

ETIHAD STADIUM NORTH STAND EXPANSION

Stage 3 Part 2.1 Spatial Coordination Crowd Modelling Analysis (DRAFT)

13 April 2023

METADATA

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Abstract	Assessment of spectator circulation for the Etihad Stadium North Stand Expansion for ingress, egress and evacuation for an unsegregated football event.
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01 EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Introduction

Movement Strategies (MS) has been commissioned by City Football Group Limited (CFGL) to provide crowd movement consultancy services to inform the development of the North Stand Expansion of the Etihad Stadium.

The study aims to assess the impact of a proposed expansion of the North Stand alongside the redevelopment of the surrounding area, including the new Co-Op Live Arena.

The key analysis from a crowd flow perspective is to provide evidence that supports the capacity calculations. The methods of analysis in this phase are static/spreadsheet modelling (which is the methodology needed for compliance with *The Guide to Safety at Sports Grounds*), *SENSE* network modelling and component dynamic/microsimulation modelling.

The analysis undertaken looks to demonstrate that the target capacity can be achieved by assessing the stand design for ingress capacity, normal egress time, emergency evacuation time as well as providing advice on the concourse capacity for the half time period.

Scope

The following scenarios have been assessed as part of this report

- **Scenario 1:** *Stadium Ingress (static)*
- **Scenario 2:** *Stadium Egress (static)*
- **Scenario 3:** *Hard Stadium Egress (SENSE)*
- **Scenario 4:** *Stadium Egress and 30-min Offset Arena Egress (SENSE)*
- **Scenario 5A:** *Simultaneous Stadium and Arena Egress (SENSE)*
- **Scenario 5B:** *Simultaneous Stadium (hard) and Arena Egress (SENSE)*
- **Scenario 6:** *Arena Egress (SENSE)*
- **Scenario 7:** *Stadium Evacuation (SENSE)*
- **Scenario 8:** *Simultaneous Stadium and Arena Evacuation (SENSE)*

EXECUTIVE SUMMARY

Pre – Event Arrivals / Ingress (Scenario 1)

- The turnstile provision exceeds the minimum requirements for spectators.

Half Time

- The concourse area available on Level 01 and Level 02 can accommodate 50% or more of the spectator population at a density of 2 persons / m².
- The proposed provision of Points of Sale (POS) on Level 01 and Level 02 can result in average maximum queues of 12 and 15 persons per POS, respectively, with maximum individual delays of 6.5 and 8.5 minutes. This would infer that anticipated spectator demand could be processed within the half time period.

Internal Post – Event Departures / Egress (Scenario 2)

- The stairs serving spectators on Levels 01, 02, 04 and 05 have sufficient capacity to accommodate spectator departures.
- Spectator demand using Ramp X and Ramp C will merge with spectator demand from other Stands. This may result in flow rates exceeding the target performance, but remain within a reasonable threshold.

Post – Event Departures / Egress (External)

- **Scenario 3:** Stadium egress with hard departure profile
 - High spectator flows are observed outside of North Stand Expansion on the eastern approach to City Square. The layout of this area will be reviewed in more detail during Stage 4 of the Design.
- **Scenario 4:** Stadium egress with surveyed departure profile and Arena departure 30 minutes after the end of the match (Normal Operation)
 - The route outside the north east of the North Stand will experience flowrates of up to 66 persons/minute/metre width.
 - Flows from the Stadium and the Arena result in high two-way flow on Joe Mercer Way that may require management and/or re-routing of spectators.
 - The north side of the Arena experiences high spectators flow on the Sportcity Way footway due to the peaked egress profile. The management of spectators or circulation width available may need to be reviewed in more detail.

EXECUTIVE SUMMARY

- **Scenario 5A:** Stadium egress with surveyed departure profile and simultaneous Arena departure (Special Operation)
 - The route to the north east of the North Stand will experience higher densities where the width reduces to 12 metres.
 - The re-routing of Arena spectators onto Alan Turing Way reduces the peak densities on Joe Mercer Way, but there might be high two-way flows on approach to City Square and on the West of City Square in front of the Squash Centre.
 - The effective width on the Arena exit leading to Alan Turing Way via Sportcity Way will likely result in high densities on egress from the Arena. The management of spectators or circulation width available may need to be reviewed in more detail.
 - The dynamic (Legion) model of the Metrolink westbound service shows that temporary queuing overlay may be accommodated without significant impact to spectator circulation.
- **Scenario 5B:** Stadium egress with hard departure profile and simultaneous Arena departure (Special Operation)
 - Results are similar to the surveyed egress, but the model shows increased congestion in front of the Squash Centre and on the route to the north east of the North Stand.
- **Scenario 6:** Arena departures only:
 - The pedestrian flows within the North Stand links are within the target Levels of Services.

Evacuation (Internal)

- For the purpose of this assessment it has been assumed that the stairs themselves will be the constraints to onward flow.
- The fire rating parameters for each area will inform the acceptable evacuation times for each area within the North Stand.
- Seating areas on Level 02 currently exceed an eight minute clearance time. Spectator demand allocated to each exit may need to be reviewed by the design team.
- Stairs STR Z6 and STR A6 currently serve Levels 02, 04 and 05. Spectator and workforce demand using these routes may result in localised queuing. A micro-simulation model could provide more detail on how spectators would merge in the stair core, and relative impact across the concourses serving each level.
- Spectator and workforce demand on Level 01 directed to Ramp X and Ramp C will merge with demand from other levels, resulting in maximum queues on the concourse of up to 870 persons. Queue area requirements and how spectators are managed will need to be considered.
- It should be noted that Exit Z0 and Exit A0 are close to capacity based on maximum flow rates.

EXECUTIVE SUMMARY

Evacuation (External)

- **Scenario 7:** Stadium Evacuation
 - High densities are experienced on the West and East of the North Stand due to the assumed routing, width available and where spectator emerge from the building line.
 - High densities might also occur on the approach to Joe Mercer Way from the Stadium.
 - It may be required to revisit how spectators are distributed / managed during an evacuation as part of the Stage 4 assessment.
- **Scenario 8:** Simultaneous Stadium and Arena Evacuation
 - Very high density is expected on Forge Lane bridge. No demand from the Arena is directed towards Alan Turing Way, meaning not all possible exits are utilised during evacuation.
 - The merging of pedestrian flows moving away from the Arena to the south, and away from the Stadium to the north is likely to lead to congested crowd conditions in City Square and outside the North Stand. An evacuation strategy should be developed for days when events are taking place at both Stadium and Arena to identify locations / routes used by both venues.

ITEMS TO BE ADDRESSED IN STAGE 4

General

- 1) Update assumptions on spectator demand and routing

Pre – Event Arrivals / Ingress

- 1) Impact of security screening overlay on the arrivals period.
- 2) How Level 01 demand accessing via turnstiles located at Entrance X and Entrance C will be managed.
- 3) Turnstile capacity available for a segregated football event.

Half Time

- 1) Better understanding of Point of Sale (POS) provision by type of item served and target transaction times to inform maximum average queue size estimates.
- 2) Provision of toilet and urinals for male and female spectators to inform maximum average queue size estimates.

Internal Post – Event Departures / Egress (Scenario 2)

- 1) Better understanding of how spectators from Level 01 in the North Stand will merge with spectators departing the West Stand via Ramp X and the East Stand via Ramp C.

External Post – Event Departures / Egress

- 1) Spectator circulation between the North Stand building line and the Commercial/Hotel/City Square areas.
- 2) Management of spectators on Joe Mercer Way.
- 3) Consider the impact of background demand in Commercial Area and Hotel Area.
- 4) Consider the impact of spectators deciding not to wait at Metrolink westbound service.
- 5) Design development of queue overlay requirements for Metrolink services.
- 6) The impact the spectator segregation may have on circulation in the North Stand.

Emergency Evacuation

- 1) Spectator and workforce numbers using stairs STR Z6 and STR A6 during an evacuation (including the impact of additional population on Level 03)
- 2) Spectator and workforce demand using Ramp X and Ramp C on Level 01.
- 3) Spectator and workforce routing away from the building line for different evacuation scenarios.
- 4) Understand Arena evacuation plan (spectators and workforce)
- 5) Impact of evacuation from the Commercial Area and Hotel Area



02 SCOPE

SCOPE

Movement Strategies (MS) has been commissioned by City Football Group Limited (CFGL) to provide crowd movement consultancy services to inform the development of the North Stand Expansion of the Etihad Stadium.

The study aims to assess the impact of a proposed expansion of the North Stand alongside the redevelopment of the surrounding area, including the new Co-Op Live Arena.

The key analysis from a crowd flow perspective is to provide evidence that supports the capacity calculations. The methods of analysis in this phase are static/spreadsheet modelling (which is the methodology needed for compliance with *The Guide to Safety at Sports Grounds*), *SENSE* network modelling and component dynamic/microsimulation modelling.

The analysis undertaken looks to demonstrate that the target capacity can be achieved by assessing the stand design for ingress capacity, normal egress time, emergency evacuation time as well as providing advice on the concourse capacity for the half time period.

This document expands on the assumptions and assessments set out in:

- 12588700-221219 MCFC North Stand Expansion Stage 3 Crowd Modelling_DRAFT (19 December 2022)
- 12588700-MCFC North Stand Expansion Stage 3 Databook_DRAFT-0.3 (15 February 2023)
- 12588700-MCFC North Stand Expansion Stage 3 Part 2 Crowd Modelling_DRAFT (24 February 2023)

Any further changes to layout, operation and/or pedestrian demand will be addressed as part of the RIBA Stage 4 crowd modelling assessment.



Figure 01: Existing Etihad Stadium with project area highlighted (Source: Google Earth)

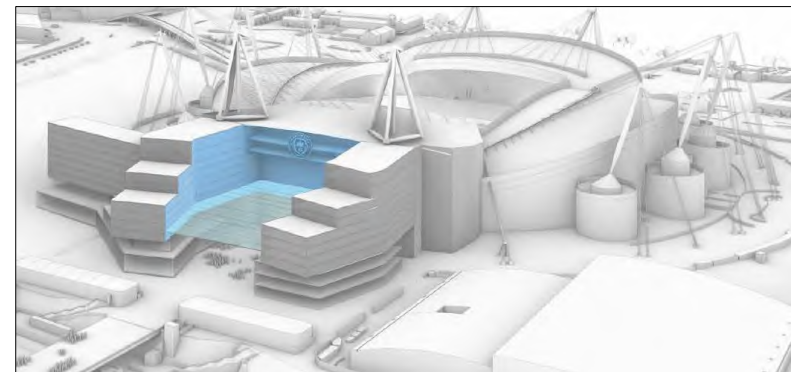


Figure 02: Illustration of the proposed North Stand redevelopment (Source: Populous)

SCOPE

The following scenarios have been assessed as part of the Stage 3 crowd modelling for the Stadium operating in an unsegregated football mode and the Arena operating in an agreed high capacity operating mode:

- **Scenario 1: Stadium Ingress (static)**

Spectator pre-event arrivals at the End State North Stand building line with a peaked arrival profile.

- **Scenario 2: Stadium Egress (static)**

Spectator post event departures within the End State North Stand building line with a hard departure profile.

- **Scenario 3: Hard Stadium Egress**

Spectator post event departures from the End State Etihad Stadium with a hard departure profile.

- **Scenario 4: Stadium Egress and 30-min Offset Arena Egress**

Spectator post event departures from the End State Etihad Stadium with the surveyed departure profile and an Arena event departure 30 minutes after the end of a football match (Normal Operation).

- **Scenarios 5A: Simultaneous Stadium and Arena Egress**

Spectator post event departures from the End State Etihad Stadium with the surveyed departure profile and a simultaneous Arena event departure (Special Operation).

- **Scenarios 5B: Simultaneous Stadium (hard) and Arena Egress**

Spectator post event departures from the End State Etihad Stadium with a hard departure profile and a simultaneous Arena event departure (Special Operation).

- **Scenario 6: Arena Egress**

Arena event post event departure.

- **Scenario 7: Stadium Evacuation**

End State full Stadium evacuation.

- **Scenario 8: Simultaneous Stadium and Arena Evacuation**

End State full Stadium evacuation and simultaneous Arena evacuation



03 ASSUMPTIONS

DESIGN INPUTS

DOCUMENTS REFERENCED

- BRA-BHE-ZZ-ZZ-PP-YC-0002 (OVG Manchester Crowd Flow Study, Multi-event scenarios)
- OVG Manchester, Details of the Special Measures Operating Plan, Buro Happold, 10 November 2022
- 230203 catering_POS.pdf

DRAWINGS REFERENCED

City Square Landscape

- NSE-POP-ZZ-00-DR-A-000600_Ver1.pdf

Stadium Ingress

- NSE-POP-NS-00-DR-A-000506_Ver1.pdf
- NSE-POP-NS-01-DR-A-000507_Ver1.pdf
- NSE-POP-NS-02-DR-A-000508_Ver1.pdf
- NSE-POP-NS-03-DR-A-000509_Ver1.pdf
- NSE-POP-NS-04-DR-A-000510_Ver1.pdf
- NSE-POP-NS-05-DR-A-000511_Ver1.pdf

Stadium Egress

- NSE-POP-NS-00-DR-A-000500_Ver2.pdf
- NSE-POP-NS-01-DR-A-000501_Ver2.pdf
- NSE-POP-NS-02-DR-A-000502_Ver2.pdf
- NSE-POP-NS-03-DR-A-000503_Ver2.pdf
- NSE-POP-NS-04-DR-A-000504_Ver2.pdf
- NSE-POP-NS-05-DR-A-000505_Ver2.pdf

Stadium Seating Areas

- NSE-POP-NZ-ZZ-DR-006001_Ver1.pdf
- NSE-POP-NZ-ZZ-DR-006002_Ver1.pdf

Arena Ingress

- BRA-POP-ZZ-01-DR-A-0502.pdf
- BRA-POP-ZZ-02-DR-A-0503.pdf
- BRA-POP-ZZ-03-DR-A-0504.pdf
- BRA-POP-ZZ-04-DR-A-0505.pdf
- BRA-POP-ZZ-GF-DR-A-0501.pdf

DESIGN INPUTS

Arena Egress

- BRA-POP-ZZ-01-DR-A-0512.pdf
- BRA-POP-ZZ-02-DR-A-0513.pdf
- BRA-POP-ZZ-03-DR-A-0514.pdf
- BRA-POP-ZZ-04-DR-A-0515.pdf
- BRA-POP-ZZ-GF-DR-A-0511.pdf

Arena Evacuation

- BRA-POP-ZZ-01-DR-A-0522.pdf
- BRA-POP-ZZ-02-DR-A-0523.pdf
- BRA-POP-ZZ-03-DR-A-0524.pdf
- BRA-POP-ZZ-04-DR-A-0525.pdf
- BRA-POP-ZZ-GF-DR-A-0521.pdf

RELEVANT GUIDANCE DOCUMENTS

- Guide to Safety at Sports Grounds (“Green Guide”), 6th Edition, 2018 (Sports Grounds Safety Authority, UK), which provides guidance for the safe design of sports grounds;
- BS EN 13200 -1:2012, Spectator facilities, Part 1: General characteristics for spectator viewing areas;
- BS EN 13200 -7:2014, Spectator facilities, Part 7: Entry and exit elements and routes;
- Pedestrian Planning and Design (J.J. Fruin, 1971), defining a quantified scale of ‘Levels of Service’ related to crowd movement on walkways, stairs and in queuing areas.



PERFORMANCE TARGETS

PERFORMANCE TARGETS

Flow Rates (Unidirectional)

The following flow rates are used for the evacuation assessment of the North Stand and for the stadium vicinity:

- 66ppl/min/m on stepped surfaces
- 82ppl/min/m on flat surfaces

Source: SGSA, 2018; Guide to Safety at Sports Grounds, 6th ed

Flow Densities

Performance targets for flow densities are defined separately for walkways and queues during different periods.

