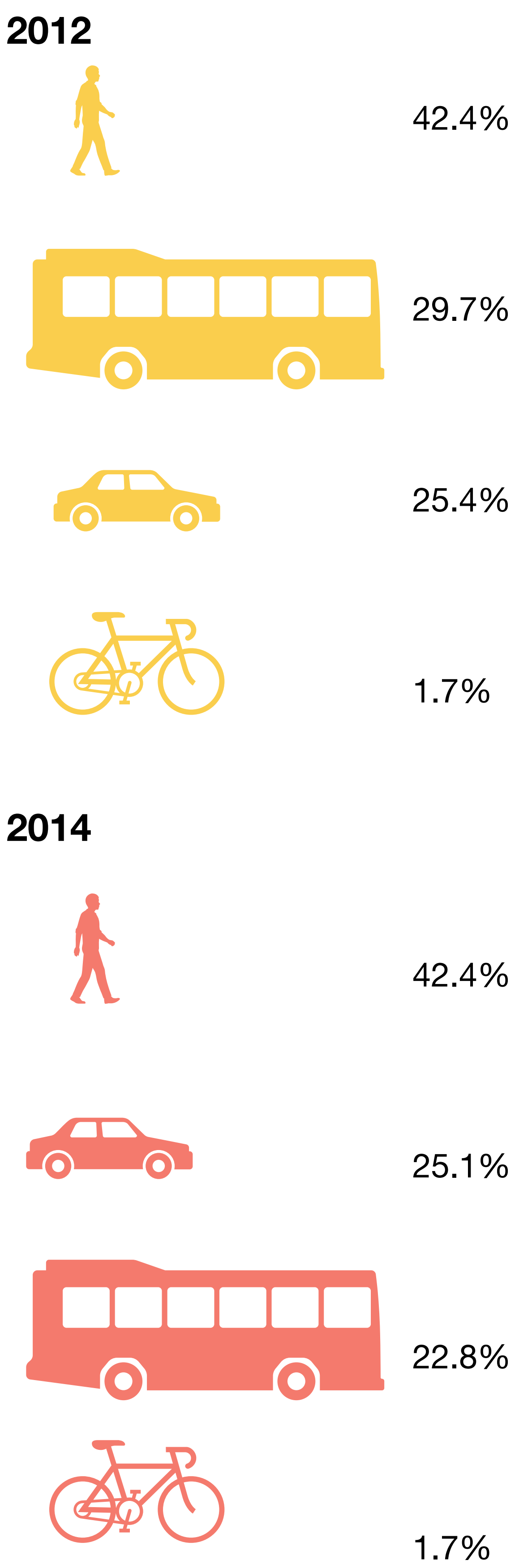
- Allow experimentation of kerb space re allocation and pricing models at critical streets.
- Gradually introduce changes along community engagement processes.
- Non-transport related uses of the kerb are also important; city authorities should find a balance and also allocate space for alternative uses such as: vendors, public seating, digital and green infrastructure, delivery lockers, market, parklets, food trucks, access for emergency services, fire hydrants, etc.

4. Oakleigh Train Station

Oakleigh Train Station is located in the Eastern sub-region of Melbourne within the local boundaries of the City of Monash. The suburb has a current population of approximately 7,893 people with a median age of 37. 2,000 families are estimated to live in Oakleigh, with 1.7 children per family (ABS 2016). The Population in the City of Monash is estimated to increase by 2036 to 214,649 residents, which corresponds to 8,628 residents in Oakleigh by the same year (.idcommunity 2017).

Almost 90% of residents are full-time and part-time employed. Out of these, 58% commute to work in private cars, 20% commute by train and the remaining work at home or walk to work. Access statistics indicate an annual patronage of 2,045 people to the station (approximately 20% of its population), weekly entries are higher during the AM Peak (7am to 9.29am), followed by the afternoon peak (3pm to 7pm) and an interpeak of 1,502 passengers between 9.30am and 2.59pm (Public Transport Victoria 2015).

Weekday entries to the station are led by residents walking to the station. In 2012, the second dominant mode of access to the station was via buses, whereas in 2014 it was instead through private cars.



Oakleigh Train Station is owned by the Victorian Rail Track Corporation (VicTrack) and is located on the Pakenham and Cranbourne lines, approximately 15km from Southern Cross Station. Immediate train stations along the corridor are Hughesdale to the north-west and Huntingdale to the south-east. These stations are located within 2km from Oakleigh, particularly Hughesdale which is only 1km away.

4.1 Policy Context

Monash City Council identifies Oakleigh as the second major Activity Centre within the municipality after Glen Waverley. Strategies under the planning scheme encourage medium to high-rise development (4-8 storeys) located adjacent to the train station, greater public transport linkages and service, as well as the *"provision of parking to meet the needs of the centre."*

The Monash Integrated Transport Strategy (year) provides directions to promote sustainable transport options. Actions within this direction include: *"Conduct assessment of current and emerging transport technologies, including autonomous vehicles and on-demand public transport"*, *"Advocate to PTV to implement trial of mini-buses to act as feeder service to train stations"* as well as strategies to increase frequency of bus operators and improve conditions at bus stops (City of Monash 2017).

Another significant direction outlined in the Monash Integrated Transport Strategy is the management of car parking. Actions relevant to kerbside management and automated vehicles within this direction include the following:

E3: Implement a street space management strategy to include roadside kerb space priority.
E5: Investigate the potential for new car share schemes in new larger residential developments.
E11. Prepare parking database to collate information on total number, location and occupancy of parking spaces in Activity Centres to assist with future planning and assessment.
E15. Continue to investigate and invest in new technologies and car parking best practice to promote most efficient use of space allocated to car parking within Monash.

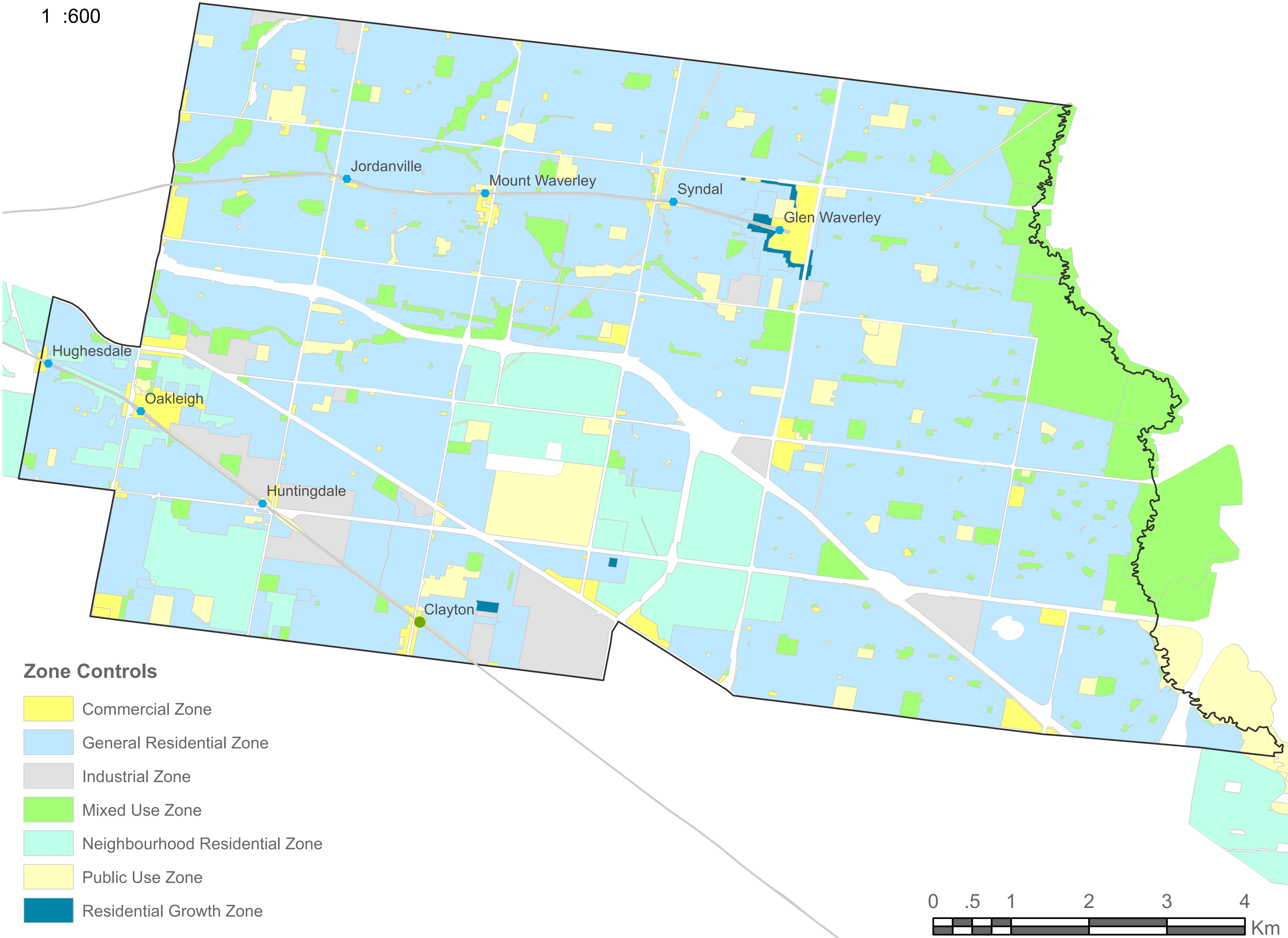
Finally, Monash has also established kerb street priority to residential, activity centre, hospital/community facilities and higher education areas by user (Table 3).

