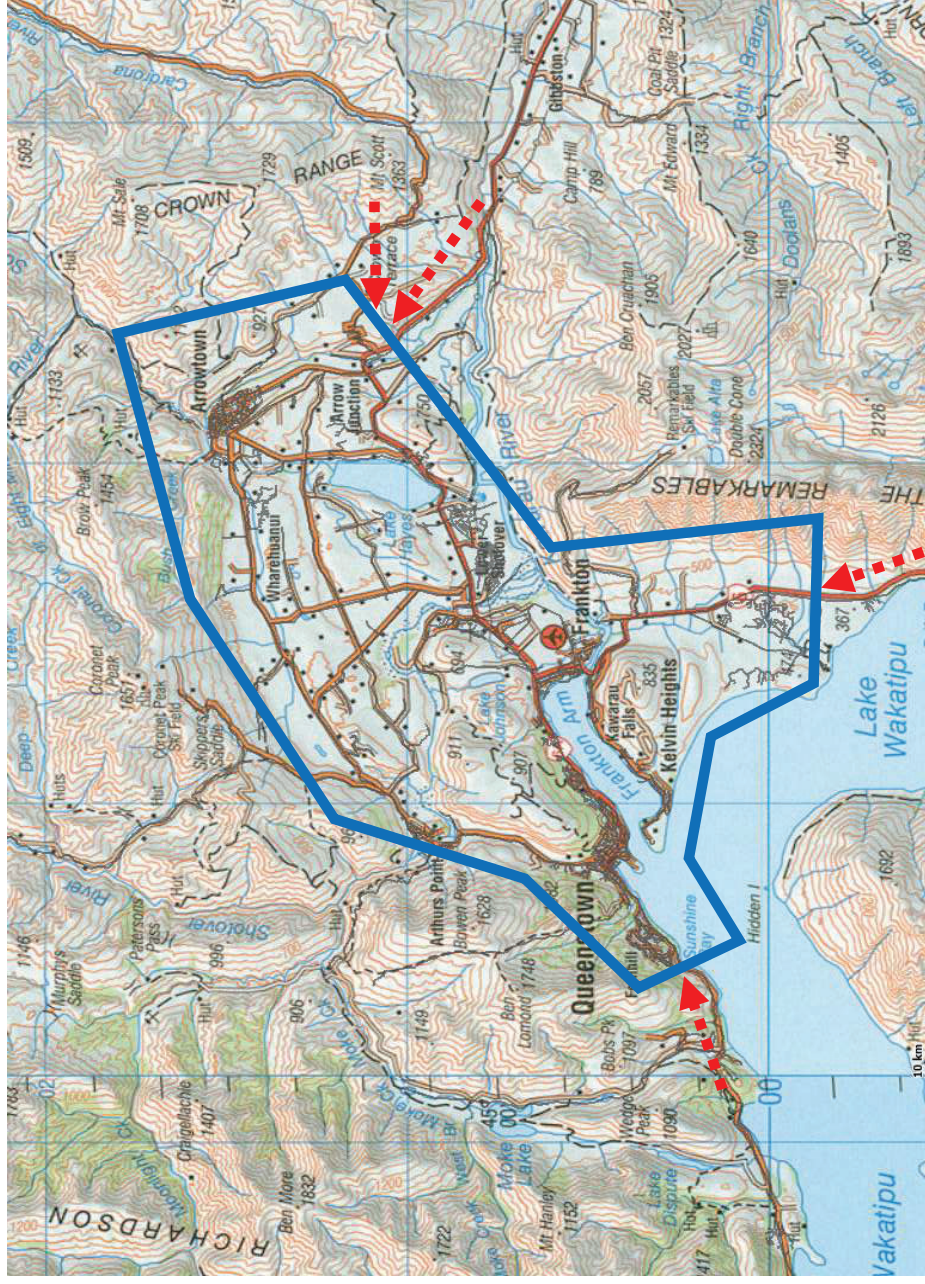

Appendix I – Wakatipu Basin Future Public Transport Demand/Capacity Analysis

Wakatipu Basin Future PT Demand/ Capacity Analysis

Agenda

- **Background to modelling work**
- **Scenarios investigated**
- **Model results**
- **Conclusions and Discussion**

Background and overview



Methodology....