For walkways, targets are set for flows occurring during Ingress, Half-Time, Egress and Evacuation. Targets are set for queues, which may occur at turnstiles, F&B facilities, toilets, vomitories or pinch-points.

These are set within the context of an A-F scale known as Fruin's Level of Service, taken from Fruin, J. 1971; *Pedestrian Planning and Design*.

The Fruin Level of Service scale provides a measure of experience, density and congestion for people walking. This ranges from LoS A, the most free-flowing level of service, to LoS F, the most restrictive of conditions considered on this scale. Whilst this is the most familiar scale across the industry, it was originally intended to represent conditions in urban transport environments and is somewhat limited in how it reflects variation at higher densities.

See the following pages for more details on the proposed performance targets.

PERFORMANCE TARGETS FOR WALKWAYS

The Fruin 'Level of Service'* scale relates to conditions on walkways experienced by users



Description for walkways	Free circulation	For one directional flows, free circulation. For reverse and crossing flows, minor conflicts.	Some restriction in selection of walking speed and ability to pass others. High probability of conflict.	Restricted and reduced walking speed for most pedestrians. Difficulties in passing with momentary stoppages of flow.	Restricted and reduced walking speed for all pedestrians. Extreme difficulties in reverse or cross flows.	Circulation reduced to shuffling. Reverse and cross flows near impossible. Frequent contact. Sporadic forward flow.
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Walking LOS	A	B	C	D	E	F
Flow rate (people / m/ minute)	21 - 23	23 - 33	33 - 49	49 - 66	66 - 82	Restricted, lower than LoS E
Density (persons/m²)	<0.31	0.31 - 0.43	0.43 - 0.72	0.72 - 1.08	1.08 – 2.17	>2.17

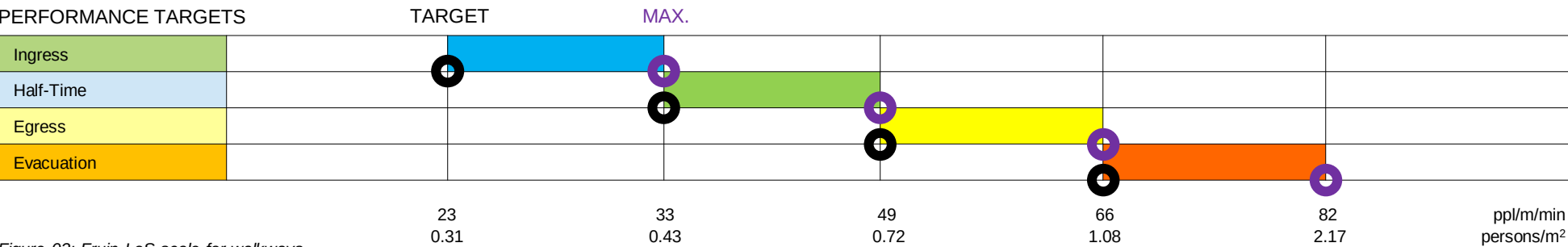


Figure 03: Fruin LoS scale for walkways

* Fruin, John J (1971) Pedestrian Planning and Design

PERFORMANCE TARGETS FOR STAIRWAYS

The Fruin 'Level of Service'* scale relates to conditions on stairways experienced by users



Description for stairways	Sufficient area is provided to freely select locomotion speed, and to bypass other slow moving pedestrians. No serious difficulties would be experienced with reverse traffic flows.	Virtually all persons may freely select locomotion speeds. However, in the lower range of area occupancy, some difficulties would be experienced in passing slower-moving pedestrians. Reverse flows would cause minor traffic conflicts.	Locomotion speeds would be restricted slightly, due to an inability to pass slower-moving pedestrians. Minor reverse-traffic flows would encounter some difficulties.	Locomotion speeds are restricted for the majority of persons, due to the limited open tread space and inability to bypass slower-moving pedestrians. Reverse flows would encounter significant difficulties and traffic conflicts.	The minimum possible area for locomotion on stairs, virtually all persons would have their normal speeds reduced, because of the minimum tread length space and inability to bypass others. Intermittent stoppages are likely to occur, as the critical pedestrian density is exceeded.	Complete breakdown in traffic flow, with many stoppages. Forward progress would depend on movement of those in front.
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Stairs LOS	A	B	C	D	E	F
Flow rate (people / m/ minute)	<16	16 -23	23 - 33	33 - 43	43 - 56	Restricted, lower than LoS E
Density (persons/m ²)	<0.54	0.54 – 0.72	0.72 – 1.07	1.07 – 1.54	1.54 – 2.7	>2.7

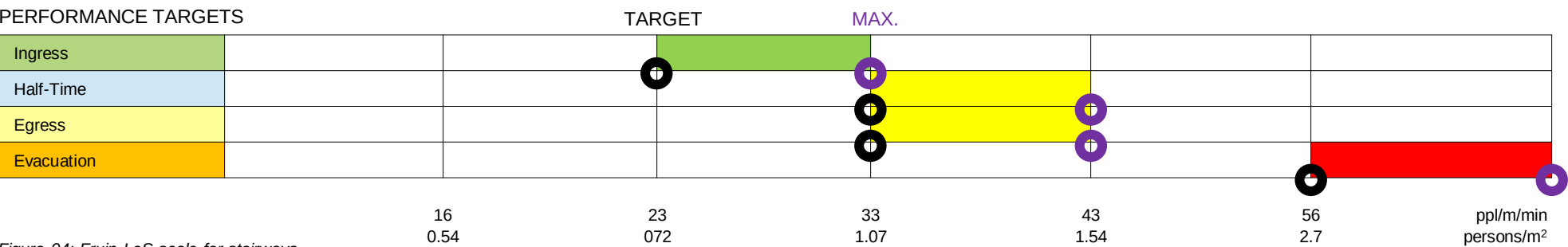


Figure 04: Fruin LoS scale for stairways

* Fruin, John J (1971) Pedestrian Planning and Design

PERFORMANCE TARGETS FOR QUEUING AND DWELLING

The Fruin ‘Level of Service’* scale relates to conditions on queuing/dwelling areas experienced by users



Description for queuing and dwelling	Free circulation: Adequate area is provided for standing and free circulation through the queuing area without disturbing others.	Circulation zone: Adequate area is provided for standing and restricted circulation through the queuing area without disturbing others.	Comfort zone: Adequate area is provided for standing and free circulation through the queuing area by disturbing others.	No touch zone: This level of occupancy is not recommended for long periods of queuing.	Touch zone: The level of area occupancy can only be sustained for a short period of time.	Unavoidable physical contact: No movement is possible.
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Dwelling/viewing LOS	A	B	C	D	E	F
Density (persons/m ²)	<0.83	0.83 – 1.07	1.07 – 1.54	1.07 – 3.57	3.57 – 5.26	>5.26

PERFORMANCE TARGETS

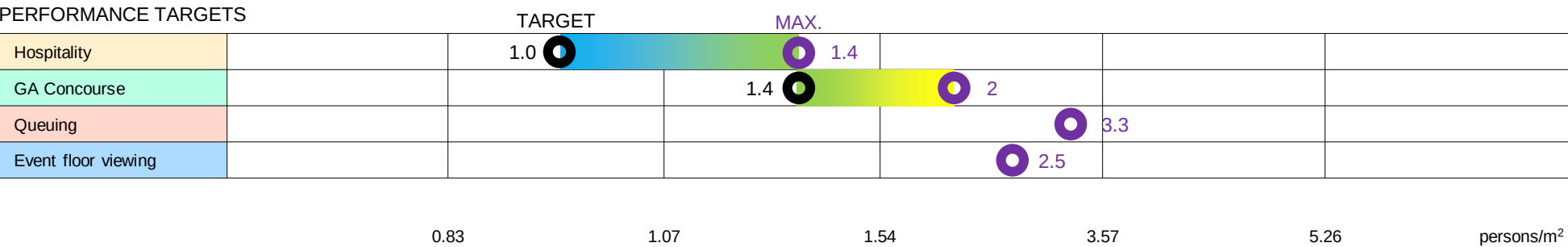


Figure 05: Fruin LoS scale for queuing and dwelling

* Fruin, John J (1971) Pedestrian Planning and Design

DYNAMIC MODELLING PERFORMANCE TARGETS (CLOSS)

The Guide to Safety at Sports Grounds, 6th Edition specifies maximum densities that are used for capacity setting and design guidance, specifically for sports grounds. A new scale has been developed to measure spectator density and reflect the conditions that are experienced around a stadium environment, in line with the densities specified in *The Guide to Safety at Sports Grounds, 6th Edition*. It allows the higher densities experienced in a modern stadium environment for walking, milling and standing to be distinguished, enabling a greater sense of the impact on safety to be visualised than with the Fruin scale.

MS has developed the Consolidated Level of Service for Stadium (CLOSS) scale to measure spectator density and reflect the conditions that are experienced around a stadium. This spans the full Fruin scale and extends to the Green Guide maxima, to provide insight into the range of pedestrian movement conditions: in stations, on streets and for spectator access, circulation and egress. The CLOSS scale has been adopted on assessments at a number of UK venues and the SGSA are familiar with it.

The colour scheme in the adjacent table provides benchmarks between these density measures, using bounds at regular intervals where possible. The colours have been selected based on visibility and contrast for ease of comparison on density maps.

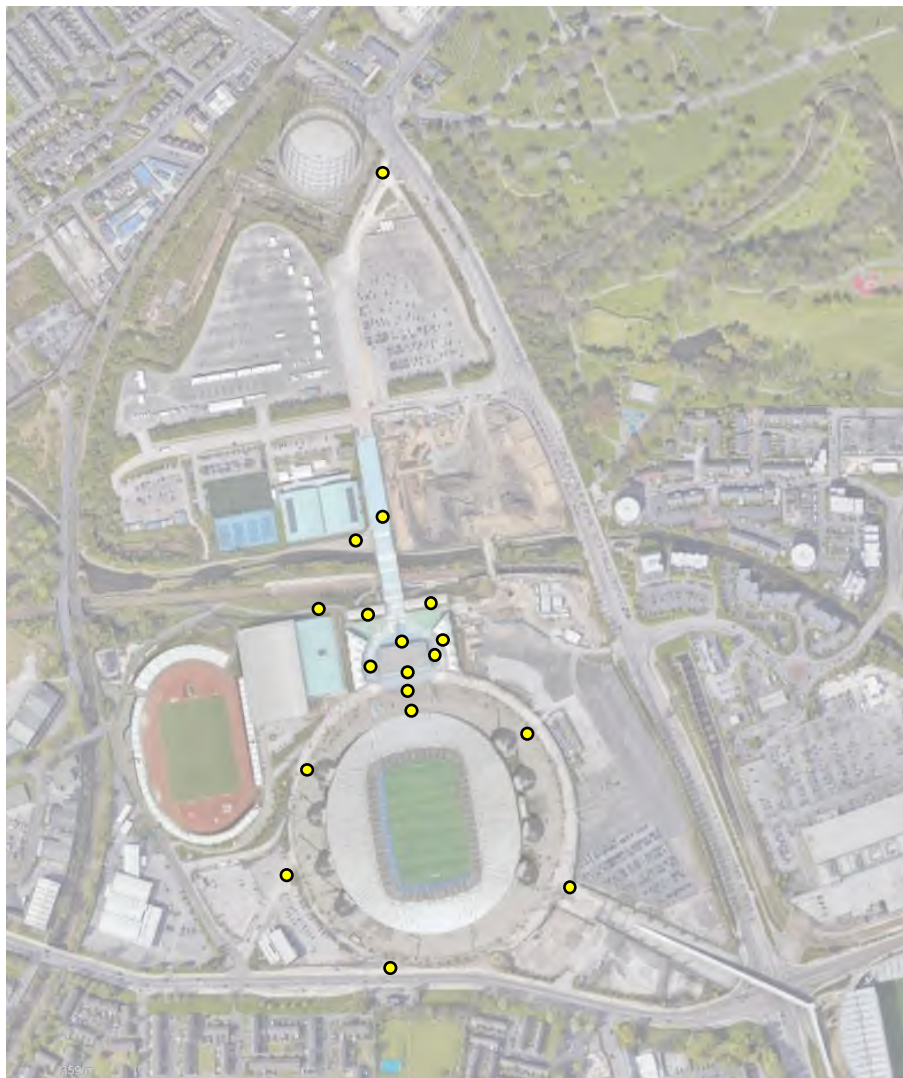
Colour	Value Range	Description	Comment
	< 1 person / m ²	Majority of spectators would have their normal walking speeds restricted and reduced in one-way flow, due to difficulties in bypassing slower-moving pedestrians.	The upper bound of Fruin Level of Service D for Walkways.
	1 - 2 people / m ²	Almost all spectators would have their normal walking speeds restricted and reduced.	The upper bound of Fruin Level of Service E for Walkways.
	2 - 3 people / m ²	All spectators have their walking speed restricted and progress may only be made by shuffling.	Fruin Level of Service F for Walkways.
	3 - 4 people / m ²	Spectators can stand in space without personal contact with others but circulation through this area is severely restricted (forward movement is only possible as a group).	The upper bound is suggested maximum density for calculating capacity and informing design in Green Guide G, Level of Service D for Queuing.
	4 - 4.7 people / m ²	Spectators can stand in space but personal contact with others is likely. Circulation through this space is difficult.	The upper bound is the absolute maximum density for calculating capacity in Green Guide G, Level of Service E for Queuing.
	4.7 - 5.38 people / m ²	Spectators can stand in space but personal contact with others is unavoidable and uncomfortable and can only be experienced for a short period of time.	The upper bound of Fruin Level of Service F for Queuing.
	> 5.38 people / m ²		

Table 01: Consolidated Level of Service for Stadia

PEDESTRIAN SURVEYS

SURVEY DATA

Figure 06: Survey camera locations



Source: Google Earth

● Survey Locations

Survey Data

Video surveys of the Etihad Stadium and the Etihad Campus were undertaken in order to understand pedestrian flows on the site on a match day.

Bi-directional movement was recorded at all points shown in Figure 06.