Table 3

User Category	Priority	Residential	Activity Centre	Hospital/ Community Facilities	Higher Education
Safety Zone	Safety is the highest priority in all situations.	1	1	1	1
Public Transport Zone	Public transport is the second highest priority in all situations for efficiency, environmental and social equity reasons. Typically bus stop. Also includes provision of cycle and bus lanes and bicycle parking on a location specific basis.	2	2	2	2
Disabled Permit Zone	People with disabilities are the third highest priority across all situations for social equity reasons.	3	3	3	3
Car Sharing	On-street parking spaces for car sharing assist in reducing overall parking demand and therefore are encouraged.	4	6	8	4
Residents (including visitors)	Residents are the next highest priority in residential areas. In Major Activity Centres residents should not expect priority access to on street parking.	5	7	4	5
Loading zone	Loading zones have a medium priority in all areas to support local economic activity. In residential areas loading operations should be conducted on-site wherever possible.	6	5	6	6
Customers	Customers have medium priority in Major Activity centres and residential areas	7	4	5	11
Local employees	Local employees are encouraged to use alternative modes or use the least convenient car parking- leaving more convenient spaces for customers	8	8	7	9
Commuters	Commuters have medium-low priority in all areas. They require access to specific locations such as railway stations and bus stops. This also includes park and ride spaces.	9	9	9	7
School Zone	School students have low priority in residential and activity centre areas as most school students are under the legal driving limit and in an attempt to encourage more sustainable transport options to commute to school.	10	10	10	8
Commercial Zone	Using the kerb side for commercial activity is a low priority except in specific circumstances where Council has slowed traffic speeds and is encouraging pedestrian activities.	11	11	11	10

Table 3. (City of Monash 2017)

Figure 7


1 :600
Jordanville
Mount Waverley
Syndal
Glen Waverley
Hughesdale
Oakleigh
Huntingdale
Clayton
Zone Controls
Commercial Zone
General Residential Zone
Industrial Zone
Mixed Use Zone
Neighbourhood Residential Zone
Public Use Zone
Residential Growth Zone
0 .5 1 2 3 4
Km

These strategies are reflected in current planning zones across Monash illustrated in Figure 7. Land surrounding Oakleigh Train Station is mostly zoned commercial and residential. Despite strategies outlined that encourage growth, Oakleigh has no Residential Growth Zones adjacent to the station, this could be due to the heritage controls reflected in the dominance of Neighbourhood Residential Zoning towards the south-west of the locality, and surrounding Oakleigh Train Station from all sides.

Oakleigh is currently acting as a residential and commercial suburb. It is not only a departure point for residents commuting to the CBD or commuting to the south-east of Victoria, but it is also a destination for commercial and leisure activities, as well as job location for some passengers. Industrial uses dominate Huntingdale and can result in spill over effects of residents to the east willing to use Oakleigh Train Station even if Huntingdale is closer.

4.2 Space at the station

13 bus routes service the station with 10 dedicated bus stopes accounting for 126 linear metres in total. Official car parks at the station provide 339 car parking spaces. 14 linear meters are dedicated exclusively for 'kiss and ride' drop of zone However, private vehicles also use nearby streets, taxi zones and other kerbspace to deliver passengers. (Figure 8)