1. Confirm objectives for PT in the Wakatipu Basin
2. Baseline the current bus operation
3. **Create bespoke “simplified” PT network model (spreadsheet)**
4. Forecast future demand using the updated strategic TRACKS model as a basis
5. Consider future public transport solutions, capacity and operational requirements
6. Determine QTC and Frankton bus hub requirements, demand and capacity
7. Assess possible park and ride solutions
8. Future considerations around water rapid transit (WRT/ferries) and mass rapid transit (MRT) and wider integration with future transport needs

Bespoke PT network model

- Generalised Cost and Multinomial Logit Model
 - Vehicle Based Trips (generalised cost in \$/h)

$$Gv (\$/h) = \left(\frac{d}{k}\right)^x \{(a * TTC) + (b * VOC) + (c * PC) + (e * AT) + MCv\}$$

- TTC = travel time cost (in mode)
- VOC = vehicle operating cost
- PC = parking charge
- AT = access time (walk, both ends of journey)
- MC_v = mode constant
- a, b, c, e = weighting factors
- d = trip length, k = mean trip length, x = cost damping coefficient

- Generalised Cost and Multinomial Logit Model

- Public Transport Based Trips (generalised cost in \$/h)

$$Gpt1 (\$/h) = \left(\frac{d}{k}\right)^x \{(a * TTC) + (b * WT) + (c * AT1) + (e * AT2) + F + TP + MCpt1\}$$

- TTC = travel time cost (in mode)
- WT = Wait time (at stop)
- TP = Transfer penalty
- F = fare
- AT = access time (walk, both ends of journey)
- MC_{pt1} = mode constant
- a, b, c, e = weighting factors
- d = trip length, k = mean trip length, x = cost damping coefficient

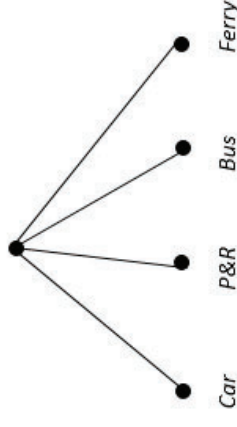
- Logit Model

- Proportion of each mode

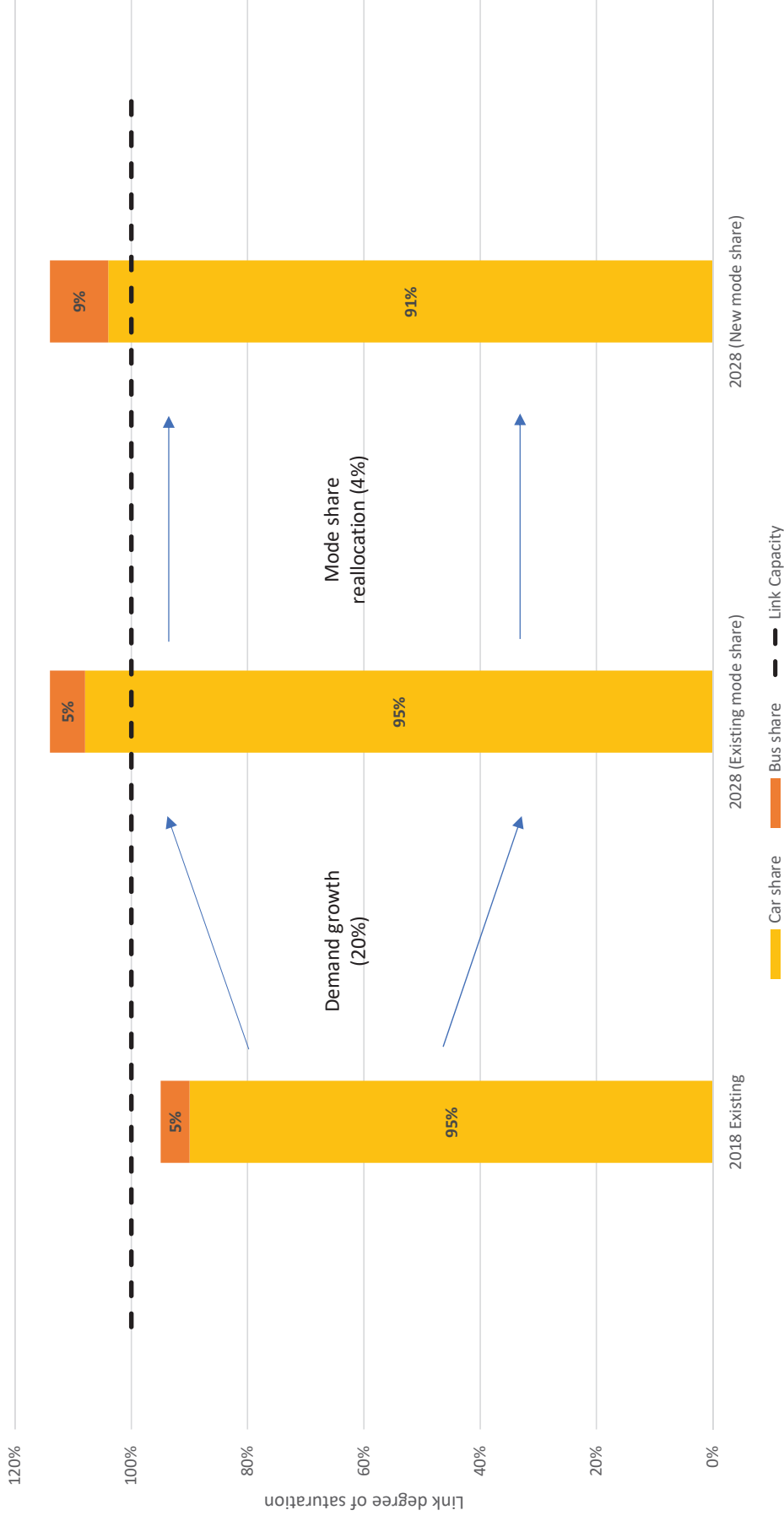
$$P_i = \frac{Exp(G_i)}{(Exp(G_i) + Exp(G_{ii}) + \dots + Exp(G_n))}$$