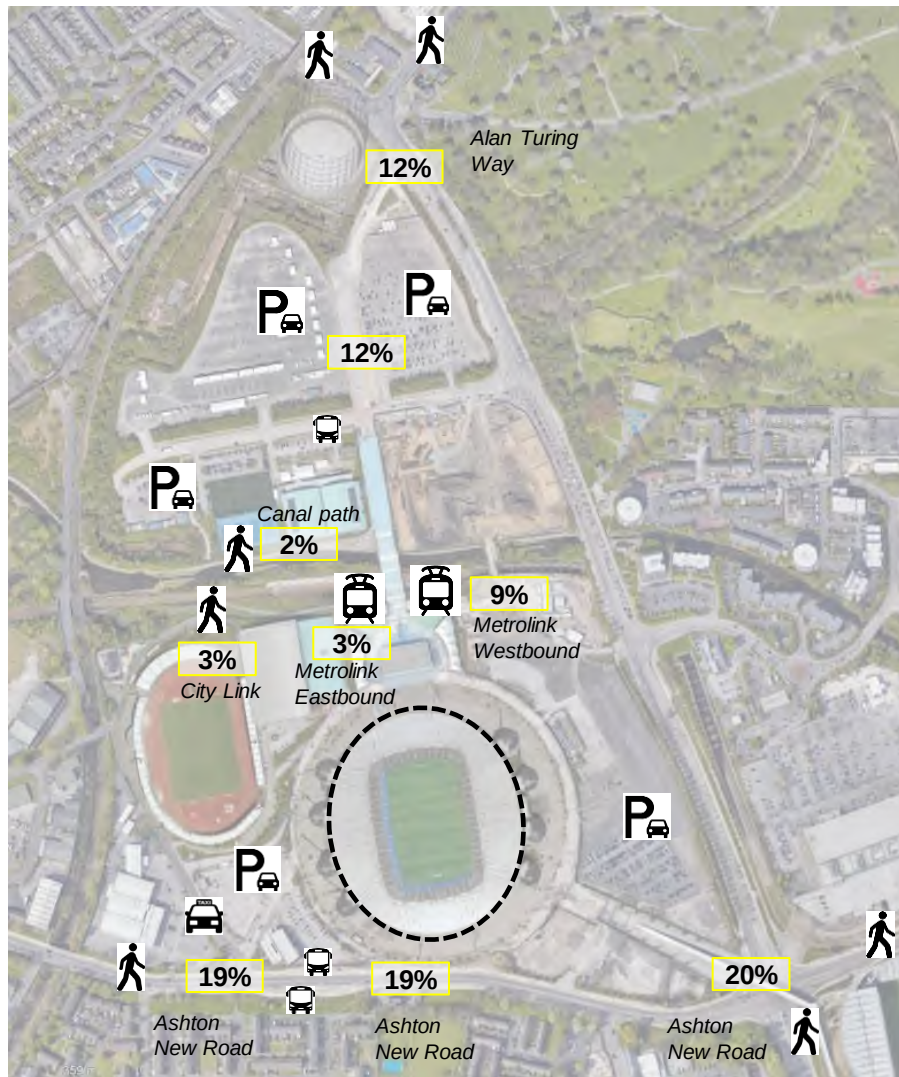
The following fixtures were surveyed during the pre-match/arrival/ingress period and the post-match/egress/departure period:

- **Manchester City vs Crystal Palace, Saturday 27 August 2022:**
 - Kick off at 15:00, Scheduled End at 16:45, Match End at 16:55
 - Premier League
- **Manchester City vs Brighton and Albion Hove, Saturday 22 October 2022:**
 - Kick off at 15:00, Scheduled End at 16:45, Match End at 16:55
 - Premier League
- **Manchester City vs Sevilla, Wednesday 2 November 2022:**
 - Kick off at 20:00, Scheduled End at 21:45, Match End at 21:50
 - UEFA Champions League

It should be noted that:

- Not all locations were surveyed for all three matches
- During the Manchester City vs Sevilla match, there were disruptions to the Metrolink service during the event. These were announced during the match, leading to spectators potentially changing typical travel patterns away from the stadium.

ETIHAD STADIUM | SPECTATOR DISTRIBUTION (EGRESS)



Source: Google Earth

Figure 07: Stadium spectator distribution for egress

Survey data for Manchester City vs Crystal Palace and Manchester City vs Brighton has been used to determine spectator distribution on egress from the Etihad Campus after the end of the event. The Manchester City vs Sevilla match was not deemed representative of a normal ingress profile.

Differences with the Ingress Distribution

The survey data shows different routes may be chosen by spectator during the ingress and egress period. These include:

- The Metrolink eastbound service have a higher demand during the ingress period (11% higher)
- The Metrolink westbound services have a lower demand during the ingress period (7% lower)
- Destinations to the north of the stadium have a lower demand during the ingress period (2% lower)
- Destinations to the south west of the stadium have a lower demand during the ingress period (1% lower).



Walking



Coach / Bus



Taxi

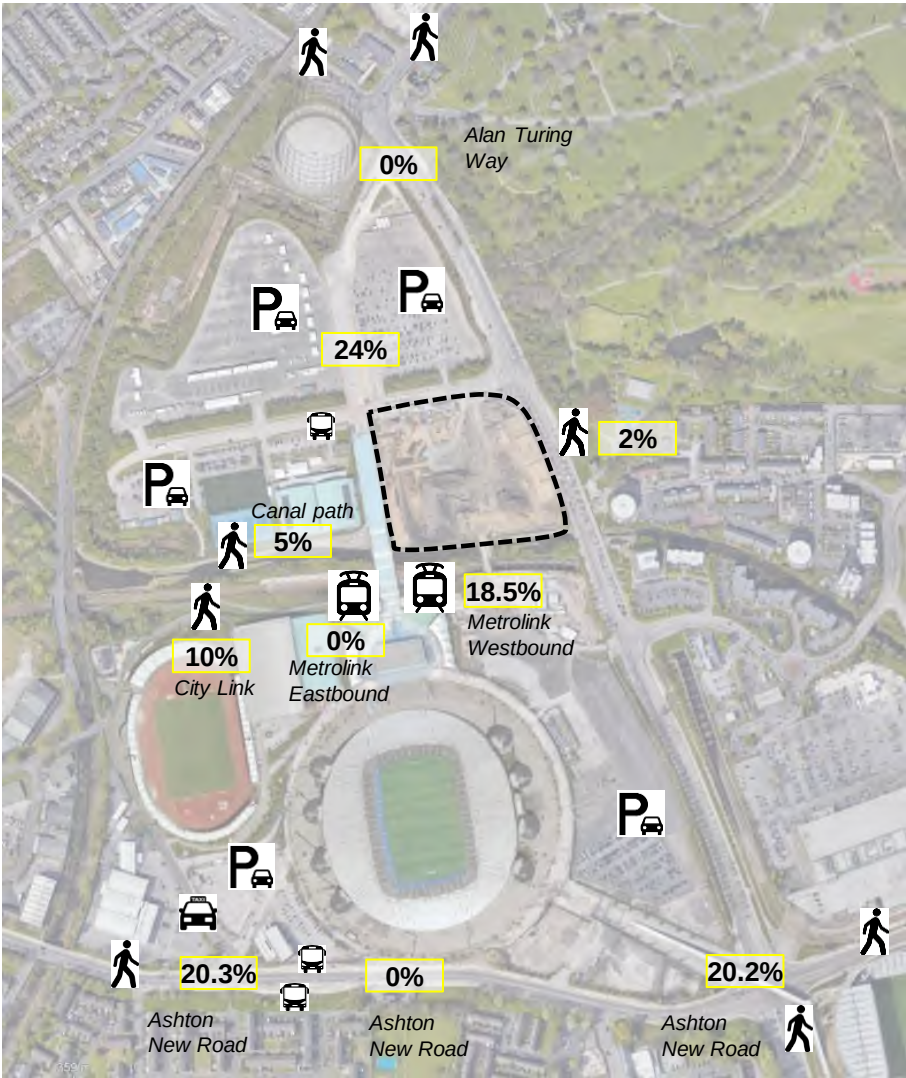


Car Park



Metrolink / Tram

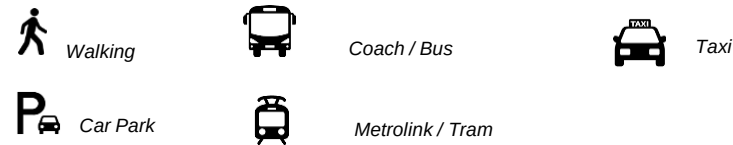
OVG ARENA | SPECTATOR DISTRIBUTION (EGRESS)



Source: Google Earth

Figure 08: Arena spectator distribution for egress

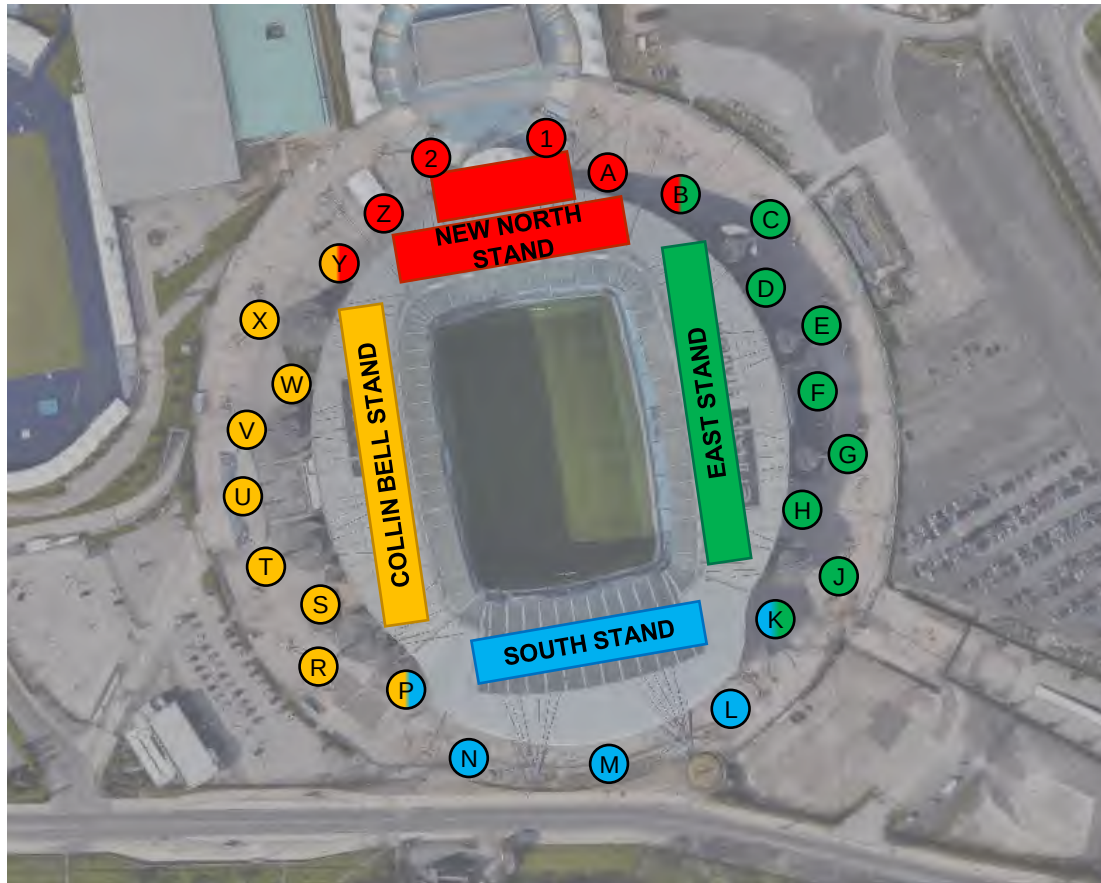
The spectator routing assumptions for the Arena egress shown in Figure 08 have been obtained from 'OVG Manchester, Details of the Special Measures Operating Plan, Buro Happold, 10 November 2022'.



STADIUM POPULATION AND ROUTING

PROPOSED SPECTATOR AND STAFF POPULATION IN EACH STAND

Figure 09: Existing stands and new North Stand



Source: Google Earth

North Stand

- 15,266 spectators
- 657 workforce
- 15,923 people total

West Stand

- 12,825 spectators
- 406 workforce
- 13,231 people total

East Stand

- 16,018 spectators
- 396 workforce
- 16,414 people total

South Stand

- 16,681 spectators
- 472 workforce
- 17,153 people total

Total

- 60,790 spectators
- 1,931 workforce
- 62,721 people total

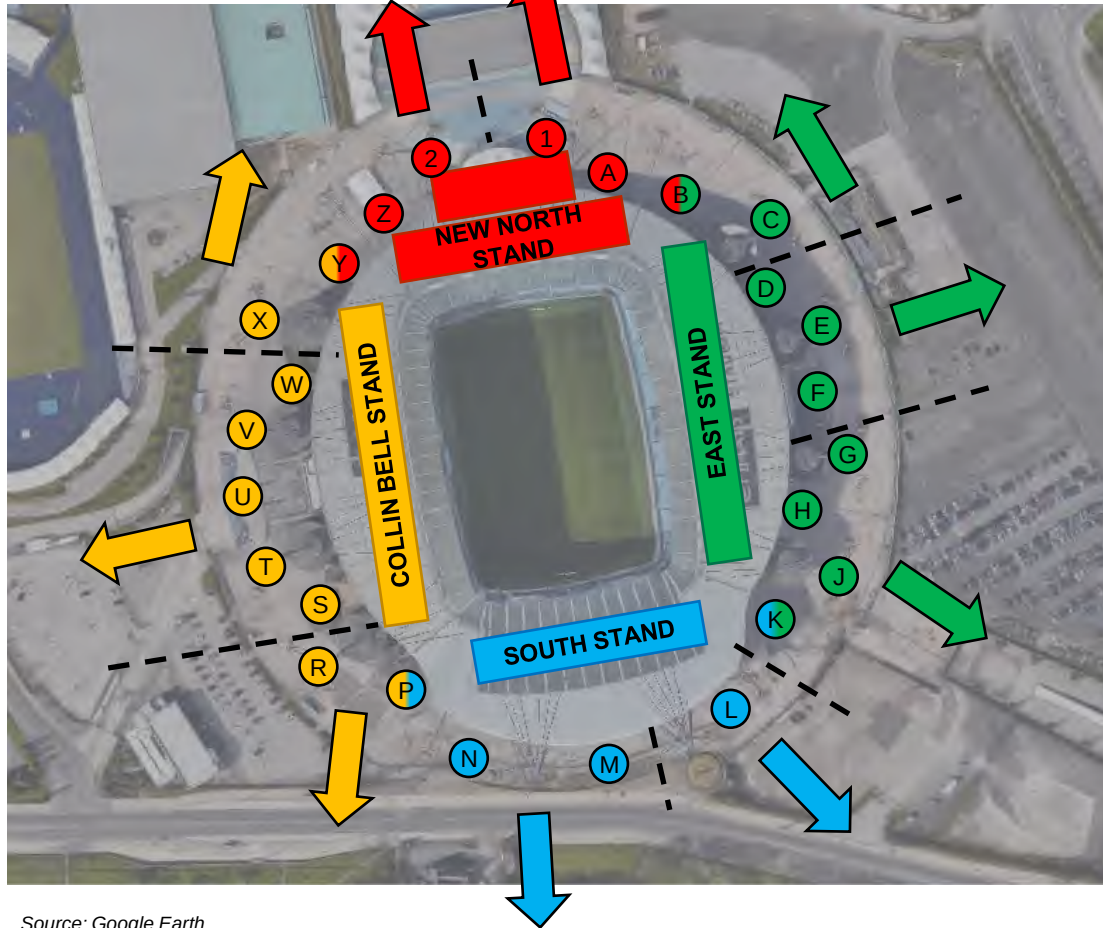
For a breakdown of Ingress, Egress and Evacuation figures per block see the latest version of the Crowd Modelling Databook.

Source:

Spectator numbers for the North Stand have been obtained from Populous
Spectators numbers have been obtained from turnstile data provided

SPECTATOR AND STAFF EVACUATION ROUTES

Figure 10: Spectators and staff evacuation routes outside the Stadium



Source: Google Earth

General Routing Assumptions

The existing stadium will have a considered emergency evacuation strategy, the most onerous of which would be a full stadium capacity evacuation and dispersal.

For the purpose of this assessment a **simultaneous full evacuation** (rather than a phased evacuation) will be assessed. Spectators will be assigned to their closest exit route using the following routing assumptions:

Routes from the East Stand, South Stand and Collin Bell Stand will need to be agreed with Manchester City.

Whilst this assessment does not look to analyse the evacuation of the East Stand, South Stand and Collin Bell Stand, the impact of persons emerging from other stands using evacuation routes designated to the North Stand Expansion is considered.