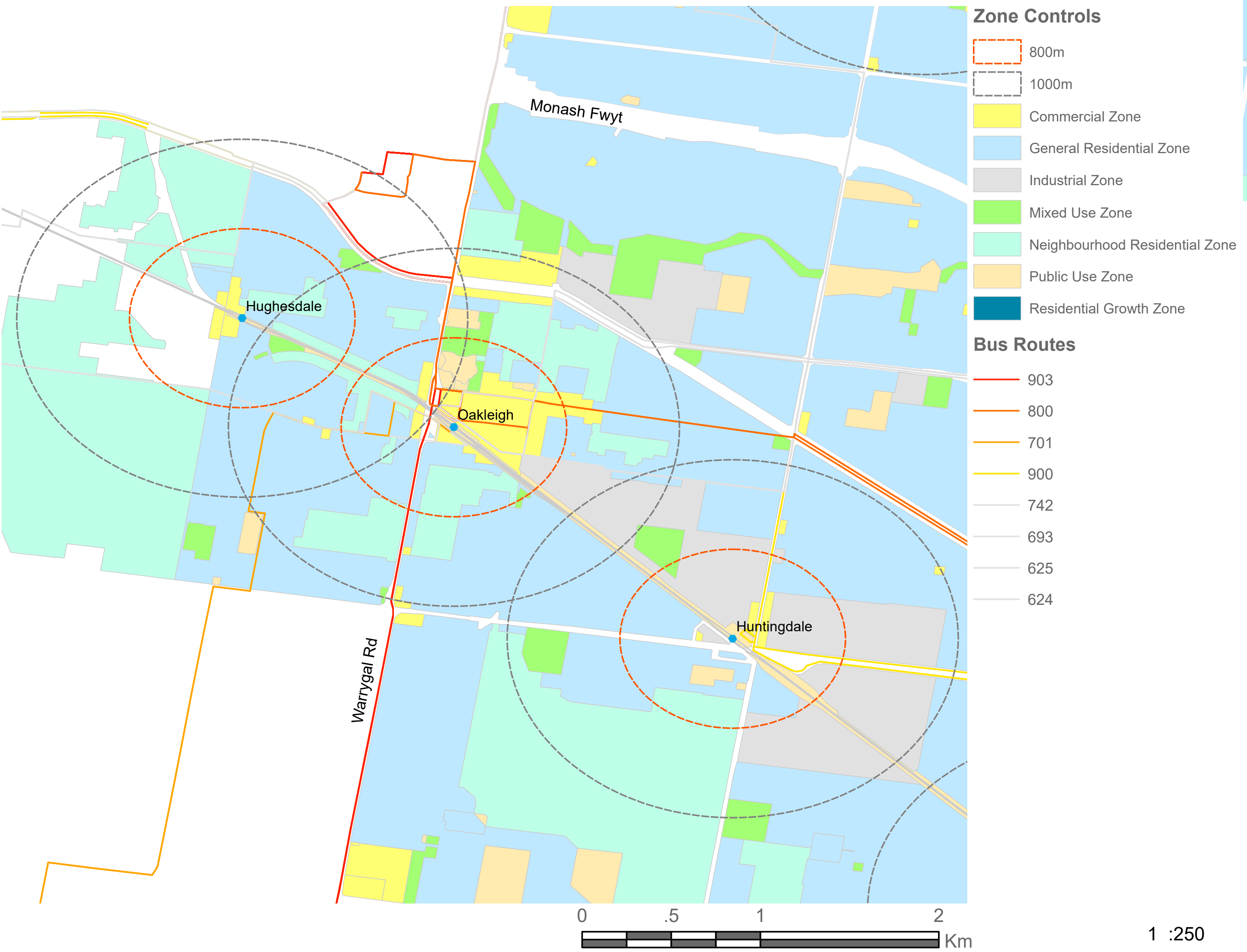
4.3 Data collection

To understand transport mode access to the station, data was collected at the train station for the morning and afternoon peak. During the morning peak, 7.30 to 8.30am a total of 143 people accessed the station by the 903 bus, 52 were dropped-off by a private car and 3 passengers arrived by taxi. During the afternoon peak, 5 to 6pm, a total of 124 people left the station using the 903 bus, 29 were picked-up by a private car and 7 passengers left using a taxi. Details of data collected are presented in Tables 4 to 7.
Data was collected by Master of Architecture Student Sienna Tardini and Maria Lasso Master of Urban Planning Student and author of this report.

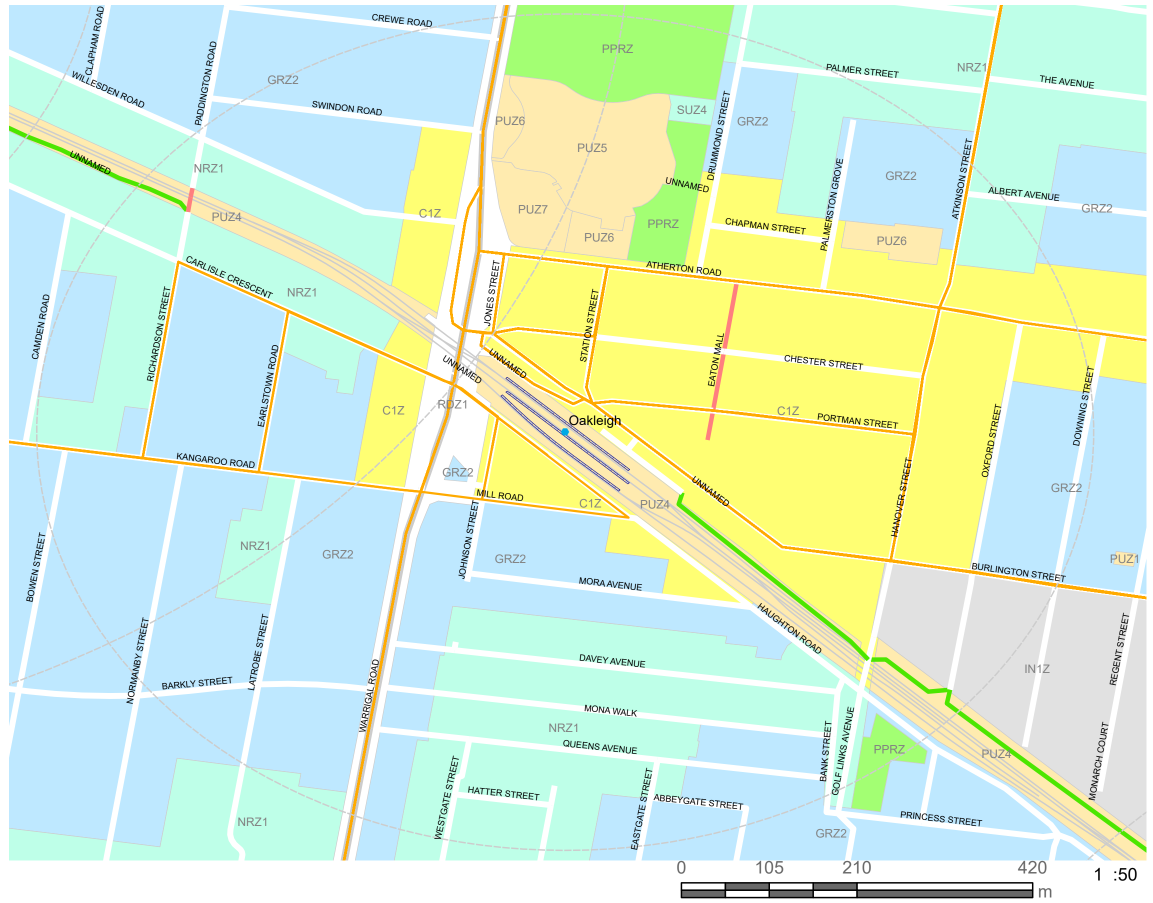
Bus Arriving	**Morning**	**7.30 to 8.30AM**	
Time	Bus No.	No. Ppl ON	No. Ppl OFF
7.34	903	3	3
7.43	900	7	7
7.44	900	19	0
7.5	903	8	6
7.58	900	7	0
8	903	28	30
8.06	900	18	5
8.08	903	15	8
8.1	900	1	9
8.12	903	40	25
8.12	903	7	6
8.14	900	17	0
8.2	900	4	2
8.24	900	10	1
8.25	903	19	4
8.29	903	20	16
8.3	900	1	3
8.32	903	3	1
8.38	900	8	3
Total	19	235	129
9	Total 903	143	99
10	Total 900	92	30

Table 4. Access by Bus (Morning Peak)

Figure 8



Monash Fwyt
Hughesdale
Oakleigh
Huntingdale
Warrygal Rd
Zone Controls
800m
1000m
Commercial Zone
General Residential Zone
Industrial Zone
Mixed Use Zone
Neighbourhood Residential Zone
Public Use Zone
Residential Growth Zone
Bus Routes
903
800
701
900
742
693
625
624
0
.5
1
2
Km
1 :250



CREWE ROAD
PPRZ
PALMER STREET
NRZ1
THE AVENUE
GRZ2
SWINDON ROAD
PUZ6
PUZ5
SUZ4
PUZ7
PPRZ
ATHERTON ROAD
CHAPMAN STREET
ALBERT AVENUE
CHESTER STREET
PORTMAN STREET
Oakleigh
KANGAROO ROAD
MILL ROAD
C1Z
PUZ4
MORA AVENUE
BURLINGTON STREET
DAVEY AVENUE
MONA WALK
QUEENS AVENUE
HATTER STREET
ABBEYGATE STREET
PRINCESS STREET
IN1Z
CARLISLE CRESCENT
BARKLY STREET
NRZ1
GRZ2
0
105
210
420
m
1 :50

Bus Arriving	Evening	5 to 6PM	
Time	Bus No.	No. Ppl ON	No. Ppl OFF
5.03	903	8	13
5.05	903	5	7
5.09	903	2	19
5.09	900	1	7
5.22	900	9	10
5.23	903	10	13
5.27	903	8	19
5.31	903	6	19
5.39	903	5	18
5.39	903	0	8
5.4	903	2	5
5.4	900	1	4
5.43	900	5	0
5.46	903	4	3
5.5	900	1	1
	15	67	146
10	Total 903	50	124
5	Total 900	17	22

Table 5. Access by Bus (Evening Peak)

Kiss and Ride	Morning
Drop off	52
Pick up	9
Total	61

Table 6. Kiss and Ride (Morning Peak)

Kiss and Ride	Evening
Drop off	8
Pick up	29
Total	37

Table 7. Kiss and Ride (Evening Peak)

5. Kerbside Management and Oakleigh Train Station

5.1 Study area

To study kerb space allocation around Oakleigh Train Station, a walking catchment analysis was conducted to the two main entrances of the station. A walking speed of 86 metres per minute was used. Figure 9 illustrates a walking catchment area for 0-5 minutes, 5-10 minutes and 10-20 minutes. Only streets within a walking catchment of 0-5 minutes are included in the study area for the purposes of measuring kerb space taken by on-street parking in streets where the eight most used bus routes use to feed the station.