- P_i = Probability of using mode i
- G_i = generalised cost of using mode i

- MNL Model



Simplified Model Function - Example



Methodology....

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Future demand analysis

- Obtained from recent Tracks model update
 - Population and dwellings: Forecasts developed by Utility
 - School: MoE projections to 2022 and then 1.5% per annum
 - Car ownership: Maintained at 2013 census levels
 - Airport: 3.2million passenger movements at 2028, 5.1 at 2048 (plus sensitivity test with cap at 2.8million)
 - Visitors: Forecasts developed by Utility (around 2.7% per annum increase in visitor nights to 2028, then 1.2% to 2048)
 - Car parking: Model adjustment of 1,600 extra spaces in Queenstown town centre by 2028, and 4,600 by 2048 (these are added to ensure trips have a destination point)
 - Public Transport – not included, but results from this PT study will be fed back into the strategic model to provide adjusted car trip matrix and assignment
 - Infrastructure: Increased capacity in GR2KF network, and on SH6A (these are added to ensure the model can assign the quantum of demand, and converge)
- Additional adjustments have been made for trips to and from Frankton Flats to better match volumes on SH6A and SH6 Ladies Mile (generally uplifted) at 2018 – adjustments also applied to 2028 and 2048 matrices

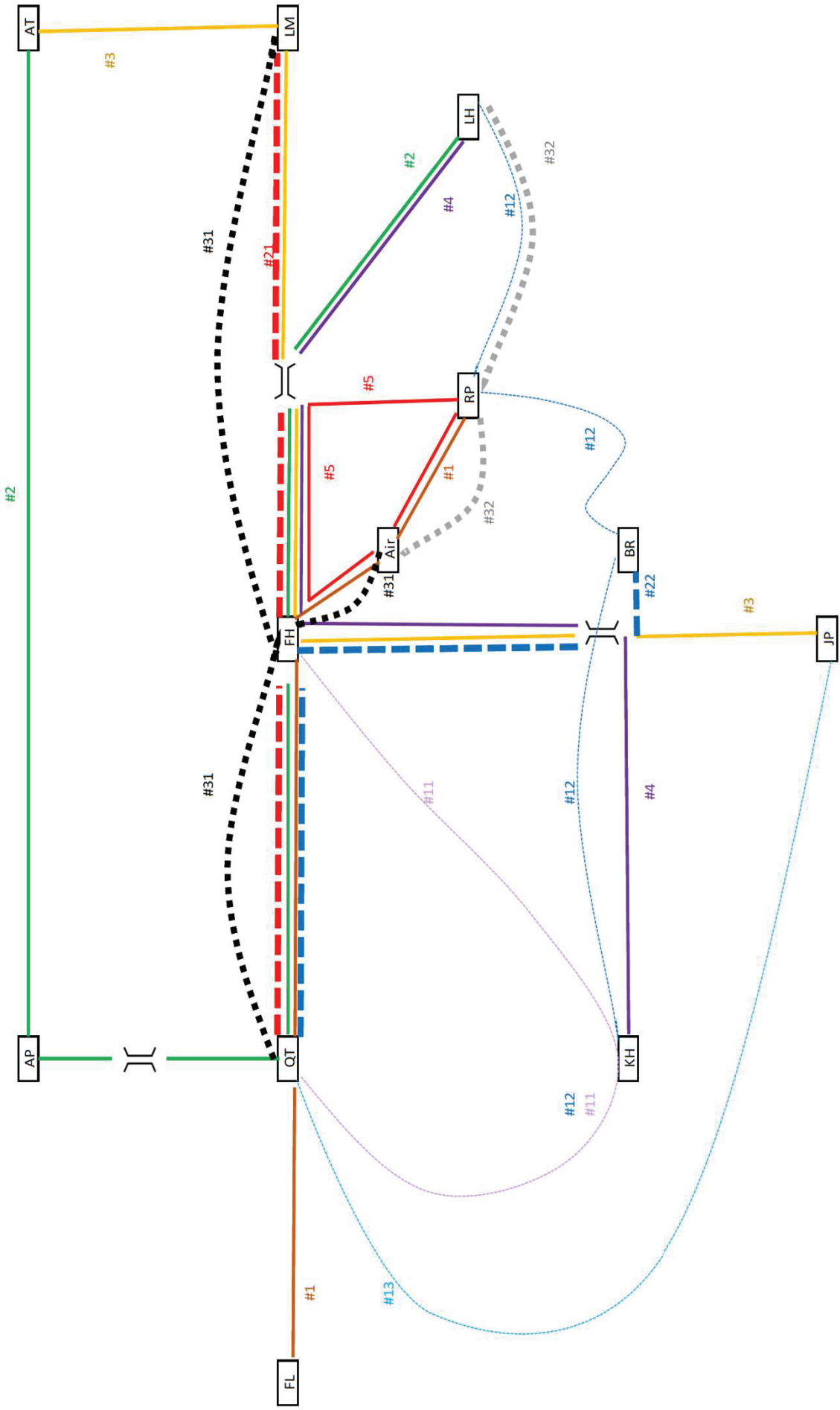
Methodology....

1. Confirm objectives for PT in the Wakatipu Basin
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7. **Assess possible park and ride solutions**
8. **Future considerations around water rapid transit (WRT/ferries) and mass rapid transit (MRT) and wider integration with future transport needs**