PROPOSED SPECTATOR AND STAFF POPULATION

	Ingress			Egress			Evacuation		
Exit	Spectators	Staff	TOTAL	Spectators	Staff	TOTAL	Spectators	Staff	TOTAL
A0	0	0	0	3,145	0	3,145	3,145	125	3,270
A1	1,922	0	1,922	935	0	935	935	124	1,059
A2	3,161	0	3,161	0	0	0	0	0	0
A3	0	0	0	304	0	304	304	80	384
A4	288	0	288	0	0	0	0	0	0
A5	0	0	0	0	0	0	0	0	0
B	5,108	0	5,108	5,108	0	5,108	5,108	0	5,108
C	2,126	0	2,126	3,113	0	3,113	3,113	80	3,193
D	704	0	704	704	0	704	704	0	704
E	1,657	0	1,657	1,657	0	1,657	1,657	79	1,736
F	1,159	0	1,159	1,159	0	1,159	1,159	79	1,238
G	2,088	0	2,088	2,088	0	2,088	2,088	79	2,167
H	536	0	536	536	0	536	536	0	536
J	1,842	0	1,842	1,842	0	1,842	1,842	79	1,921
K	3,618	0	3,618	3,618	0	3,618	3,618	0	3,618
L	2,021	0	2,021	2,021	0	2,021	2,021	118	2,139
M	5,034	0	5,034	5,034	0	5,034	5,034	118	5,152
N	4,344	0	4,344	4,344	0	4,344	4,344	118	4,462

Continued on next page

PROPOSED SPECTATOR AND STAFF POPULATION

Exit	Ingress			Egress			Evacuation		
	Spectators	Staff	TOTAL	Spectators	Staff	TOTAL	Spectators	Staff	TOTAL
P	5,282	0	5,282	5,282	0	5,282	5,282	118	5,400
R	1,599	0	1,599	1,599	0	1,599	1,599	82	1,681
S	571	0	571	571	0	571	571	0	571
T	2,296	0	2,296	2,296	0	2,296	2,296	81	2,377
U	1,592	0	1,592	1,592	0	1,592	1,592	81	1,673
V	1,088	0	1,088	1,088	0	1,088	1,088	81	1,169
W	664	0	664	664	0	664	664	0	664
X	1,794	0	1,794	1,794	0	1,794	1,794	81	2,862
Y	4,925	0	4,925	4,925	0	4,925	4,925	0	4,925
Z0	0	0	0	3,145	0	0	3,145	125	3,270
Z1	1,922	0	1,922	935	0	1,922	935	124	1,059
Z2	3,161	0	3,161	0	0	3,161	0	0	0
Z3	0	0	0	304	0	0	304	80	384
Z4	288	0	288	0	0	288	0	0	0
Z5	0	0	0	0	0	0	0	0	0
Total	60,790	0	60,790	60,790	0	60,790	60,790	1,932	62,722

Table 02: Proposed Stadium spectator and staff population

ARENA POPULATION AND ROUTING

OVG ARENA | PROPOSED SPECTATOR AND STAFF POPULATION

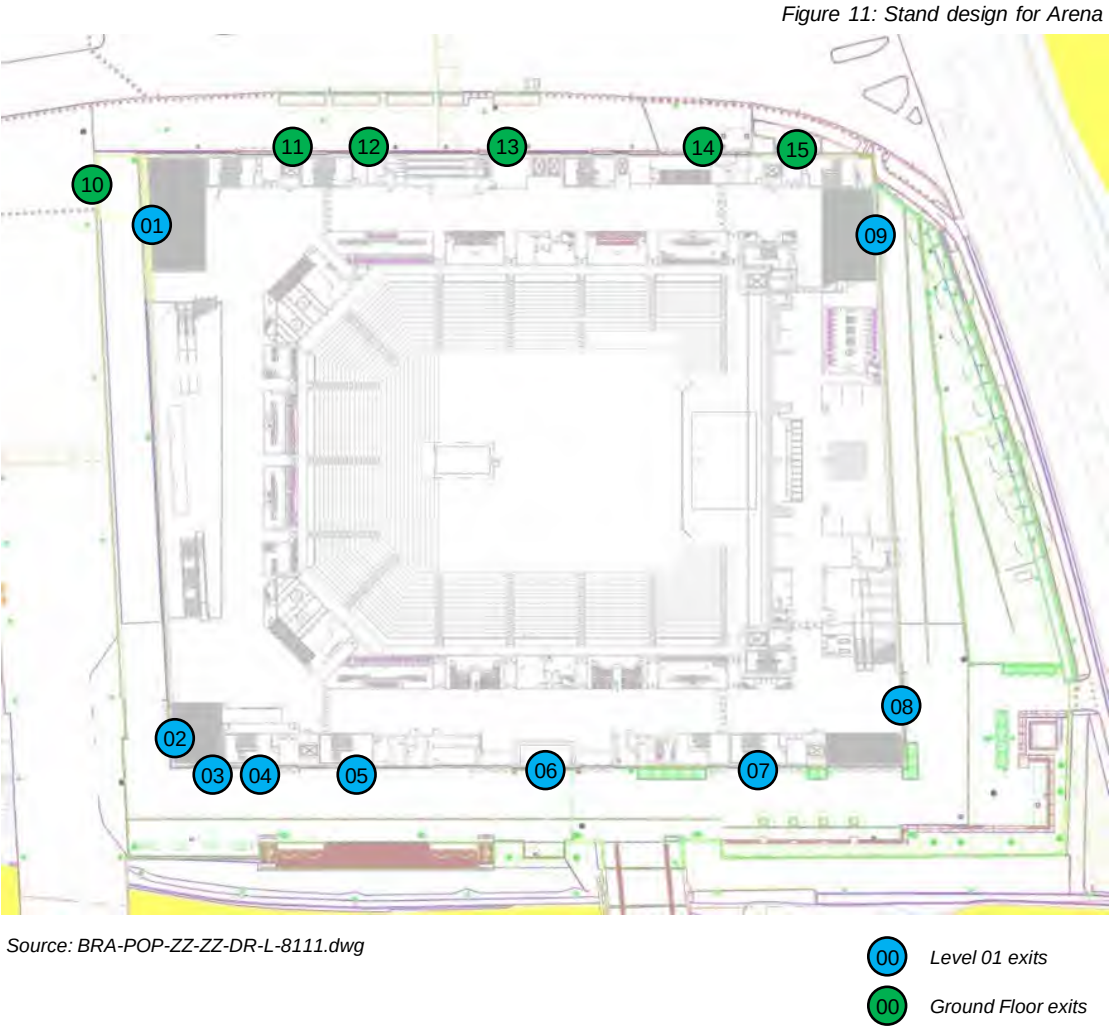


Table 02: Proposed Arena spectator and staff population

Ingress*		
Spectators	Staff	TOTAL
23,500	0	23,500

Egress*		
Spectators (50% Hospitality)	Staff	TOTAL
22,447	0	22,447

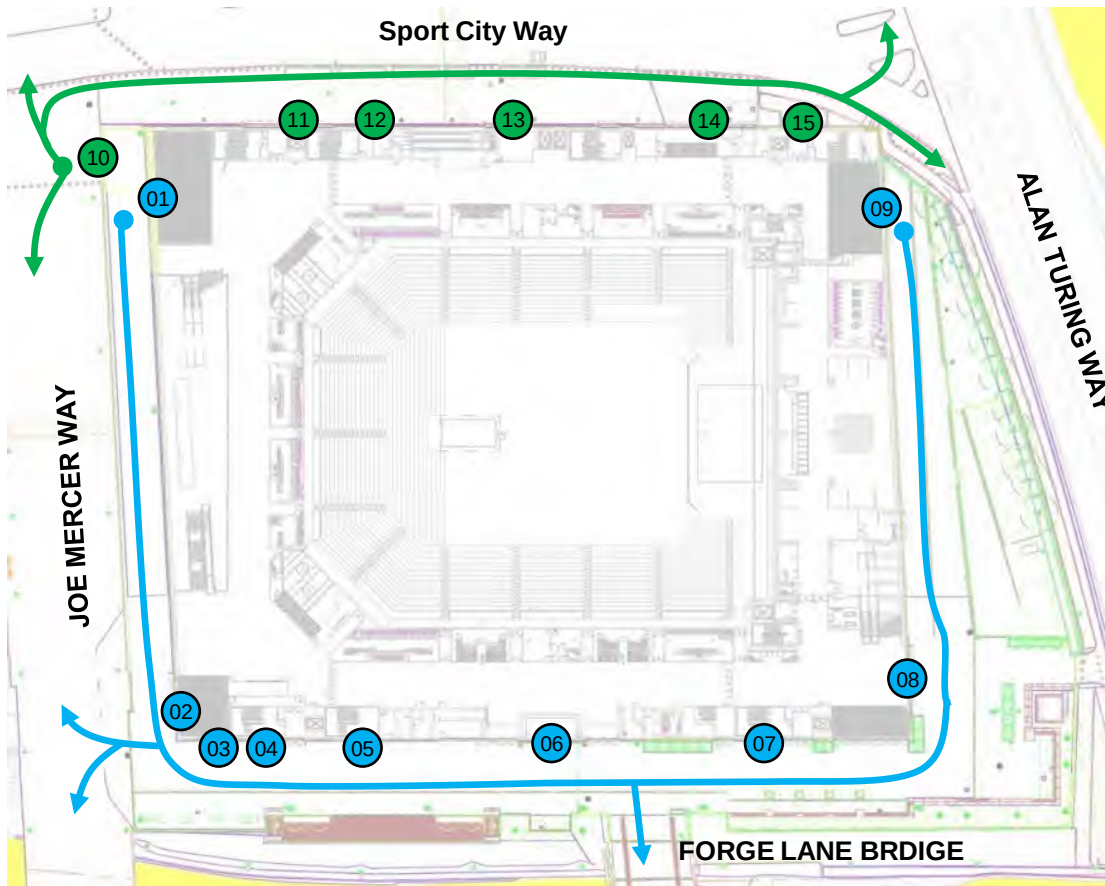
Evacuation*		
Spectators	Staff	TOTAL
23,500	800	24,300

For a breakdown of Ingress, Egress and Evacuation figures per exit see the latest version of the Crowd Modelling Databook. As agreed with OGV Live Arena demand figures from drawings provided for GF and L01 have been lowered proportionally to limit capacity to 23,500. This reflects the conditions set out in the venue planning conditions

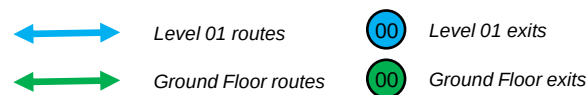
Source:
 Spectator numbers for the Arena have been obtained from 'OVG Manchester, Details of the Special Measures Operating Plan, Buro Happold, 10 November 2022'.
 Egress, ingress and evacuation assumptions taken from drawings: BRA-POP-ZZ-...-DR-A-05...

OVG ARENA | PROPOSED SPECTATOR ROUTES

Figure 12: Arena proposed spectator routes



Source: BRA-POP-ZZ-ZZ-DR-L-8111.dwg



Spectators exiting Level 01 will be able to circulate around the external concourse and make their way to one of two routes:

- Joe Mercer Way (to the West)
- Forge Lane Bridge (to the South)

Following discussions with the Co-Op Live Arena, the route From Level 1 to Alan Turing Way (to the East) is assumed not be in use.

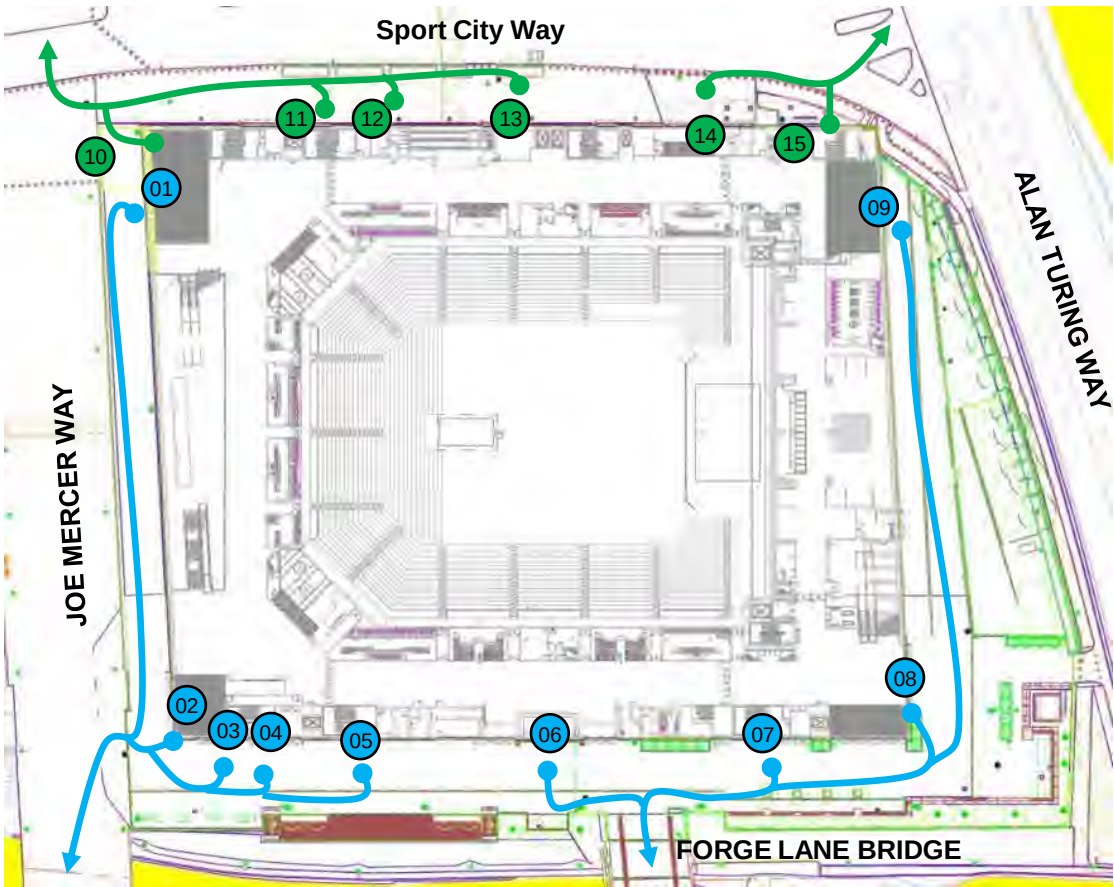
Spectators exiting the Ground Floor will exit the building line directly onto one two routes:

- Joe Mercer Way, from exit 10 only (to the West)
- Sports City Way (to the North)

For special operations, exits 14 and 15 will be directed to Alan Turing Way.

OVG ARENA SPECTATOR AND STAFF EVACUATION ROUTES

Figure 13: Arena proposed spectator and staff evacuation routes



Level 01 evacuation routing has been obtained from BRA-POP-ZZ-01-DR-A-0521.pdf.
Routing assumptions for Ground Floor provided by OVG on 17/02/2023.

Source: BRA-POP-ZZ-ZZ-DR-L-8111.dwg

- Level 01 routes
- Ground Floor routes
- Level 01 exits
- Ground Floor exits

ETIHAD CAMPUS PEDESTRIAN NETWORK

SPECTATOR PEDESTRIAN NETWORK



Source: Google Earth

●—● Pedestrian Routes

The routes shown in Figure 14 are assumed to be available to pedestrians on match days.

More detail is provided in the following pages for:

- Pedestrian routes available around the North Stand, including the proposed development to the north of the stand.
- Pedestrian routes available around the Arena. It should be noted that the image shows the Level 01 floor only, although routes for the Ground Floor are also presented.