Streets west to Warrigal Road were excluded from the study area. This decision was made when considering that walking catchment analysis does not include time waiting to cross streets, and therefore crossing an arterial road such as Warrigal Road would increase walking time to entrances to the station. Portman Street, Haughton Street, Station Street, Chester Street, Atherton Street, Mill Road, Mora Avenue, Johnson Street and Jones Street were streets included in the analysis (Figure 10). All streets are local streets controlled by Monash City Council, however, kerb space of roads immediately adjacent to the station, such as Portman Street and Haughton Road is owned by Transport for Victoria and VicTrack.

The private road south to Portman street label as ‘unnamed’, has not been included in the analysis as it corresponds to a private road used to access Coles car parking. However, this road is of particular significance, as it is immediately adjacent to the station and provides underground access from Burlington Street to the Station.

5.2 Coding the Kerb

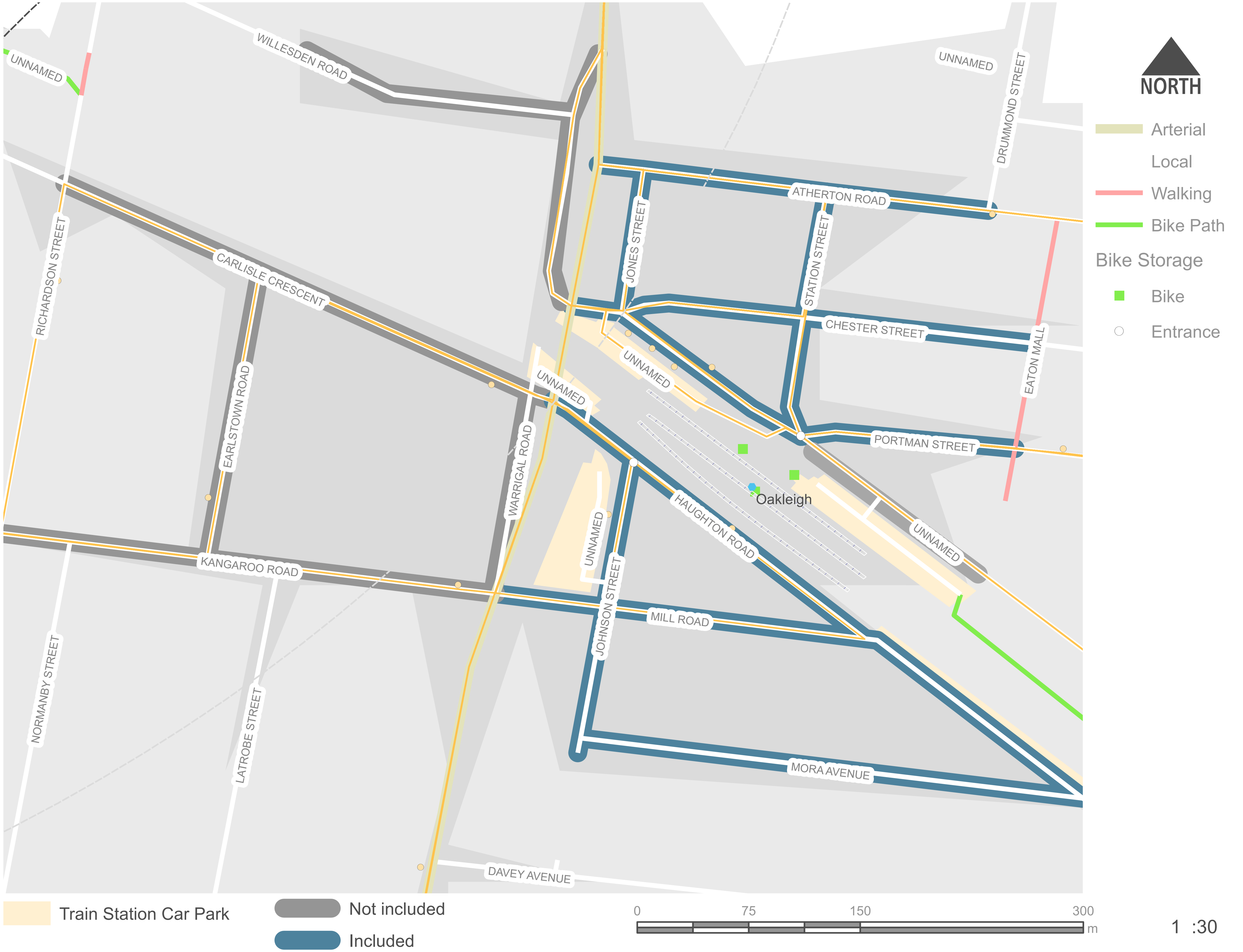
Figures 11-19 presents percentage of linear metres allocated for unrestricted parking, taxi zones, bus zones, 2-minute to 4-hour parking, loading zones and motorcycle parking out the total linear metres available for kerb use. Space available for kerb use excludes driveway entrances to buildings and non-stopping zones, therefore percentages add up to 100%.

Portman Street is located immediately to the north of the main entrance to the train station, official unrestricted parking was studied within the Portman Street analysis. Hence, results under Figure 11 show 59% of kerbspace allocated for unrestricted parking and 10% for 1-hour parking. This supports access to the station by private vehicles and park and ride. Taxi zones account for 14% of the kerbspace available, however, this area is currently under construction and this taxi zone and unrestricted parking previously located at the station would be replaced by a bus interchanged that will free up space towards the west on Portman Street.

Figure 9


EUSTON ROAD
LOGIE COURT
BLETCHLEY ROAD
CLAPHAM ROAD
CREWE ROAD
TAYLOR STREET
NELSON AVENUE
NORTH
PADDINGTON ROAD
WILLESDEN ROAD
SWINDON ROAD
PALMER STREET
THE AVENUE
DRUMMOND STREET
ATKINSON STREET
UNNAMED
Walking Cat.
ALBERT AVENUE
10-20 min
5-10 min
0-5 min
CHAPMAN STREET
PALMERSTON GROVE
CARLISLE CRESCENT
ATHERTON ROAD
CAMDEN ROAD
RICHARDSON STREET
JONES STREET
STATION STREET
EATON MALL
CHESTER STREET
EARLSTOWN ROAD
PORTMAN STREET
Oakleigh
KANGAROO ROAD
OXFORD STREET
Buffer
JOHNSON STREET
MILL ROAD
HANOVER STREET
800m
1000m
BURLINGTON STREET
DOWNING STREET
MORA AVENUE
Bus Routes
903
REGENT STREET
BOWEN STREET
HAUGHTON ROAD
800
NORMANBY STREET
LATROBE STREET
BARKLY STREET
DAVEY AVENUE
624
625
MONA WALK
693
WARRIGAL ROAD
QUEENS AVENUE
BANK STREET
GOLF LINKS AVENUE
MONARCH COURT
701
PRINCESS STREET
742
WESTGATE STREET
EASTGATE STREET
900
DALLAS AVENUE
HATTER STREET
ABBEYGATE STREET
WILLGILSON COURT
BISHOP STREET
Train Station Car Park
0
150
300
600
m
1 :60

Figure 10



NORTH
Arterial
Local
Walking
Bike Path
Bike Storage
Bike
Entrance
WILLESDEN ROAD
UNNAMED
RICHARDSON STREET
CARLISLE CRESCENT
EARLSTOWN ROAD
WARRIGAL ROAD
KANGAROO ROAD
NORMANBY STREET
LATROBE STREET
DAVEY AVENUE
JONES STREET
ATHERTON ROAD
STATION STREET
CHESTER STREET
DRUMMOND STREET
EATON MALL
PORTMAN STREET
HAUGHTON ROAD
Oakleigh
JOHNSON STREET
MILL ROAD
MORA AVENUE
Train Station Car Park
Not included
Included
0
75
150
300
m
1 :30

Remaining uses are allocated for loading zones and short-term parking, 10-minute parking and 30-minute parking.