Scenario Tests

Scenario Name	Bus + WRT						Bus + WRT; P&R E&S	Bus + WRT; P&R E&S; RP MRT LH-RP	Bus + WRT; P&R E&S; MRT QT-AP	Bus + WRT; P&R S; MRT QT-LM	Bus + WRT; P&R E&S; RP MRT LH-FH	Bus + WRT; P&R S; MRT QT-FH; RP MRT LH-FH
	A1	A2	A3	A4	B1	B2						
Scenario ID	A1	A2	A3	A4	B1	B2	C1	C2	D1	D2		
Fares	bus \$2, ferry \$5	bus \$2, ferry \$2	As A1	As A1	As A1	As A1	As A1	As A1	As A1	As A1	As A1	
Parking	As existing	As A1	x2 cost	As A1	As A1	As A1	As A1	As A1	As A1	As A1	As A1	
Bus Lanes; LM-BP, LP-BP, Marina, Hensman, Cor Dr	None	As A1	As A1	All	As A4	As A4	As A4	As A4	As A4	As A4	As A4	
Frequencies	FH-RP 8ph	As A1	As A1	As A1	4ph	4ph	4ph	4ph	4ph	4ph	4ph	
	LH-QT-AT 2ph	As A1	As A1	As A1	As A1	As A1	As A1	As A1	As A1	As A1	As A1	
	LH-KH 2ph	As A1	As A1	As A1	As A1	As A1	As A1	As A1	As A1	As A1	As A1	
	JP-AT 2ph	As A1	As A1	As A1	As A1	As A1	As A1	As A1	As A1	As A1	As A1	
	Frankton 4ph ew	As A1	As A1	As A1	As A1	As A1	As A1	As A1	As A1	As A1	As A1	
Park & Ride	-	-	-	-	East - 3ph - QT	East - 3ph - QT	East - 3ph - QT	-	East - 3ph	-	-	
	-	-	-	-	South - 3ph - QT	South - 3ph - QT	South - 3ph - QT	South - 3ph - QT	South - 3ph - QT	South - 3ph - QT	South - 3ph - QT	
NZTA MRT	-	-	-	-	-	-	Queenstown to Airport	Queenstown to Airport and Ladies Mile	Queenstown to Airport	Queenstown to Airport and Ladies Mile	Queenstown to Airport and Ladies Mile	
RP MRT	-	-	-	-	-	Lake Hayes to Airport	-	-	Lake Hayes to Airport	Lake Hayes to Airport	Lake Hayes to Airport	
Capacities	Small increase at SH6/SH6A; small reduction along SH6A (new intersections); small increase in Queenstown town centre (optimisation or arterials); Edith Cavell as two-lane											