Figure 14: Pedestrian network

SPECTATOR PEDESTRIAN NETWORK CAMPUS DESTINATIONS

ID	Location	ID	Location
201	Car Park 01 (CP01)	501	Canal Path (CA01)
202	Car Park 02 (CP02)	502	Citylink (CT01)
203	Car Park 03 (CP03)	503	Athletics Track (AH01)
204	Car Park 04 (CP04)	504	Metrolink Eastbound (ME01)
205	Car Park 05 (CP05)	505	Metrolink Westbound (MW01)
206	Car Park 06 (CP06)	801	Gibbon Street North (GS01)
207	Car Park 07 (CP07)	802	Gibbon Street South (GS02)
208	Taxi Pick Up (TX01)	803	Briscoe Lane North (BL01)
209	Bus DOPU Sportcity Way (BS01)	804	Briscoe Lane South (BL02)
210	Bus DOPU Eastbound (BS02)	805	Sportcity Way North (SC01)
211	Bus DOPU Westbound (BS03)	806	Sportcity Way South (SC02)
302	Alan Turing Way 02 SE (AT02)	807	Rowsley Street East (RS01)
303	Alan Turing Way 03 SW (AT03)	808	Rowsley Street West (RS01)
304	Alan Turing Way 04 NE (AT04)	809	Overbridge (BR01)
305	Alan Turing Way 05 NW (AT05)	810	Grey Mare Lane West (GM01)
401	Ashton New Road 01 (AN01)	811	Grey Mare Lane East (GM02)
404	Ashton New Road 04 (AN04)	901	Manchester Tennis Centre (TF01)
405	Ashton New Road 05 (AN05)	1001	F&B North Stand West (FB01)
406	Ashton New Road 06 (AN06)	1002	F&B North Stand West (FB02)
		1003	Shop North Stand (S01)

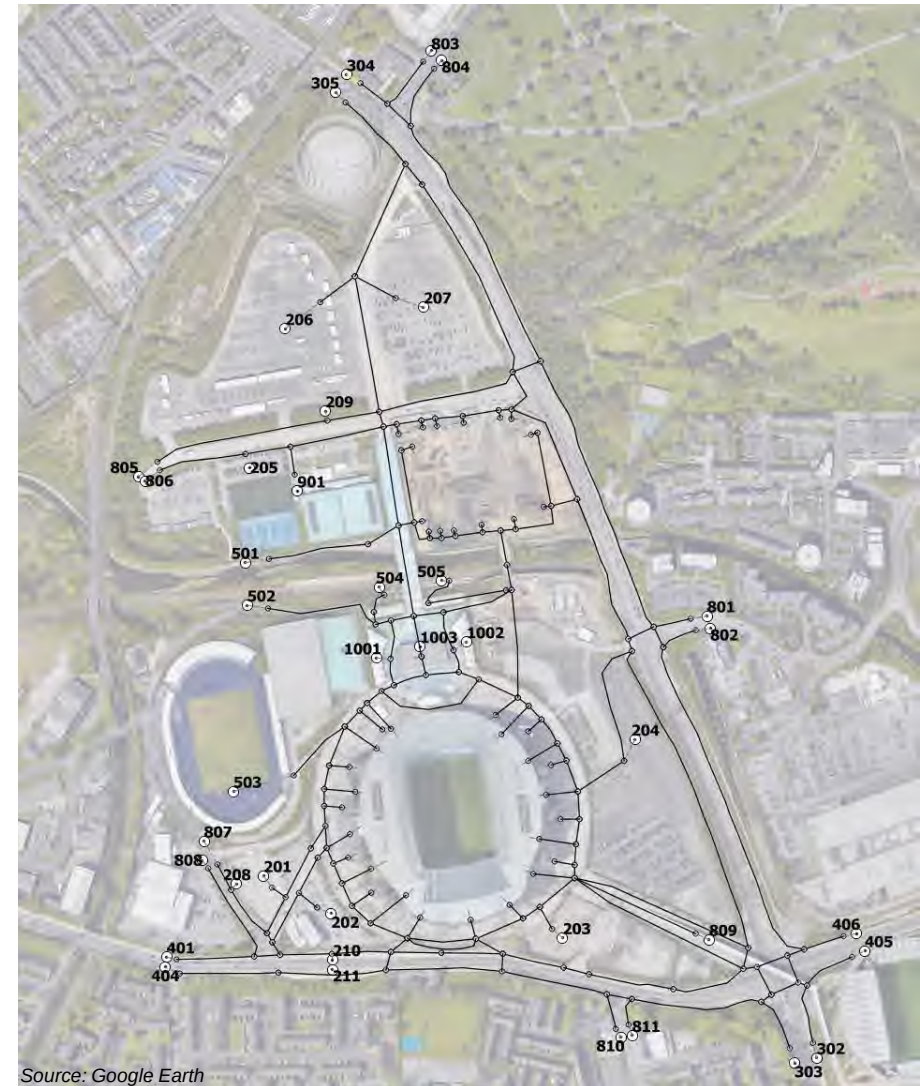


Figure 15: Etihad Campus origin/destination network

Normal operations

North Stand and Arena Network Widths

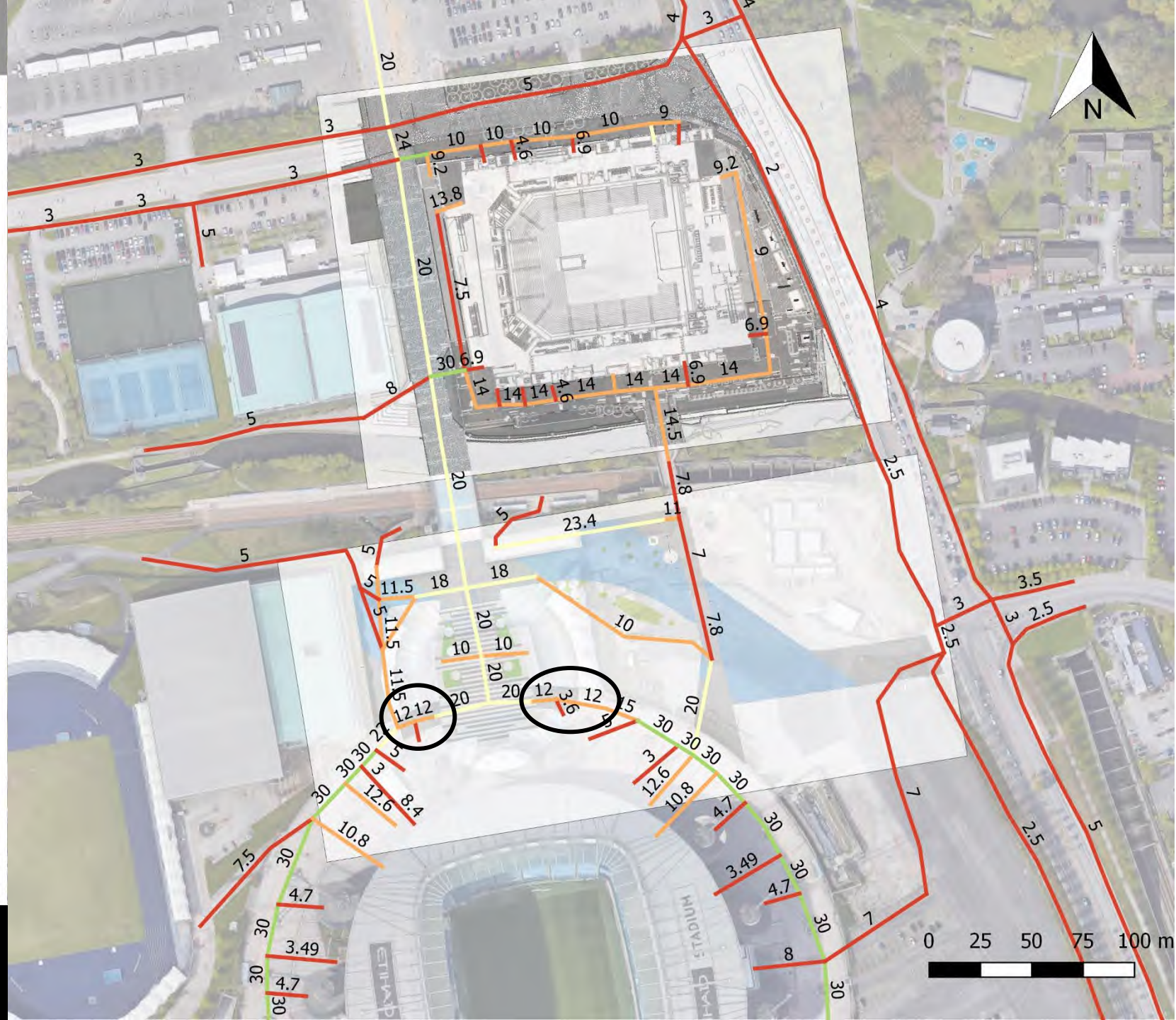
The assumed widths for this model have been measured in CAD provided, or directly on Google Maps when CAD was not available.

Flows out of the Stadium are constrained by the width of the exit doors.

The effective width between the hotel and commercial space and the revised North Stand design has been reduced from 15m to 12m which may have an effect on crowd movement.

Legend

- 1 - 8 m
- 8 - 15 m
- 15 - 25 m
- 25 - 30 m



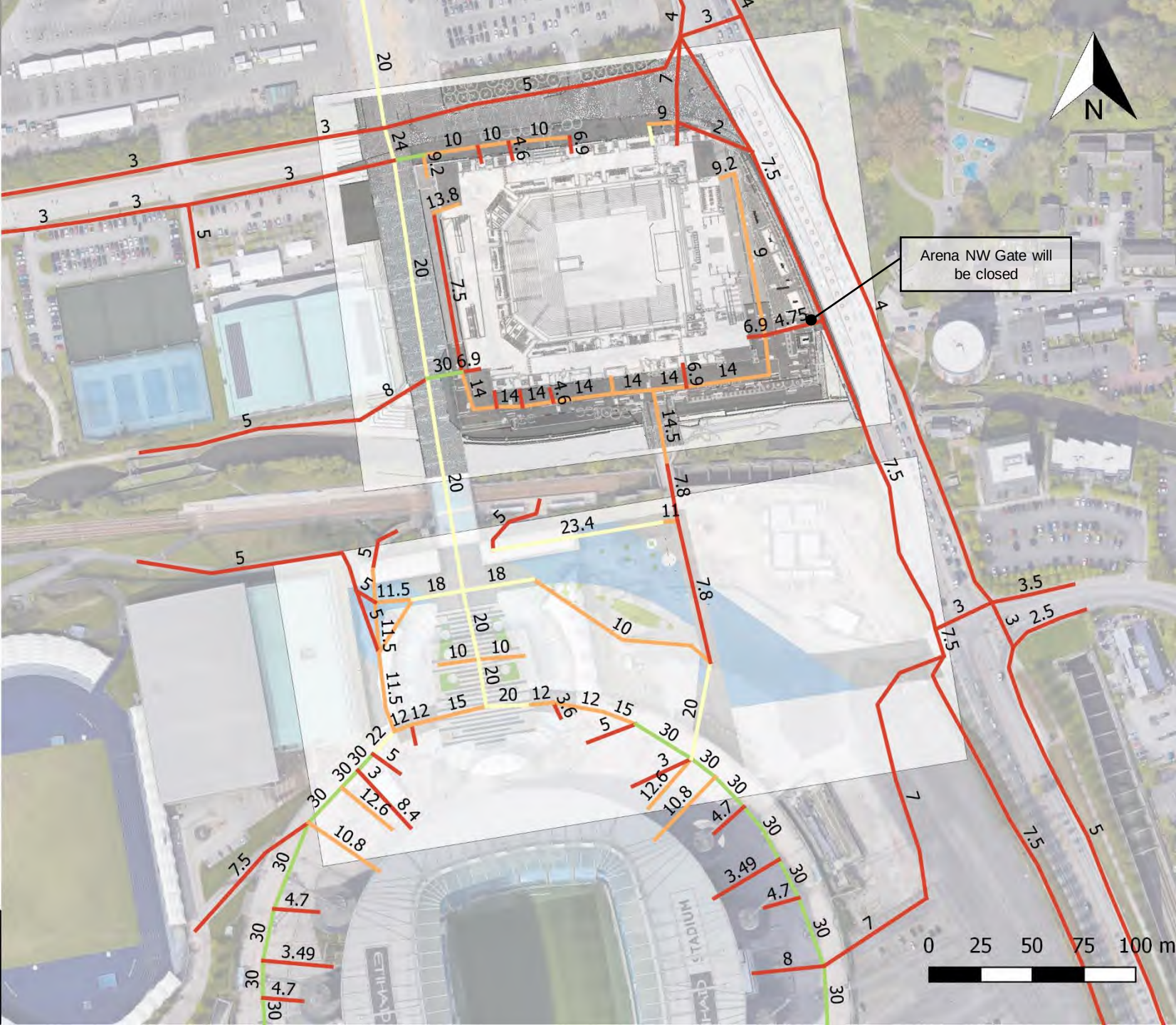
North Stand and Arena Network Widths

For the Special Operations scenario, it is assumed that 7.5m width will be provided along Alan Turing Way (OVG Manchester, Details of the Special Measures Operating Plan, Buro Happold, 10 November 2022)

Following discussions with the Stadium and the Arena it is assumed that the Arena NW Gate will not be open for Special Operations.

Legend

- 1 - 8 m
- 8 - 15 m
- 15 - 25 m
- 25 - 30 m



04 PRE EVENT ARRIVALS / INGRESS

PRE EVENT ARRIVALS TO THE ETIHAD CAMPUS

The arrival profile of spectators in the vicinity of the Stadium, shown in Figure 17, has been extracted from the Manchester City vs Brighton, Chelsea and Sevilla matches.

The peak 15-minute period arrival period into the Etihad Campus area occurs 15 – 30 minutes before kick off, with between 20 and 21% of spectators arriving during this period.

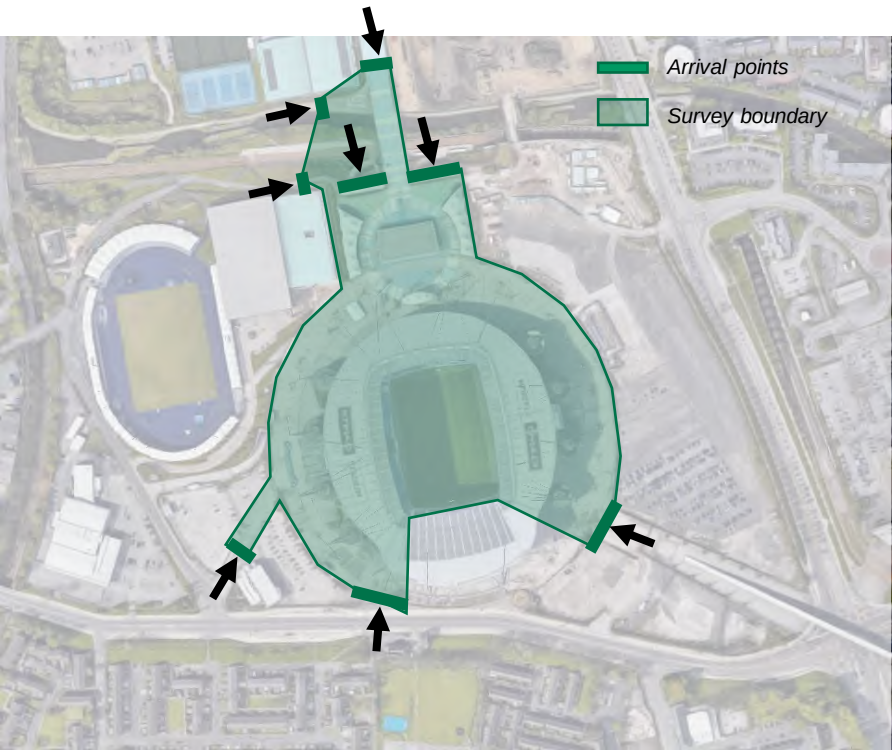


Figure 16: Demarcation area for ingress analysis

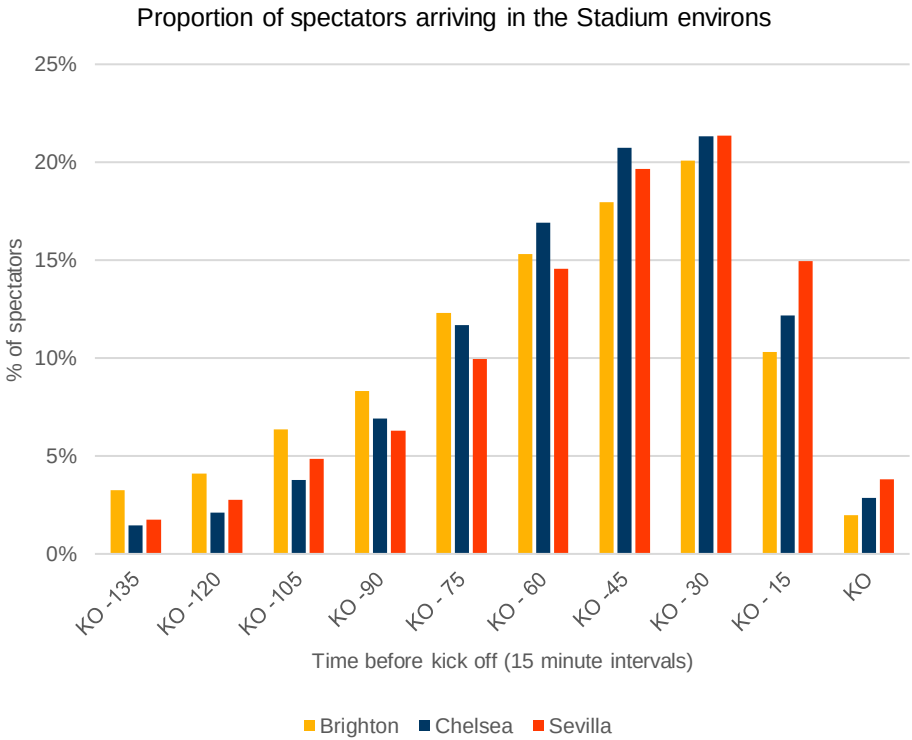


Figure 17: Spectator arrival in Stadium environs

TURNSTILE DATA | INGRESS PROFILE BY STAND

Turnstile data for each of the fixtures surveyed was provided by CFGL. The data presented spectator entries per minute through each turnstile.