Haughton Street is located immediately to the south of the second entrance to the train station (Figure 12). It accommodates 40% of unrestricted parking servicing the station and 22% of kerbside space allocated for buses, often replacement buses. Remaining uses are 2-hour parking and 2-minute parking.

Station Street located to the north of Oakleigh Train Station, between Portman Street and Atherton Road provides kerb 5% of its available kerbspace to a loading zone for the pub in the corner and other commercial uses, and the 95% remaining is reserved for 1-hour parking (Figure 13).

Chester Street is the only street providing space for motorcycle storage (4%) as well as the only street providing on-street disable parking. The remaining 24% is allocated to loading zones considering the intensity of commercial uses on the street and 68% to 1-hour parking (Figure 14).

Johnson Street and Jones Street are relatively short streets running in a north-to-south direction. Figure 15 illustrates various kerb uses along Johnson St. Most of the kerb is used for 2-hour parking (28), followed by residential parking (23%) and bus zones (23%).The remining space is used for 4-hour parking and 1-hour parking. Kerb space along Jones St only accommodates 2-hour parking (Figure 16).

Further away from the train station are the streets towards the end of the walking catchment service area. These streets are Atherton St, Mill Road and Mora Avenue. Atherton St to the north of the train station allocates 81% of its kerb space for 1-hour parking, 11% for 30-minute parking and 8% for bus zone (Figure 17). Mill Road and Mora Avenue are located in General Residential Zones and Neighbourhood Residential Zones, as illustrated in Figure 8. Therefore, most of the kerb spaces is allocated for permit restricted on street residential parking. The remaining uses are for 4-hour parking, 2-hour parking and 2-minute parking.