Schematic of PT Services - some may not operate in every Scenario



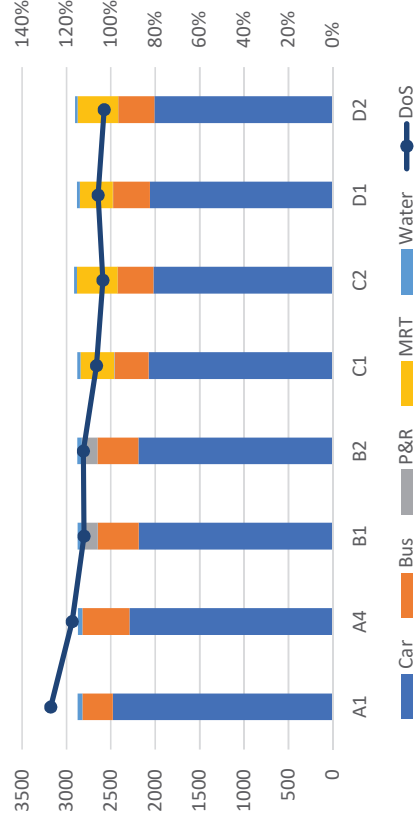
Assumptions (future)

- Parking charge increase in QTC in line with parking strategy (plus “by proxy” consideration of changes to parking supply)
- Access (walk) times in QTC increased for car mode in line with parking strategy
- PT fares as existing (\$2 all modes except \$5 ferry)
- Park and Ride sites assumed to be adjacent to SH6/Howards Drive roundabout and SH6/Boyd Road
- Mode penalties – MRT is 50% of other PT (perceived “gold plating”)
- Transfer penalties – generally 5 minutes throughout (all mode transfers)
- Wait times – all 50% of frequency (capped at 15 minutes)
- P&R access time – additional of 5 minutes to represent access, parking, walk to stand
- Transfers – all transfers allowed between other modes, except water-based services
- Water services – all catchment is assume to be walk-up (i.e. no significant level of parking provided at wharves) so attraction is currently local only. No transfer/interaction with other modes, due to limited opportunities
- All generalised costs at 2028 prices

Point Summary – SH6A (2028)

SH6A	A1		A4		B1		B2		C1		C2		D1		D2	
	Car	Bus	Car	Bus	Car	Bus	Car	Bus	Car	Bus	Car	Bus	Car	Bus	Car	Bus
AM Peak	2300	299	2245	352	2150	319	2149	320	2007	319	1997	324	2013	278	1952	324
	0	0	0	0	125	0	125	0	11	0	1	0	10	0	1	0
	0	0	0	0	0	0	0	0	257	10%	274	10%	285	11%	318	12%
	25	1%	27	1%	32	1%	33	1%	35	1%	36	1%	34	1%	32	1%
Total	2624	100%	2624	100%	2626	100%	2628	100%	2629	100%	2633	100%	2621	100%	2627	100%
DoS	118%		115%		110%		110%		103%		102%		103%		100%	
SH6A	A1		A4		B1		B2		C1		C2		D1		D2	
PM Peak	2480	342	2290	531	2188	463	2193	460	2077	381	2021	403	2062	414	2010	407
	0	0	0	0	178	0	175	0	6	0	2	0	6	0	2	0
	0	0	0	0	0	0	0	0	380	13%	456	16%	369	13%	457	16%
	53	2%	52	2%	47	2%	50	2%	36	1%	33	1%	35	1%	30	1%
Total	2875	100%	2873	100%	2875	100%	2878	100%	2881	100%	2915	100%	2885	100%	2906	100%
DoS	127%		117%		112%		112%		107%		104%		106%		103%	

Total passengers on SH6A - PM Eastbound



Mode Summary – Water (2028)