The turnstile data for each of the matches surveyed has been interrogated to understand arrival profile variations by stand and match.

The arrival profile into the Stadium follows a similar pattern for each stand and each match, with **up to 25% of demand for a particular Stand entering the Stadium in a 15-minute period**.

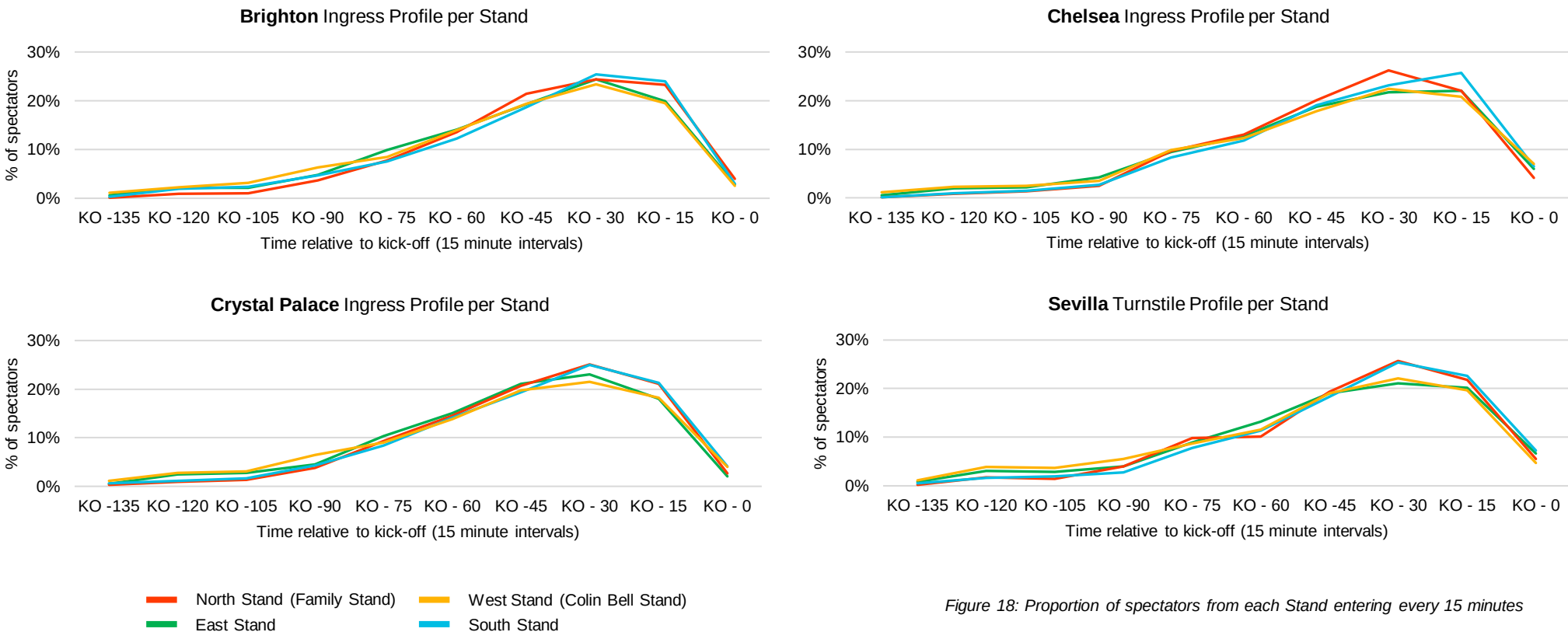


Figure 18: Proportion of spectators from each Stand entering every 15 minutes

TURNSTILE DATA | INGRESS PROFILE

Figure 19 summarises spectator turnstile profiles for each of the matches surveyed.

To assess queuing that may occur outside the turnstiles, a ‘peaked’ profile will be used for spectator arrivals to the entry turnstiles. This is because **the turnstile data reflects the throughput of the turnstiles only and may not accurately show queues that may form outside.**

For the purpose of this assessment, it is assumed 40% of all spectator demand will arrive within a 15 minute period. The turnstile data received indicates the maximum proportion of ingress within 15 minutes was 24%, achieved at the MCFC vs. Brighton fixture at approximately 30 – 15 minutes before kick-off.

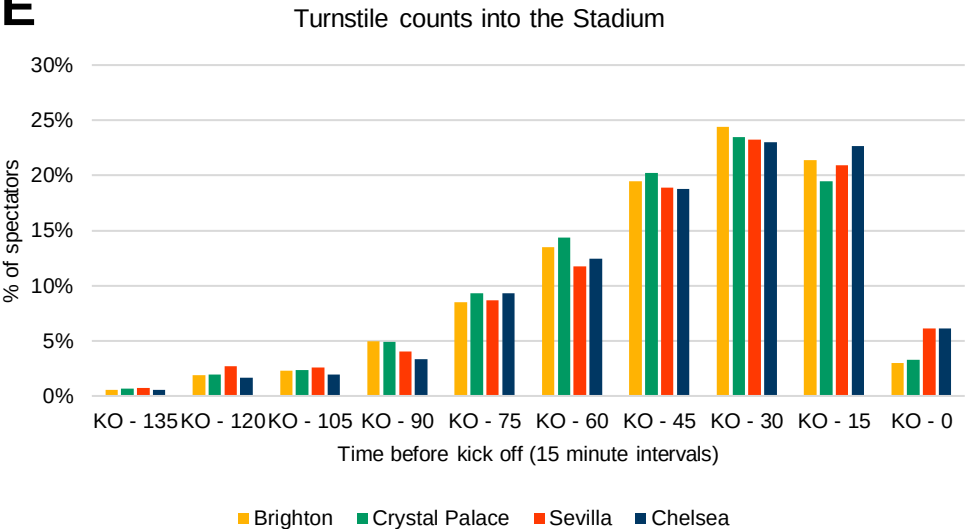


Figure 19: Proportion of spectators entering the Stadium every 15 minutes from turnstile data

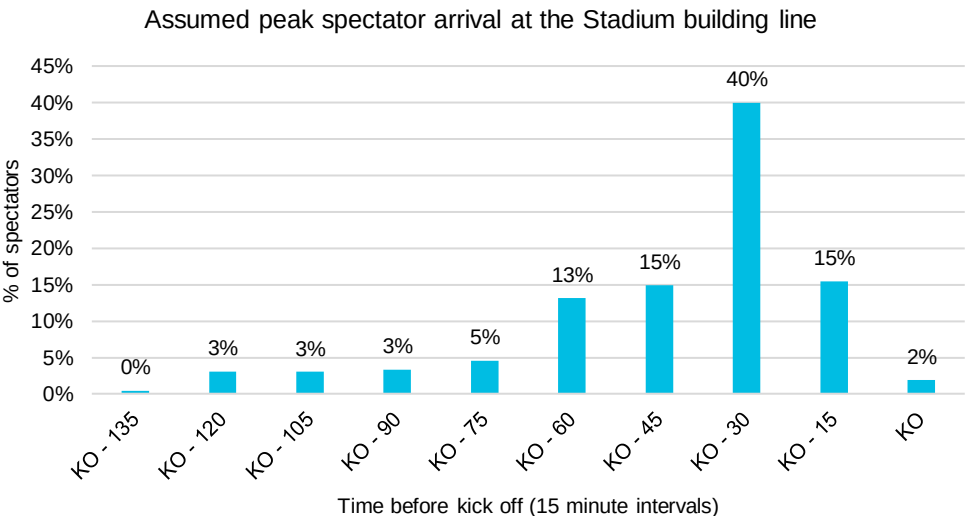
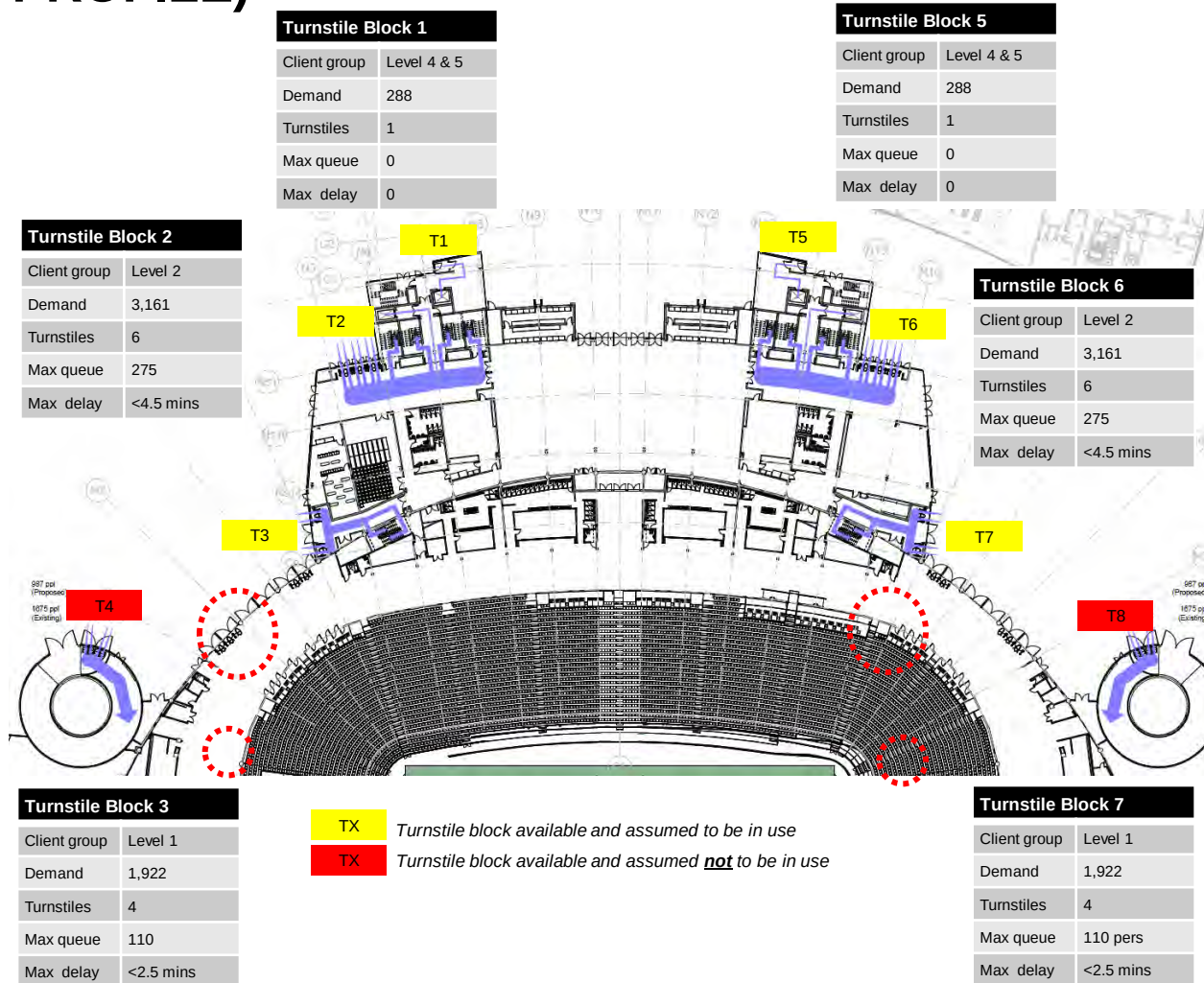


Figure 20: Assumed peak spectator arrival profile

SPECTATOR INGRESS – TURNSTILE PROVISION (PEAKED ARRIVAL PROFILE)



Based on the requirements set out in *The Guide to Safety at Sports Grounds, 6th Edition*, the turnstile provision meets the minimum requirements for spectators, as set out in the table below:

Level	Spectators	Turnstiles required	Turnstiles provided
Level 4 & 5	576	1	2
Level 2	6,322	10	12
Level 1	3,844	6	8

Table 03: Turnstile provision

For the purpose of this assessment, a peak arrival period of 40% of spectators over a 15 minute period has been assumed. It has also been assumed that all Level 01 spectator demand would enter via dedicated new turnstile blocks (T3 and T7).

The presented max queues and delays are calculated using a throughput of 660 persons per hour per turnstile.

It should be noted that this assessment **assumes an appropriate** security screening overlay requirement on entry to the stand that that can provide a flow rate at least equal to that of the turnstiles.

Resulting in a maximum queue of 45 spectators per turnstile and a maximum individual delay of 4.5 minutes.

Figure 21: Level 00 turnstile provision, based on 660 persons/turnstile/hour

Source: NSE-POP-NS-00-DR-A-000506_Ver1.pdf

PEDESTRIAN POPULATION BUILD UP OUTSIDE THE STADIUM

The population in Etihad Campus at a given time will be defined by calculating the **difference between arrivals outside the venues and recorded entry into building lines**. It should be noted that this methodology will include persons queuing to access the Stadium.

Figure 21 presents the percentage of total attendance outside of the Stadium before kick off for three of the matches surveyed.

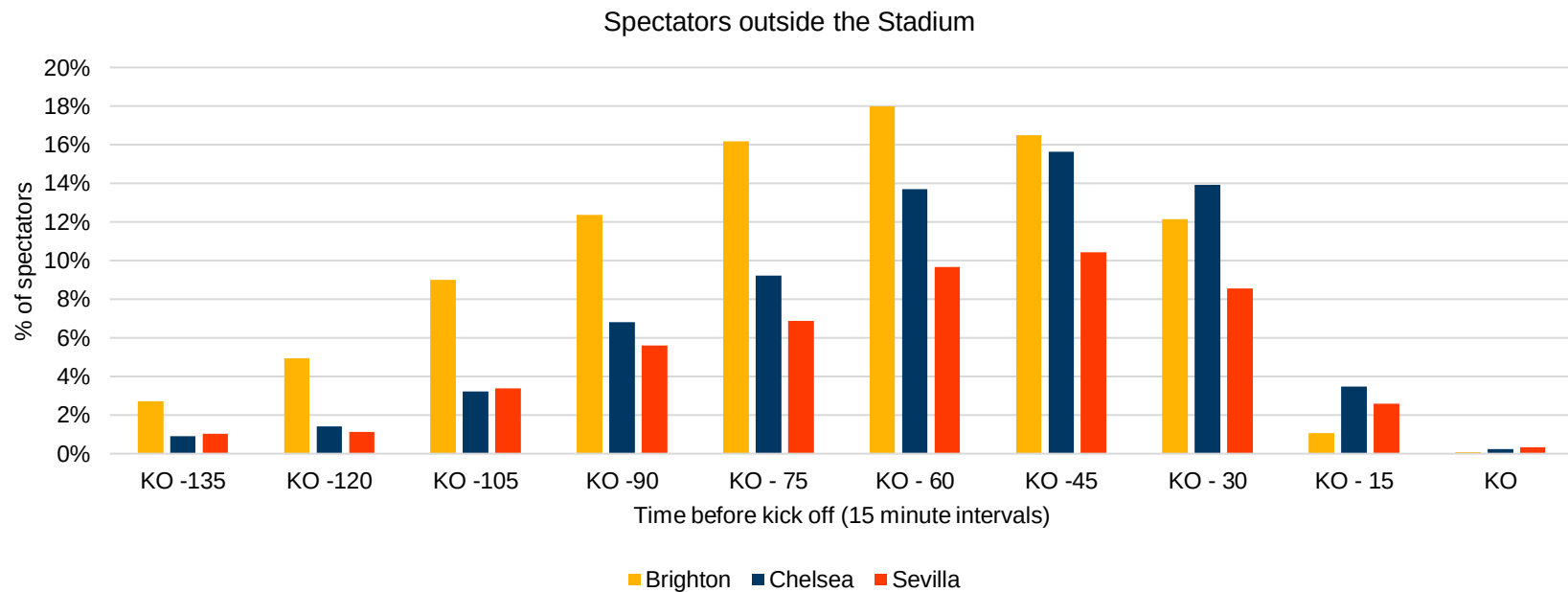


Figure 22: Proportion of spectators outside the Stadium every 15 minutes



05 HALF TIME

LEVEL 01 – HALF TIME



Figure 23: Level 01 concourse POS

Source: 230203 catering_POS.pdf

Dwelling Area

The Level 01 concourse is quoted as having 1,792 m² on the main concourse and an additional 401 m² in the Players Club. Based on the a population of 3,844 spectators, the main concourse can accommodate 90% of spectator demand at a density of 2 persons / m² as recommended in The Guide to safety at Sports Grounds.