Figure 11

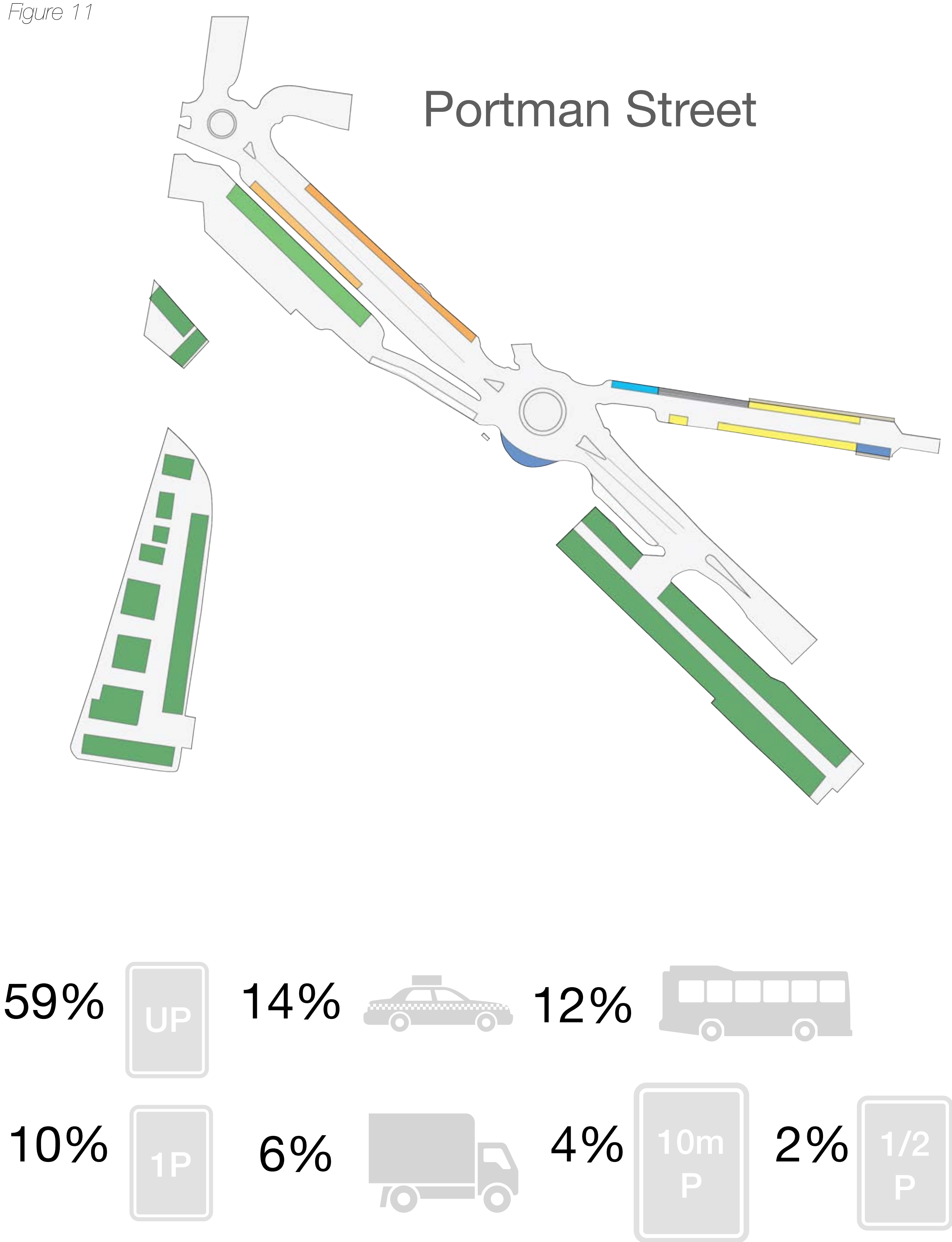


Figure 12

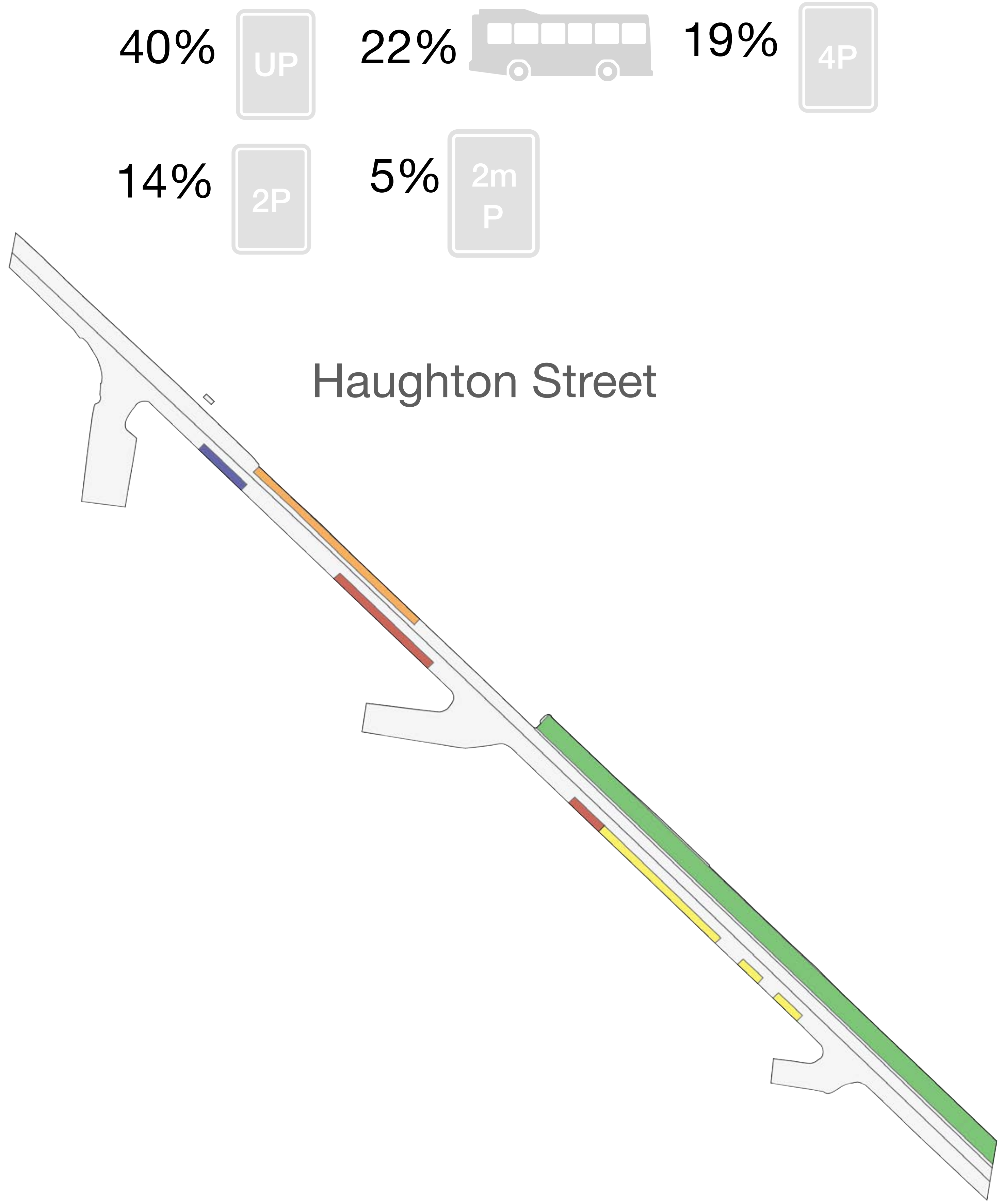
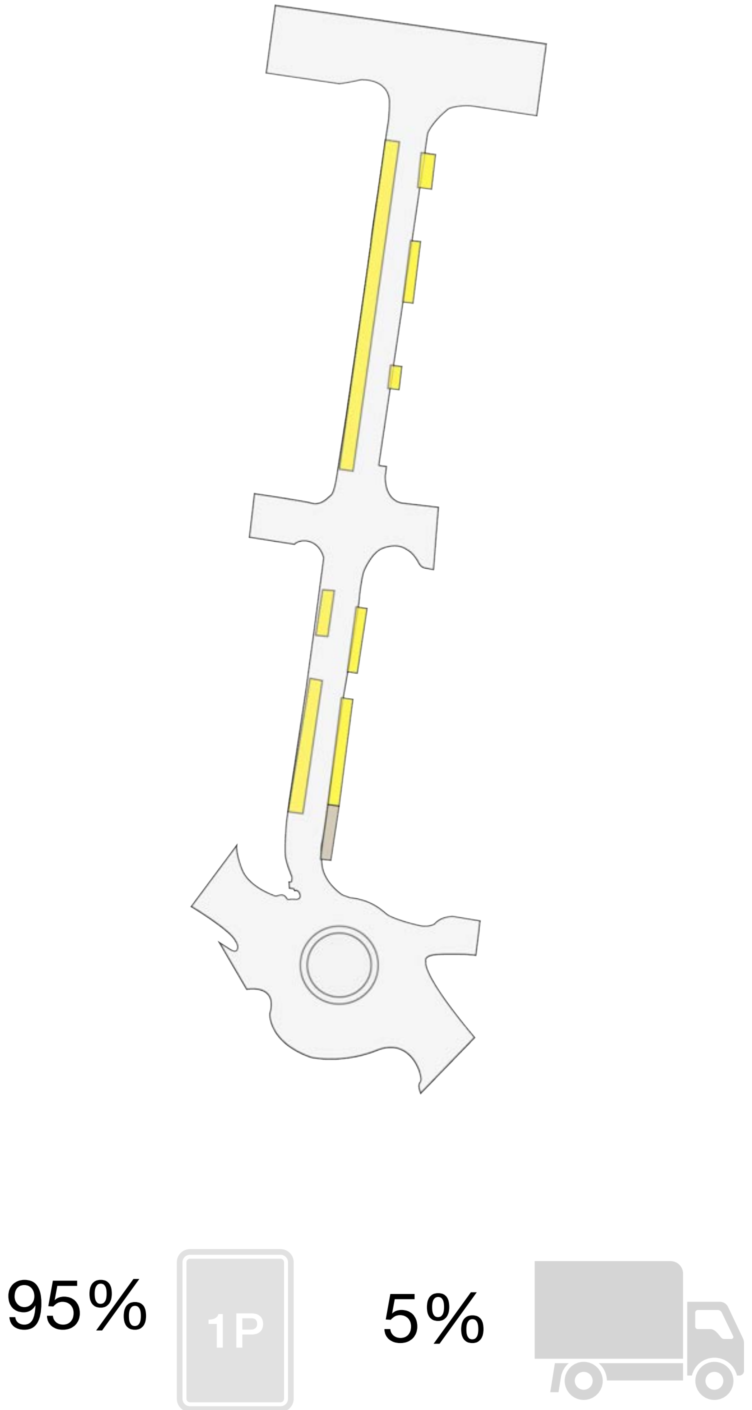
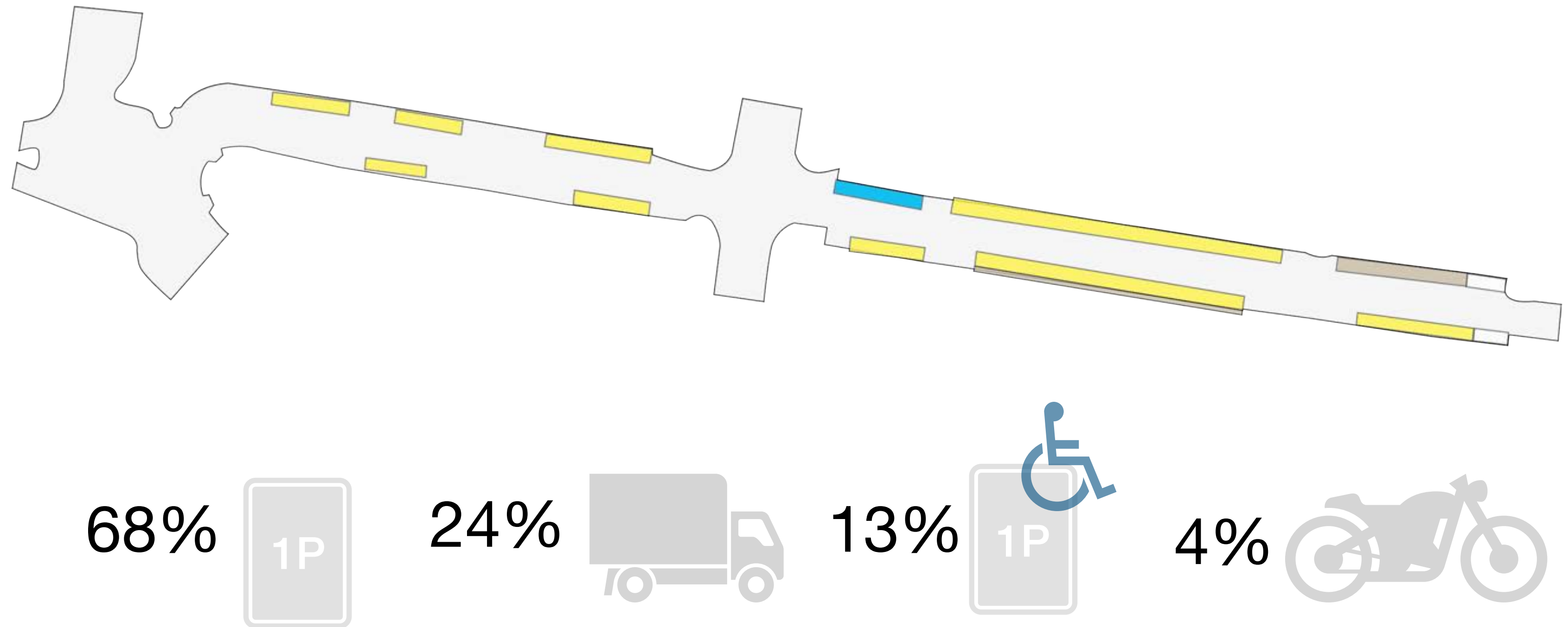