- Summary
 - Lake Hayes service unlikely to be economically viable, max 22p/h in Scenario A1 PM peak (i.e. before improvement of other PT modes)
 - Boyd Road P&R has reasonable patronage (around max 50 p/h PM peak all scenarios), so is an alternative to a bus-based service at this location
 - Jacks Point service has very low patronage – due to access times to and from the wharf
 - Frankton Arm (including Kelvin Heights) has moderate patronage (sufficient for 30 minute headway in PM peak), but still restricted by access times to the lake. Also patronage deteriorates as other PT modes improve
- Conclusion
 - Water service has limited potential to take a significant mode share, but does provide an attractive mode for land use parcels close to the lake/river
 - Potential for Boyd Road water-based P&R service – less effective (patronage) than a bus-based operation (as does not serve Frankton)

Mode Summary – Local Bus (2028)

	p/h	Model bph	Optimum bph	Corridor v/c
A1	342	10	9	127%
A4	531	10	13	120%
B1	640	19	16	113%
B2	635	19	16	114%
C1	416	10	10	108%
C2	405	10	10	107%
D1	414	10	10	107%
D2	407	10	10	103%

- Worst Case – Eastbound PM Peak on SH6A
 - All scenarios assume 10bph local services along SH6A
 - Scenarios B1-B2 assume additional 9bph P&R services along SH6A
 - Scenarios C1-D2 replace P&R buses along SH6A with MRT
- Likely that in scenarios C1-D2 that reduced frequency along SH6A could be applied, and replaced by transfer at Frankton Hub to MRT (say nominal service with 6bph)
- Operation of B1 and B2 puts significant stress on operation of both SH6A corridor (stop congestion with a bus every 3-4 minutes in each direction) and Queenstown town centre (sizeable hub with turnarounds and layover spaces required)

Mode Summary – MRT (2028)

No.	Route	Section	Max Passengers (per hour)				
			B2	C1	C2	D1	D2
2028 PM	Queenstown to Ladies Mile/Airport	Queenstown to Frankton Hub	0	352	456	344	459
		Frankton Hub to Ladies Mile	0	0	405	0	370
		Frankton Hub to Airport	0	290	336	307	345
	Ladies Mile/Airport to Queenstown	Airport to Frankton Hub	0	160	234	164	241
32a	Lake Hayes to RP/Airport	Ladies Mile to Frankton Hub	0	0	9	0	9
		Frankton Hub to Queenstown	0	164	168	164	171
32b	RP/Airport to Lake Hayes	Lake Hayes to RP/Airport	3	0	0	13	14
		RP/Airport to Lake Hayes	22	0	0	85	61