Concessions

For the purpose of this assessment, it has been assumed that 50% of spectators will look to access Points of Sale (POS) over a 5 minute period:

- 85% of spectators will look to purchase a beverage, each transaction taking 15 seconds.
- 15% of spectators will look to purchase food, with each transaction taking 45 seconds.
- Each transaction serves 1.8 people.

The total provision of 52 POS on Level 01 will result in an average maximum queue of 12 persons per POS and a maximum individual delay of less than 6.5 minutes. This would infer that anticipated spectator demand could be processed within the half time period.

Toilets

Following discussions with Populous we understand provision of male/female toilets is being developed. This will be reviewed in more detail in Stage 4.

LEVEL 02 – HALF TIME

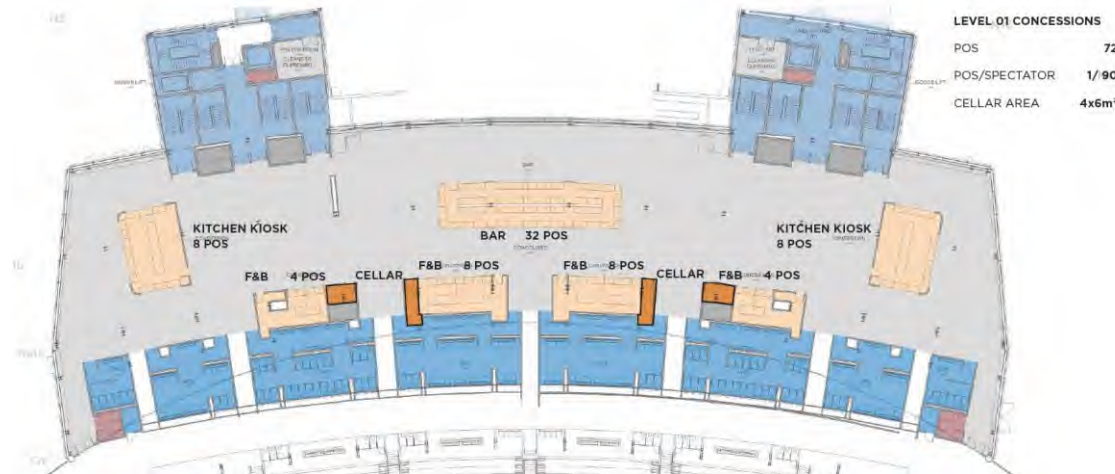


Figure 24: Level 02 concourse POS

Source: 230203 catering_POS.pdf

Dwelling Area

The Level 02 concourse is quoted as having 1,767 m² on the main concourse. Based on the a population of 6,322 spectators, the main concourse can accommodate 56% of spectator demand at a density of 2 persons / m² as recommended in The Guide to safety at Sports Grounds.

Concessions

For the purpose of this assessment, it has been assumed that 50% of spectators will look to access Points of Sale (POS) over a 5 minute period:

- 85% of spectators will look to purchase a beverage, each transaction taking 15 seconds.
- 15% of spectators will look to purchase food, with each transaction taking 45 seconds.
- Each transaction serves 1.8 people.

The total provision of 72 POS on Level 02 will result in an average maximum queue of 15 persons per POS and a maximum individual delay of less than 8.5 minutes. This would infer that anticipated spectator demand could be processed within the half time period.

Toilets

Following discussions with Populous we understand provision of male/female toilets is being developed. This will be reviewed in more detail in Stage 4.



05 POST EVENT DEPARTURES / EGRESS

POST EVENT DEPARTURES / EGRESS

Assumed peak spectator departure for Stadium

The average egress profile for the Stadium was obtained from the survey data for multiple locations at the Manchester City vs Brighton fixture (22 October 2022). This showed a peak egress of 24% of spectators leaving over a 5 minute period (and 55.3% over a 15 minute period).

In order to fully test the pedestrian routes available, a 'hard egress' scenario of 75% of spectators leaving over a 15 minute period will also be assessed.

Figure 25 shows both egress profiles.

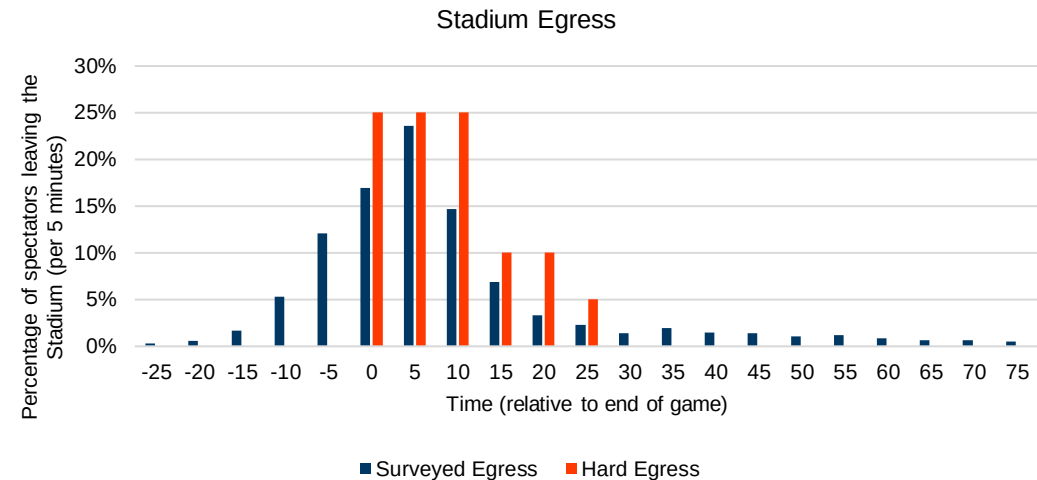


Figure 25: Selected Stadium departure profiles

Assumed peak spectator departure for OVG Arena

Arena departures profiles will be based on the 'OVG Manchester, Details of the Special Measures Operating Plan, Buro Happold, 10 November 2022' document.

Spectators are assumed to depart the Arena evenly over an 8 minute period (see Figure 26).

It should be noted that 50% of Hospitality spectators are not expected to egress immediately after the event ends and 5% of spectators depart in the 15 minutes before the end of the event.

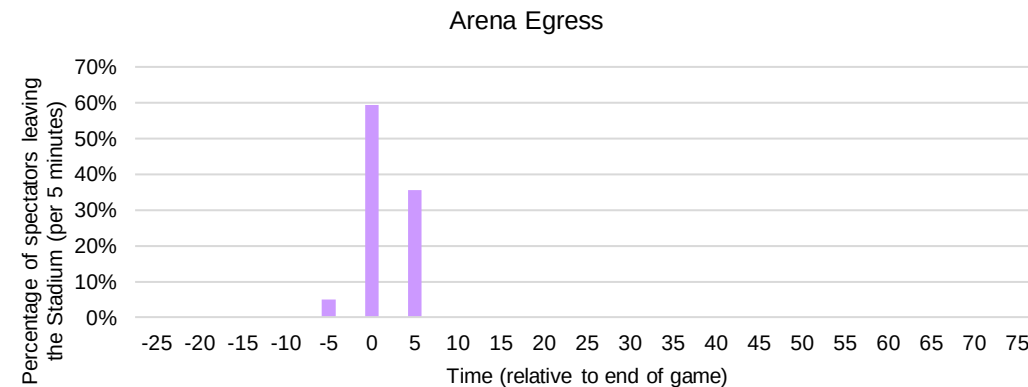


Figure 26: Arena departure profiles

SPECTATOR EGRESS IN THE NORTH STAND

LEVEL 05 – SPECTATOR CIRCULATION ON EGRESS ROUTES (STATIC ASSESSMENT)

STR Z6	
Client group	Level 5
Demand	228
Stair Width	1.30 metres
Stair Capacity	60 pers/min
Peak Demand	13 pers/min

STR A6	
Client group	Level 5
Demand	228
Stair Width	1.30 metres
Stair Capacity	60 pers/min
Peak Demand	13 pers/min

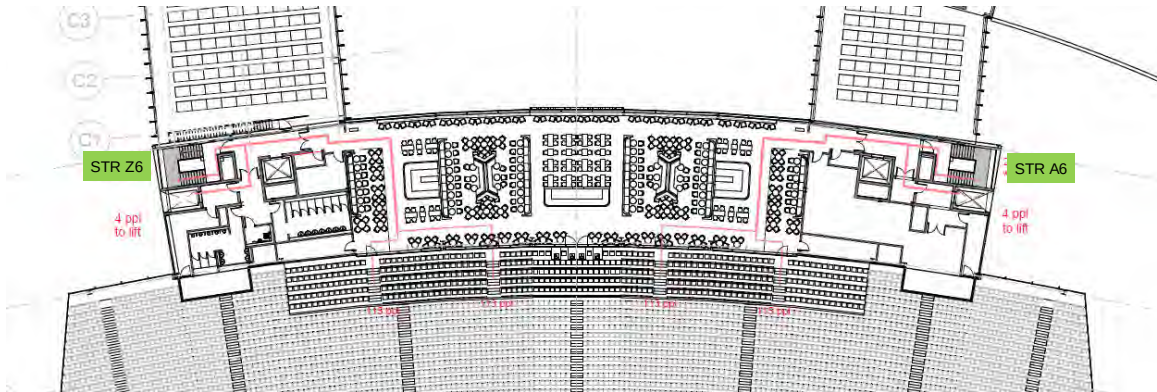


Figure 27: Level 05 concourse during departures

Source: NSE-POP-NS-05-DR-A-000505_Ver2.pdf

For the purpose of this assessment, it has been assumed that:

- 85% of spectators look to depart the concourse over a 15 minute period. This is considered a robust egress assumptions.
- During the departure period, spectators will look to access the exit stair closest to them.

It should be noted that stair capacity has been assessed against the desired performance capacity target, rather than the maximum permissible capacity from a safety perspective. It may be that this is therefore understating the potential performance of the infrastructure.

The assessment undertaken for Level 05 indicates that the exit stairs can accommodate the spectator demand during the departures period. It should be noted that use of lifts has not been considered during the departure period.

LEVEL 04 – SPECTATOR CIRCULATION ON EGRESS ROUTES (STATIC ASSESSMENT)

STR Z6	
Client group	Level 4
Demand	228
Stair Width	1.30 metres
Stair Capacity	60 pers/min
Peak Demand	4 pers/min

STR A6	
Client group	Level 4
Demand	228
Stair Width	1.30 metres
Stair Capacity	60 pers/min
Peak Demand	4 pers/min

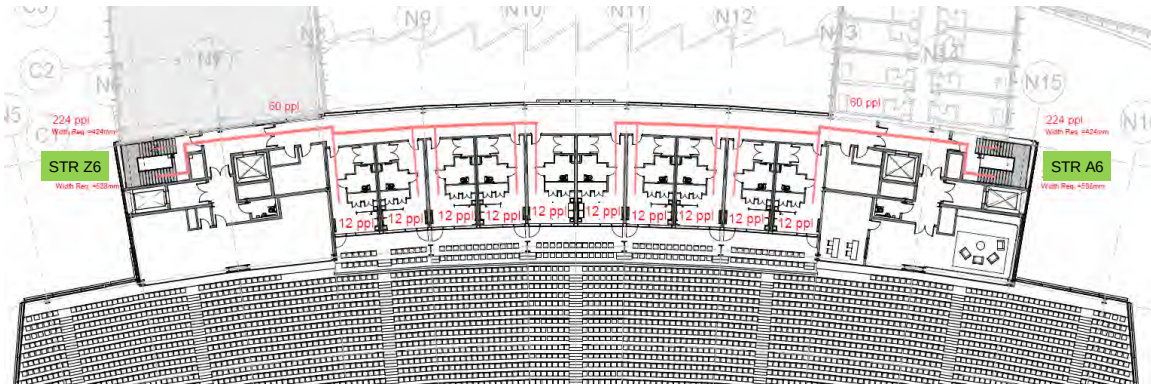


Figure 28: Level 04 concourse during departures

Source: NSE-POP-NS-04-DR-A-000504_Ver2.pdf

For the purpose of this assessment, it has been assumed that:

- 85% of spectators look to depart the concourse over a 15 minute period. This is considered a robust egress assumptions.
- During the departure period, spectators will look to access the exit stair closest to them.

It should be noted that stair capacity has been assessed against the desired performance capacity target, rather than the maximum permissible capacity from a safety perspective. It may be that this is therefore understating the potential performance of the infrastructure.

The assessment undertaken for Level 04 indicates that the exit stairs can accommodate the spectator demand during the departures period. It should be noted that use of lifts has not been considered during the departure period.

LEVEL 02 – SPECTATOR CIRCULATION ON EGRESS ROUTES (STATIC ASSESSMENT)

STR Z2		STR Z3		STR Z4		STR Z5		STR Z6	
Client group	Level 2	Client group	Level 2	Client group	Level 2	Client group	Level 2	Client group	Level 2
Demand	783	Demand	779	Demand	813	Demand	770	Demand	0
Stair Width	1.50 metres	Stair Width	1.50 metres	Stair Width	1.50 metres	Stair Width	1.50 metres	Stair Width	1.30 metres
Stair Capacity	65 pers/min	Stair Capacity	65 pers/min	Stair Capacity	65 pers/min	Stair Capacity	65 pers/min	Stair Capacity	60 pers/min
Peak Demand	44 pers/min	Peak Demand	44 pers/min	Peak Demand	46 pers/min	Peak Demand	44 pers/min	Peak Demand	0 pers/min

For the purpose of this assessment, it has been assumed that:

- 85% of spectators look to depart the concourse over a 15 minute period. This is considered a robust egress assumptions.
- During the departure period, spectators will look to access the exit stair closest to them.

It should be noted that stair capacity has been assessed against the desired performance capacity target, rather than the maximum permissible capacity from a safety perspective. It may be that this is therefore understating the potential performance of the infrastructure.

The assessment undertaken for Level 02 indicates that the exit stairs can accommodate the spectator demand during the departures period. It should be noted that use of lifts has not been considered during the departure period.