Figure 13



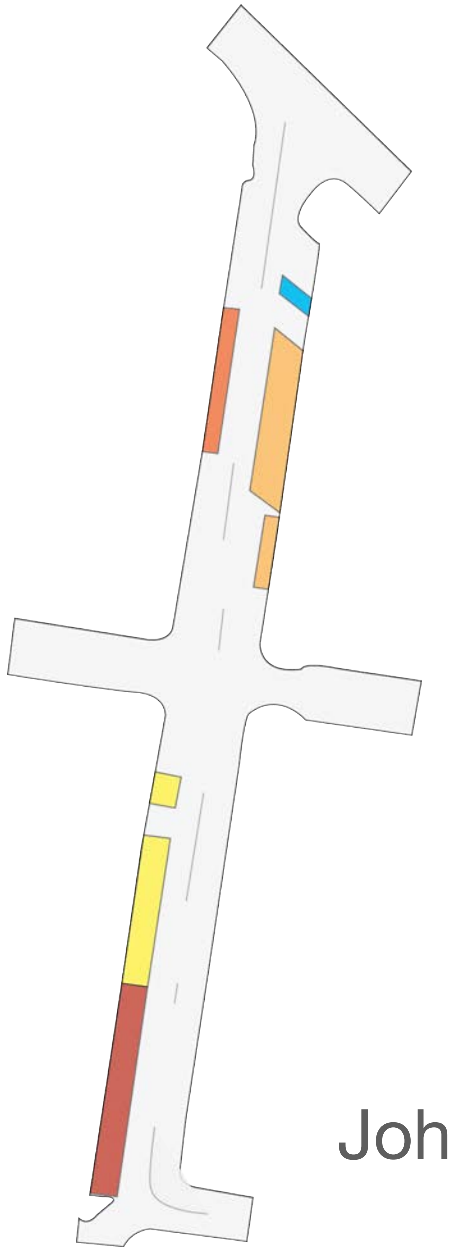
Station Street

Figure 14



Chester Street

Figure 15



Johnson Street

28% 2P

23% (school)

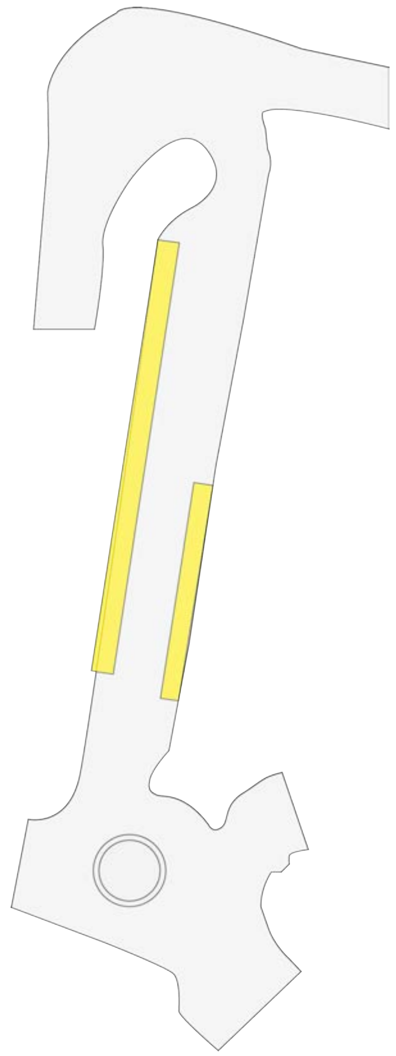
23% (bus)

21% 4P

4% 1P

Figure 16

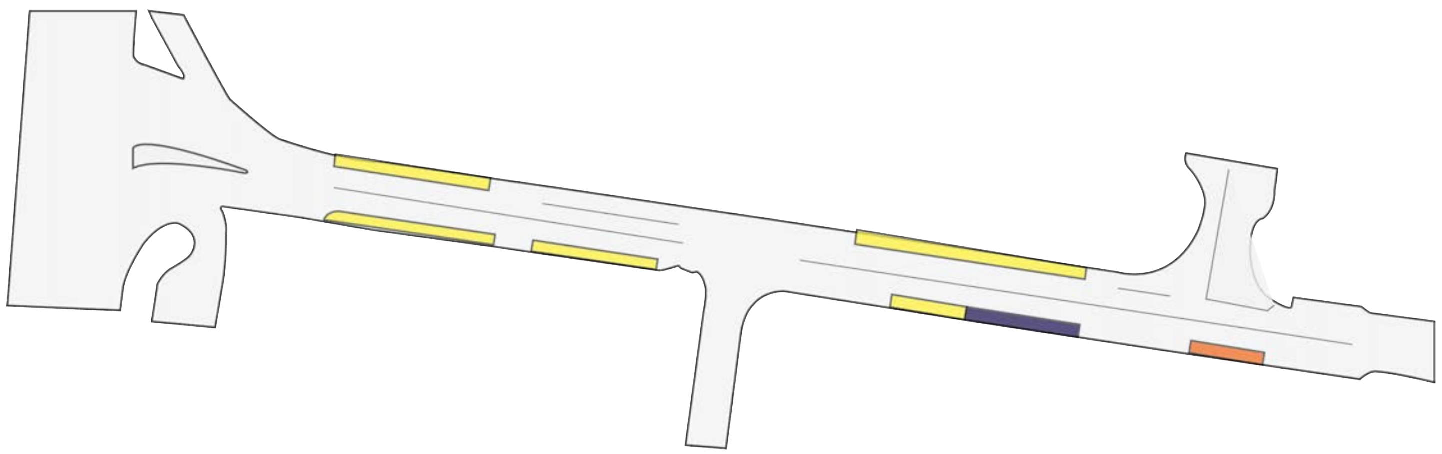
Jones Street



100% 2P

Figure 17

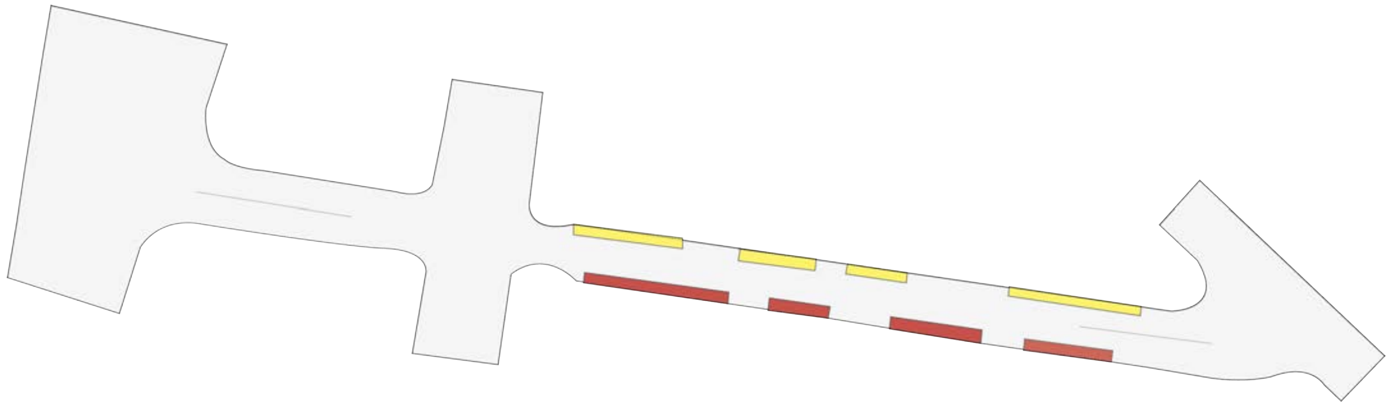
Atherton Street



81% 1P   11% 1/4 P   8% (bus)