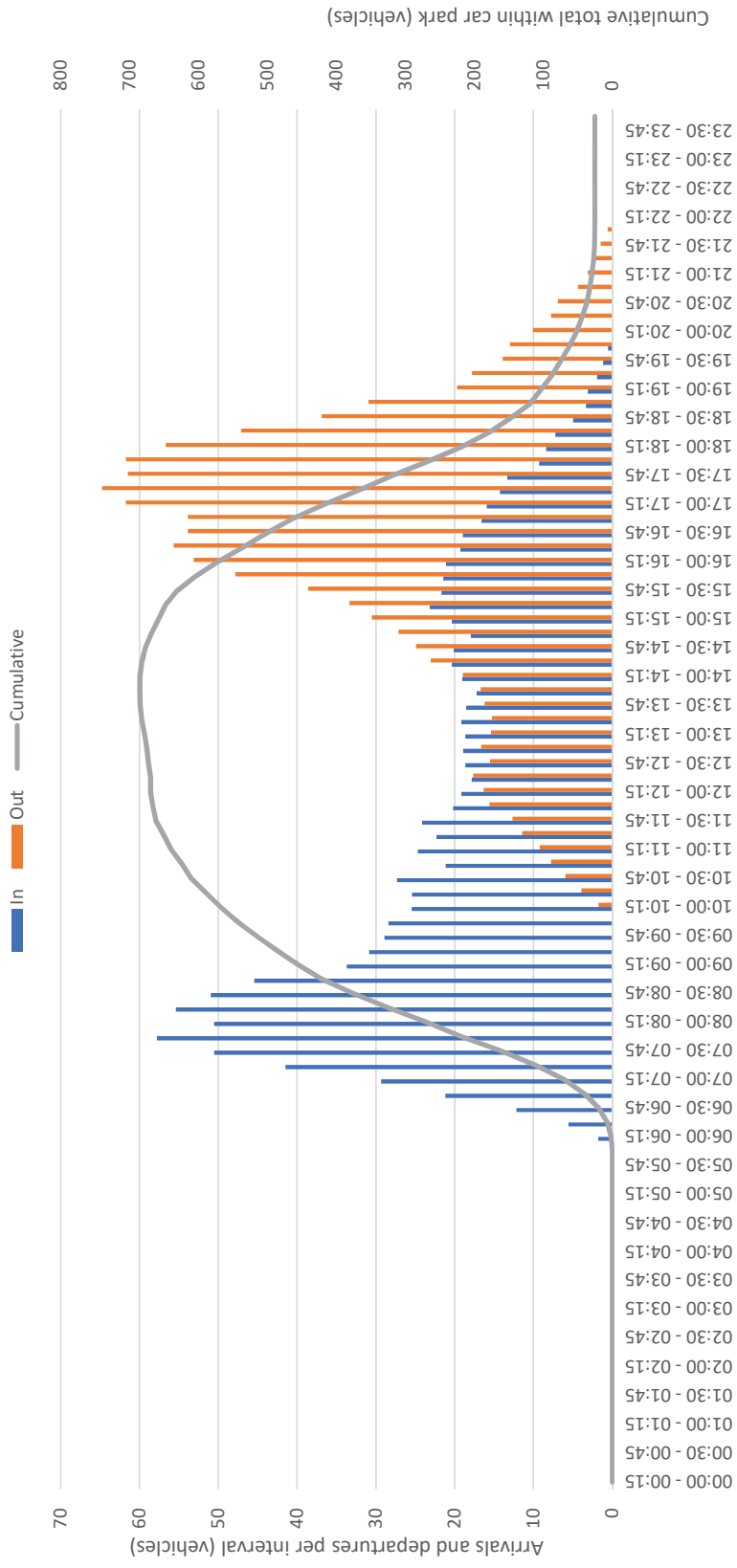
- **Conclusions**
 - At 2028, maximum patronage on SH6A section is approaching 500p/h (approaching 1x10 seat cabin every 60 seconds); on Ladies Mile section is 400p/h (1x10 seat cabin every 80 seconds)
 - At 2048, maximum patronage on SH6A section is around 1200p/h (approaching 1x10 seat cabin every 30 seconds); on Ladies Mile section is around 800p/h (1x10 seat cabin every 45 seconds)
 - Remarkables Park gondola limited patronage, maximum in scenario D1 when offers the only (through) MRT service to Queenstown – due to high access time/penalty for location

Mode Summary – P&R service (2028)

- Conclusions – East site
 - Highest patronage on through MRT service to Queenstown (C2/D2), then through bus-based (B1/B2), then Frankton transfer scenario (C1/C2)
 - Bus-based service at >10 minute frequency (B1 and B2 in PM) – but depends on vehicle
 - Gondola-based service at around 80 minute frequency in worst case (C2)
- Conclusions – South site
 - Highest patronage on B1 and B2 scenarios, 20 minute frequency required
 - Water-based alternative at Boyd Road is around 50% as effective as bus-based P&R in terms of patronage
- Conclusions – 2048
 - Bus based service (B1/B2) requires combined 20bph along SH6A to serve the two P&R sites (plus 20bph of local services), with v/c on corridor still at 140% saturation

Mode Summary – P&R East (2028)

Ladies Mile Park & Ride - Arrival and Departure Profile



Mode Summary – P&R Sites (2028)

Year	Scenario	Type	Max Car Park Occupancy	Parking Area (ha)	Max pass/h	Service Occupancy (pass)	Max service frequency (b/h or c/h)
2028 - East Site	B1	Bus	620	1.86	305	40	8
	B2	Bus	607	1.82	290	40	8
	C1	Bus	494	1.48	231	40	6
	C2	Gondola	685	2.06	303	10	31
	D1	Bus	503	1.51	213	40	6
	D2	Gondola	695	2.09	308	10	31

Year	Scenario	Type	Max Car Park Occupancy	Parking Area (ha)	Max pass/h	Service Occupancy	Max service frequency
2028 - South Site	B1	Bus	234	0.70	106	40	3
	B2	Bus	233	0.70	105	40	3
	C1	Bus	224	0.67	105	40	3
	C2	Bus	200	0.60	91	40	3
	D1	Bus	244	0.73	101	40	3
	D2	Bus	203	0.61	91	40	3

Conclusions

- Around 700 spaces required by 2028 (2ha parking area) at East site (if gondola extended to Ladies Mile) – increasing to 1300 spaces by 2048 (3.8ha)
- Around 600 spaces required by 2028 (1.8ha) at East site (if gondola not extended to Ladies Mile)
- Around 200 spaces required by 2028 (0.7ha) at South site (likely to be all scenarios) – increasing to 800 spaces by 2048 (2.5ha)