Mill Road

Figure 18

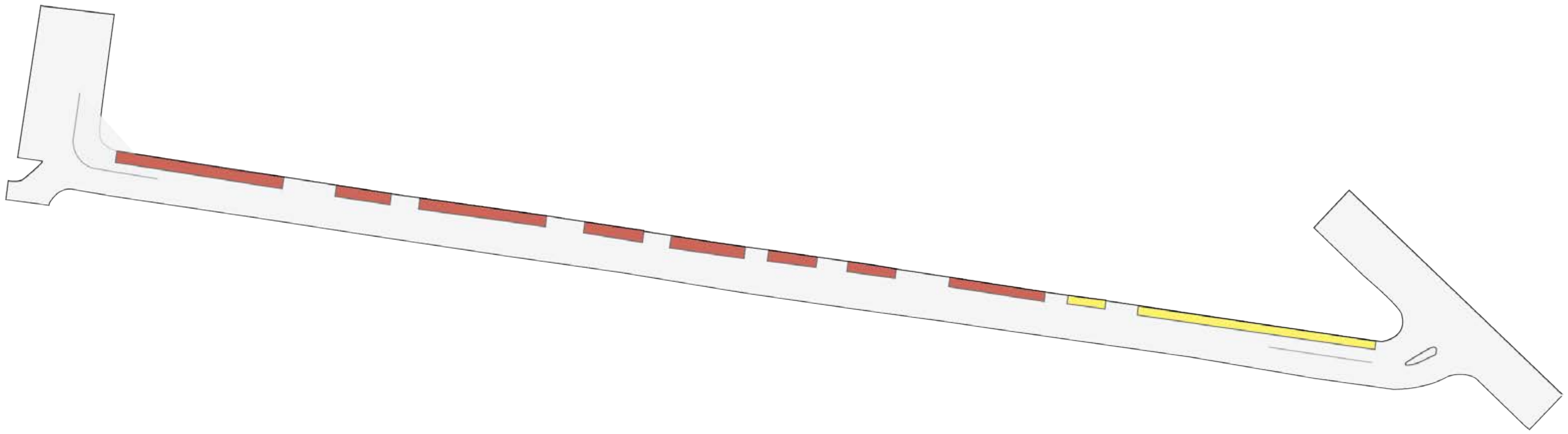


53%

47% 2P

Figure 19

Mora Avenue



38%

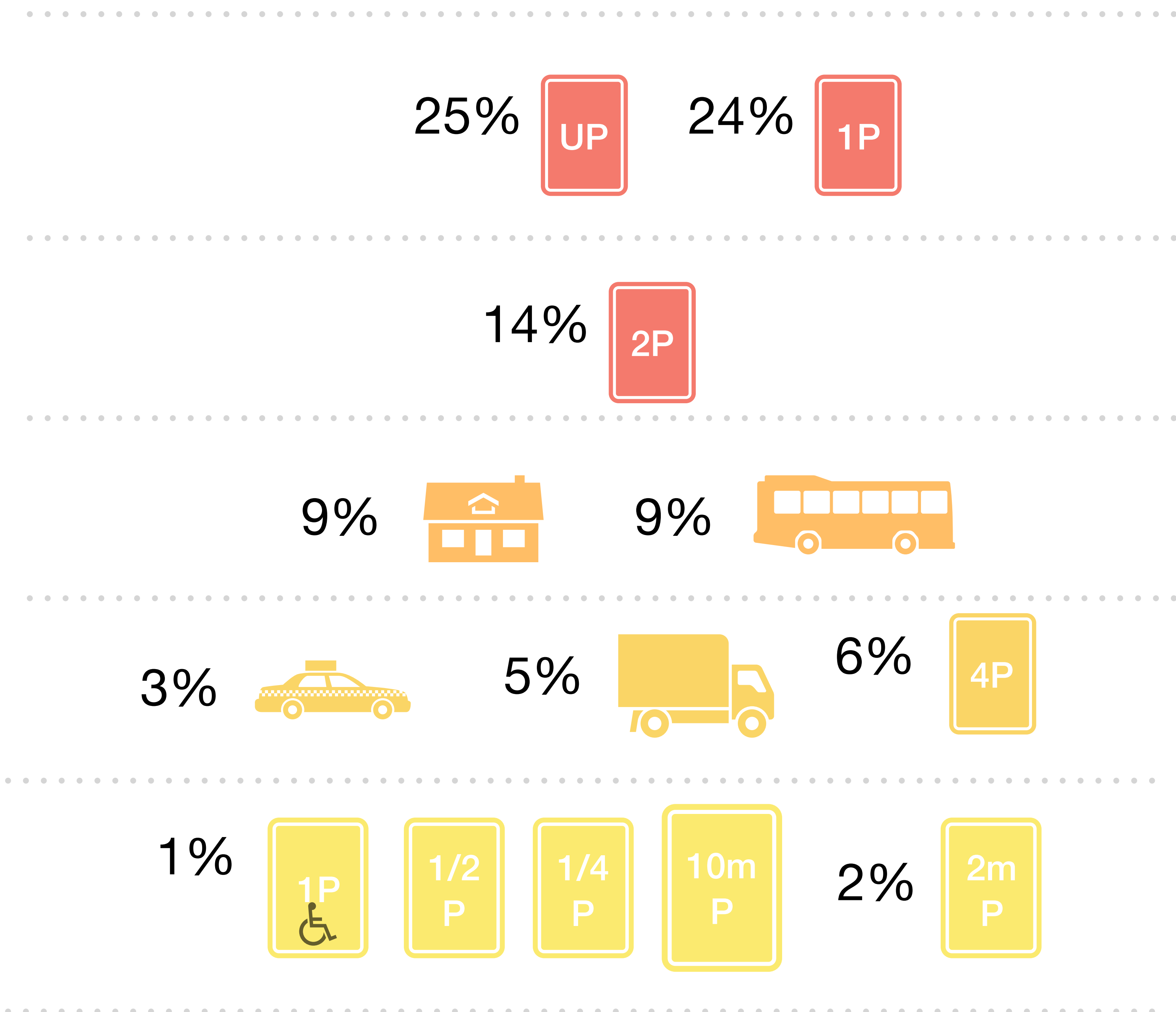
12% 4P 40% 2P 5% 2m P

5.3 Results

The allocation of kerbspace within walking catchment to the station of 0-5 minutes follows a traditional kerb use of suburban stations within Greater Melbourne. It is a result of balancing on-street parking and loading zones for commercial uses and space for access to the station such as unrestricted parking spaces, taxi and bus zones.

Figure 20 summarizes total space allocated at the kerb. As expected, unrestricted parking dominates kerb space allocation with 25% of available space used for this purpose. 25% is used for 1-hour and 14% for 2-hour parking both supporting commercial activities. In the middle is 9% of the space designated for permit zones for residential zones towards the further north and south of the train station, 9% for bus zones, mostly on immediate streets adjacent to the entrances of the station. Taxi uses and loading uses are towards the bottom with 3% and 5% of the kerb space. Finally, the remaining 1% is allocated for 30-minute, 25-minute, 10-minute and 2-minute parking.

Figure 20 Kerb Space allocation at a 0-5min walking catchment to TS



5.4 Recommendations

It has become crucial to not only respond to, but to also anticipate the deployment of new technologies such as automated vehicles. If city authorities do not anticipate and take an active role in this transition, automated vehicles will be deployed following market incentives which do not necessarily benefit the community.

The introduction of automated vehicles should be seen as an opportunity to the gradual disappearance of street parking.

City authorities, particularly local governments, should understand the impact of future transport changes in kerb access and on the road network. City authorities should establish strategies to guide experimentation such as kerbside re-allocation, design and pricing models. The first action all local governments should take is to ensure access to required metrics and monitoring systems to start measuring kerb use productivity and efficiency. Then, test kerbside allocation, pricing models and kerbside designs at a neighbourhood scale through community engagement processes. This will potentially lead to the integration of kerbside management in planning practices at local, state and federal level.

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