Hub Summary – Queenstown (2028)

		Queenstown Hub									
		A1	A4	B1	B2	C1	C2	D1	D2		
2028	AM Peak	Each Direction	10	10	19	19	10	10	10	10	
		Total	Bus and P&R v/h (e/w)	793	890	999	999	865	741	704	743
			MRT Pass/h	0	0	0	0	320	330	345	366
	Water Pass/h	51	53	55	56	59	63	61	56		
PM Peak	Each Direction	10	10	19	19	10	10	10	10		
	Total	Bus and P&R v/h (e/w)	825	1072	1163	1157	873	821	903	913	
		MRT Pass/h	0	0	0	0	516	624	508	629	
Water Pass/h	109	105	91	93	71	67	68	58			

- **Conclusions**

- A1-A4 scenarios likely to require at least 3 stands in each direction (not including additional for layover)
- B1-B2 scenarios likely to require at least 5 stands in each direction (not including additional for layover – Park and Ride vehicles?)
- C1-D2 scenarios likely to require at least 2 stands in each direction, assuming MRT can extract more passengers if bus frequencies reduced)
- All the above exclude regional services and private coaches

Hub Summary – Frankton (2028)

2028	Hubs		A1	A4	B1	B2	C1	C2	D1	D2
			AM Peak	Total	36	36	54	54	54	42
	Total	Bus and P&R v/h (e/w)	414	456	711	709	699	477	638	498
		MRT Pass/h	0	0	0	0	567	912	612	952
	PM Peak	Total	36	36	54	54	54	42	54	42
		Bus and P&R v/h (e/w)	561	833	1160	1138	933	713	942	749
		MRT Pass/h	0	0	0	0	967	1608	979	1531

- **Conclusions**
 - A1-A4 scenarios likely to require at least 10 stands (not including additional for layover)
 - B1-B2, C1 and D1 scenarios likely to require at least 12 stands (not including additional for layover and turnaround)
 - C2, D2 scenarios likely to require at least 10 stands, assuming MRT can extract more passengers if bus frequencies reduced)
 - All the above exclude regional services and private coaches

Overall Summary and Discussion

- Scenarios A1, A4 (Conventional bus, water services)
 - Limited impact in terms of mode shift (due to high delay)
 - Operation (v/c) on network >130% on key links at 2028
 - Suggest **DISCARD** as insufficient impact
- Scenarios B1, B2 (Conventional bus, water services, Bus-based Park and Ride)
 - Creates significant mode share off network
 - Operation (v/c) on network >120% on key links at 2028
 - Creates bus congestion along SH6A and Queenstown town centre, requires large bus hub in town centre
 - Alternative is to consider LRT for main SH6A corridor, with similar results to B1/B2, but smaller hub required. But operation of network is still poor, so would require significant demand management programme for network to operate satisfactorily
 - Suggest **RE-ASSESS** if other programme of works (sensitivities) applied

Overall Summary and Discussion

- Scenarios C1, D1 (Conventional bus, water services, Bus-based Park and Ride, Gondola on SH6A)
 - Good level of mode share on MRT (and other PT modes)
 - Requires 10 minute frequency of P&R bus for Ladies Mile to Frankton hub
 - Operation (v/c) on network >110% on key links at 2028
 - MRT provides key PT route into town centre, with smaller hub requirement for skeleton conventional bus service
 - Suggest **ACCEPT** as option for 2028
- Scenarios C2, D2 (Conventional bus, water services, Gondola-based Park and Ride, Gondola on SH6A and SH6)
 - Good level of mode share on MRT (and other PT modes)
 - Operation (v/c) on network >110% on key links at 2028
 - MRT provides spine PT route along E-W SH6, with smaller hub requirements in Queenstown and Frankton
 - Suggest **ACCEPT** as option for 2028, but can be phased for introduction towards 2048

Potential Future Sensitivities

- Demand side
 - Airport terminal location/size
 - Land use assumptions (residential and/or employment and/or visitor)
 - Fare sensitivities (all PT modes)
 - Parking charge/supply changes
 - Demand damping
 - peak spreading
 - trip suppression
 - active modes
 - TDM
- Supply side
 - Infrastructure assumptions (bus lanes, other network changes)
 - Frankton Hub locations
 - MRT access variations (car-based, active-mode based)
 - Park and Ride service assumptions

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Wakatipu Basin Future PT Demand/ Capacity Analysis