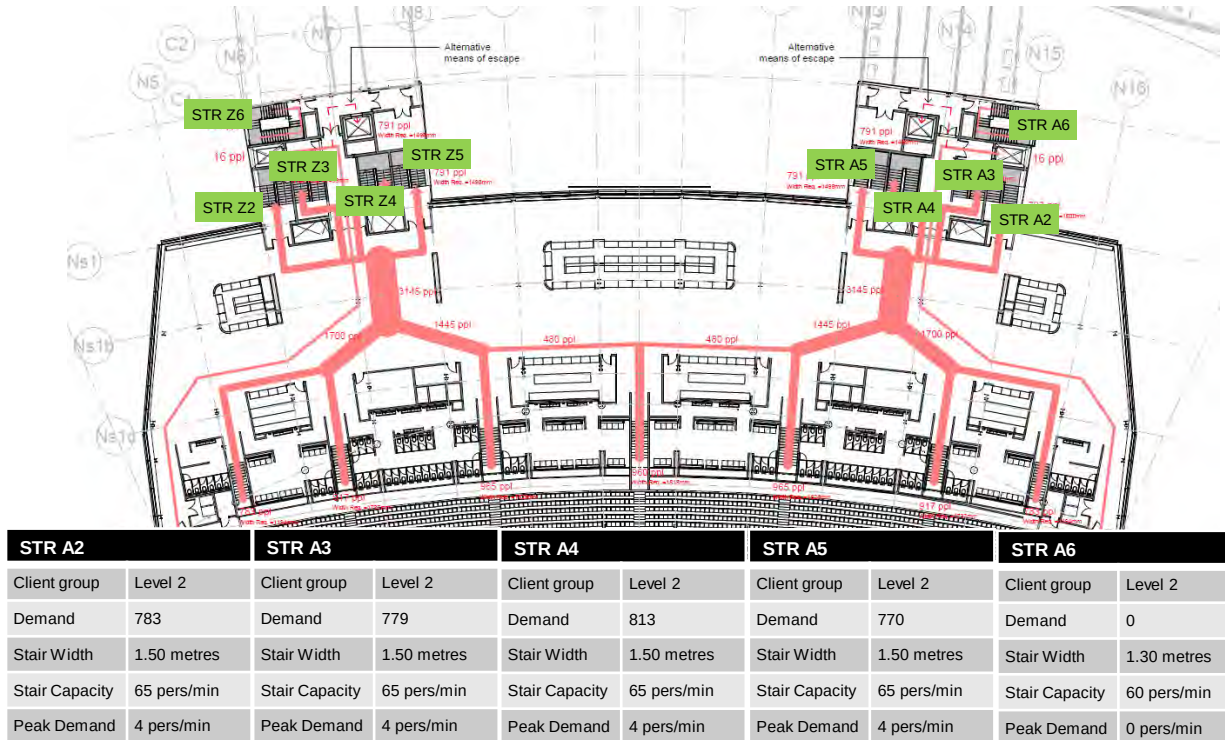
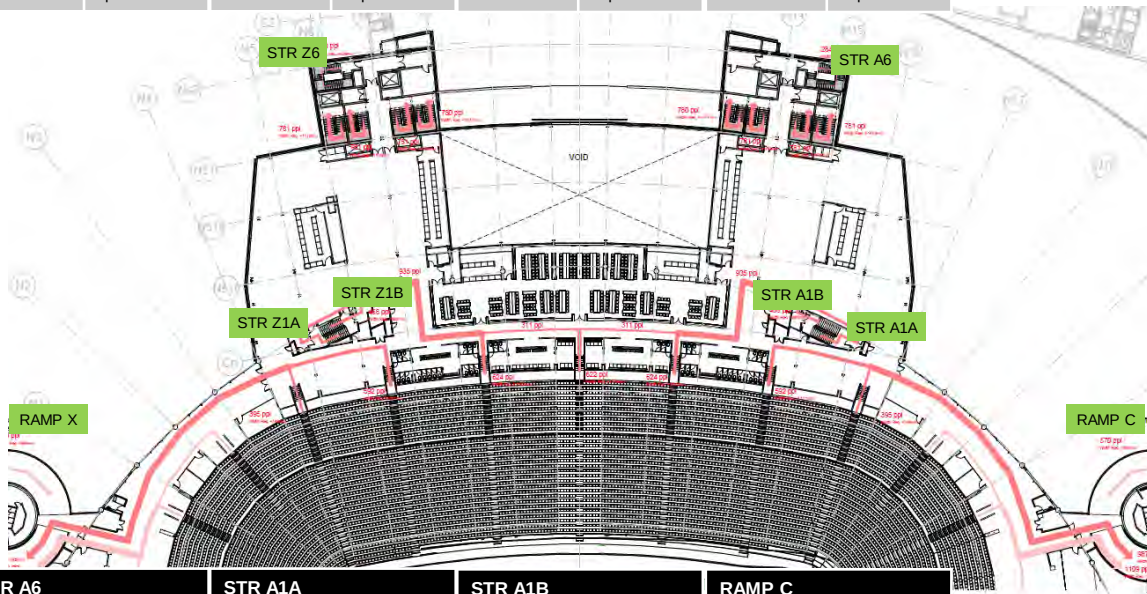


Figure 29: Level 02 concourse during departures

Source: NSE-POP-NS-02-DR-A-000502_Ver2.pdf

LEVEL 01 – SPECTATOR CIRCULATION ON EGRESS ROUTES (STATIC ASSESSMENT)

STR Z6		STR Z1A		STR Z1B		RAMP X	
Client group	Level 1	Client group	Level 1	Client group	Level 1	Client group	Level 1
Demand	0	Demand	468	Demand	467	Demand	987
Stair Width	1.30 metres	Stair Width	1.35 metres	Stair Width	1.35 metres	Ramp Width	3.55 metres
Stair Capacity	60 pers/min	Stair Capacity	58 pers/min	Stair Capacity	58 pers/min	Stair Capacity	152 pers/min
Peak Demand	0 pers/min	Peak Demand	27 pers/min	Peak Demand	27 pers/min	Peak Demand	56 pers/min



STR A6		STR A1A		STR A1B		RAMP C	
Client group	Level 1	Client group	Level 1	Client group	Level 1	Client group	Level 1
Demand	0	Demand	468	Demand	467	Demand	987
Stair Width	1.30 metres	Stair Width	1.35 metres	Stair Width	1.35 metres	Ramp Width	3.85 metres
Stair Capacity	60 pers/min	Stair Capacity	58 pers/min	Stair Capacity	58 pers/min	Stair Capacity	165 pers/min
Peak Demand	0 pers/min	Peak Demand	27 pers/min	Peak Demand	27 pers/min	Peak Demand	56 pers/min

For the purpose of this assessment, it has been assumed that:

- 85% of spectators look to depart the concourse over a 15 minute period. This is considered a robust egress assumptions.
- During the departure period, spectators will look to access the exit stair closest to them.

It should be noted that stair capacity has been assessed against the desired performance capacity target, rather than the maximum permissible capacity from a safety perspective. It may be that this is therefore understating the potential performance of the infrastructure.

The assessment undertaken for Level 01 indicates that the exit stairs can accommodate the spectator demand during the departures period. It should be noted that use of lifts has not been considered during the departure period.

Ramp X and Ramp C may also have spectator demand from other stand using this route:

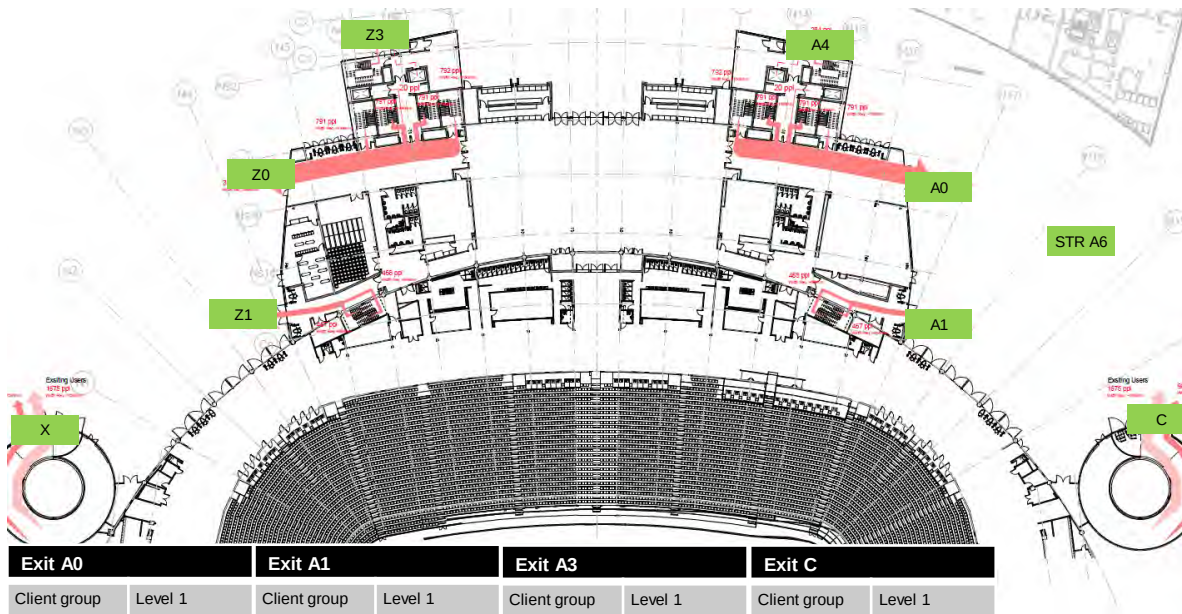
- If 1,794 spectators from the West Stand use Ramp X, peak flow would increase to 158 persons / minute. This is above the target performance but could be accommodated.
- If 2,126 spectators from the East Stand use Ramp C, peak flow would increase to 176 persons / minute. This is above the target performance but could be accommodated.

Figure 30: Level 01 concourse during departures

Source: NSE-POP-NS-01-DR-A-000501_Ver2.pdf

LEVEL 00 – SPECTATOR CIRCULATION ON EGRESS ROUTES (STATIC ASSESSMENT)

Exit Z0		Exit Z1		Exit Z3		Exit X	
Client group	Level 1	Client group	Level 1	Client group	Level 1	Client group	Level 1
Demand	3,145	Demand	1,059	Demand	509	Demand	2,781
Door Width	5.00 metres	Door Width	3.10 metres	Door Width	1.90 metres	Door Width	4.80 metres
Door Capacity	330 pers/min	Door Capacity	205 pers/min	Door Capacity	125 pers/min	Door Capacity	316 pers/min
Peak Demand	178 pers/min	Peak Demand	60 pers/min	Peak Demand	29 pers/min	Peak Demand	158 pers/min



Exit A0		Exit A1		Exit A3		Exit C	
Client group	Level 1	Client group	Level 1	Client group	Level 1	Client group	Level 1
Demand	3,145	Demand	1,059	Demand	509	Demand	3,113
Door Width	5.00 metres	Door Width	3.10 metres	Door Width	1.90 metres	Door Width	4.80 metres
Door Capacity	330 pers/min	Door Capacity	205 pers/min	Door Capacity	125 pers/min	Door Capacity	316 pers/min
Peak Demand	178 pers/min	Peak Demand	60 pers/min	Peak Demand	29 pers/min	Peak Demand	188 pers/min

For the purpose of this assessment, it has been assumed that:

- 85% of spectators look to depart the North Stand over a 15 minute period. This is considered a robust egress assumptions.
- During the departure period, spectators will look to access the exit stair closest to them.

It should be noted that exit capacity has been assessed against the desired performance capacity target, rather than the maximum permissible capacity from a safety perspective. It may be that this is therefore understating the potential performance of the infrastructure.

The assessment undertaken for Level 00 indicates that the exit stairs can accommodate the spectator demand during the departures period. It should be noted that use of lifts has not been considered during the departure period.

Figure 31: Level 00 concourse during departures

Source: NSE-POP-NS-00-DR-A-000500_Ver2.pdf

SPECTATOR EGRESS IN THE ETIHAD CAMPUS

SCENARIO 3: STADIUM HARD EGRESS

Scenario 3

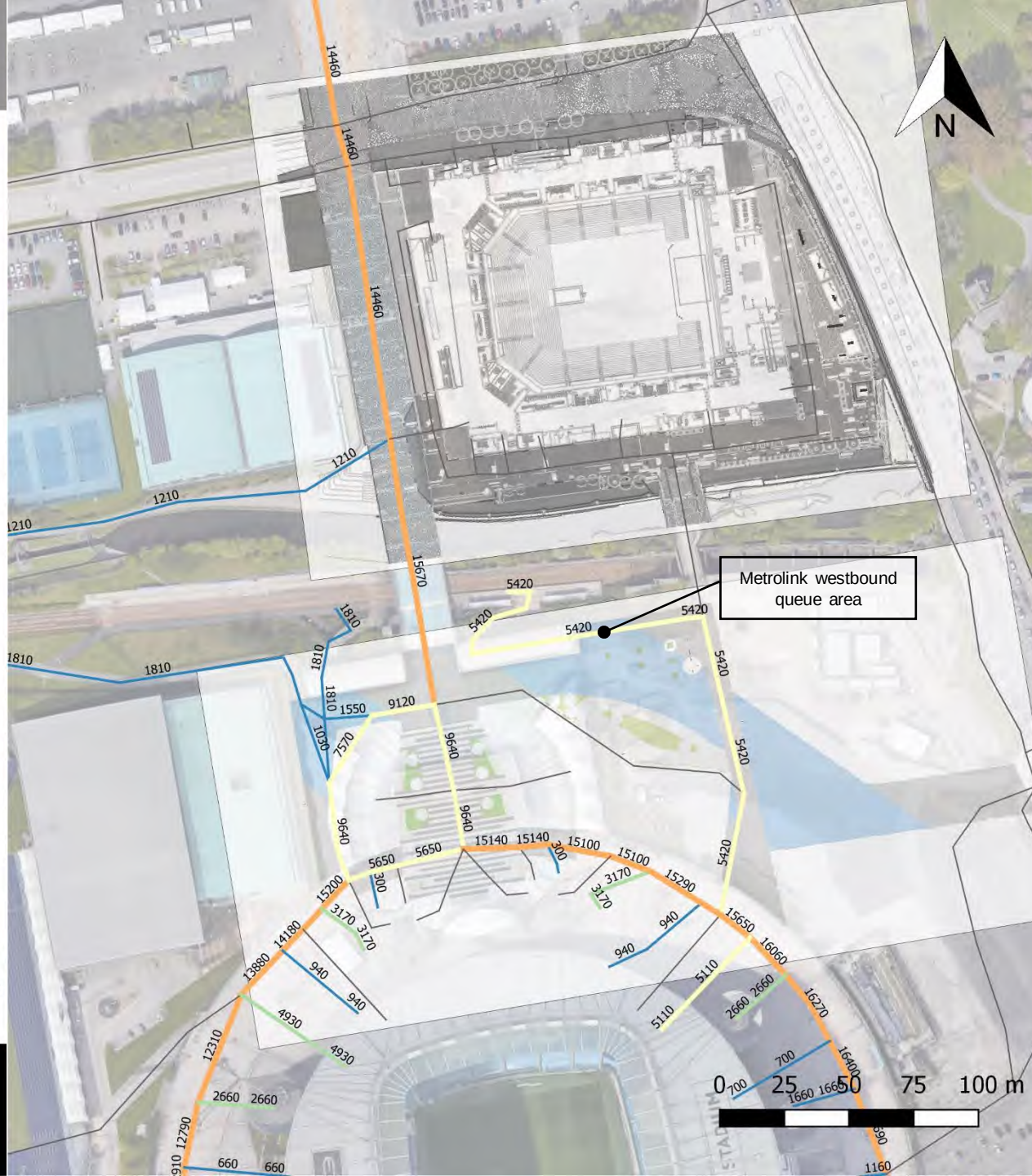
Stadium Hard Egress

North Stand and Arena Static Assignment by Link

- 15,670 people use JMW
- 9,640 people use the City Square West
- 9,640 people use the City Square
- 5,420 people use the Westbound Metrolink.

Legend

- No people
- < 2,500 ppl
- 2,500 - 5,000
- 5,000 - 10,000
- 10,000 - 20,000
- > 20,000 ppl

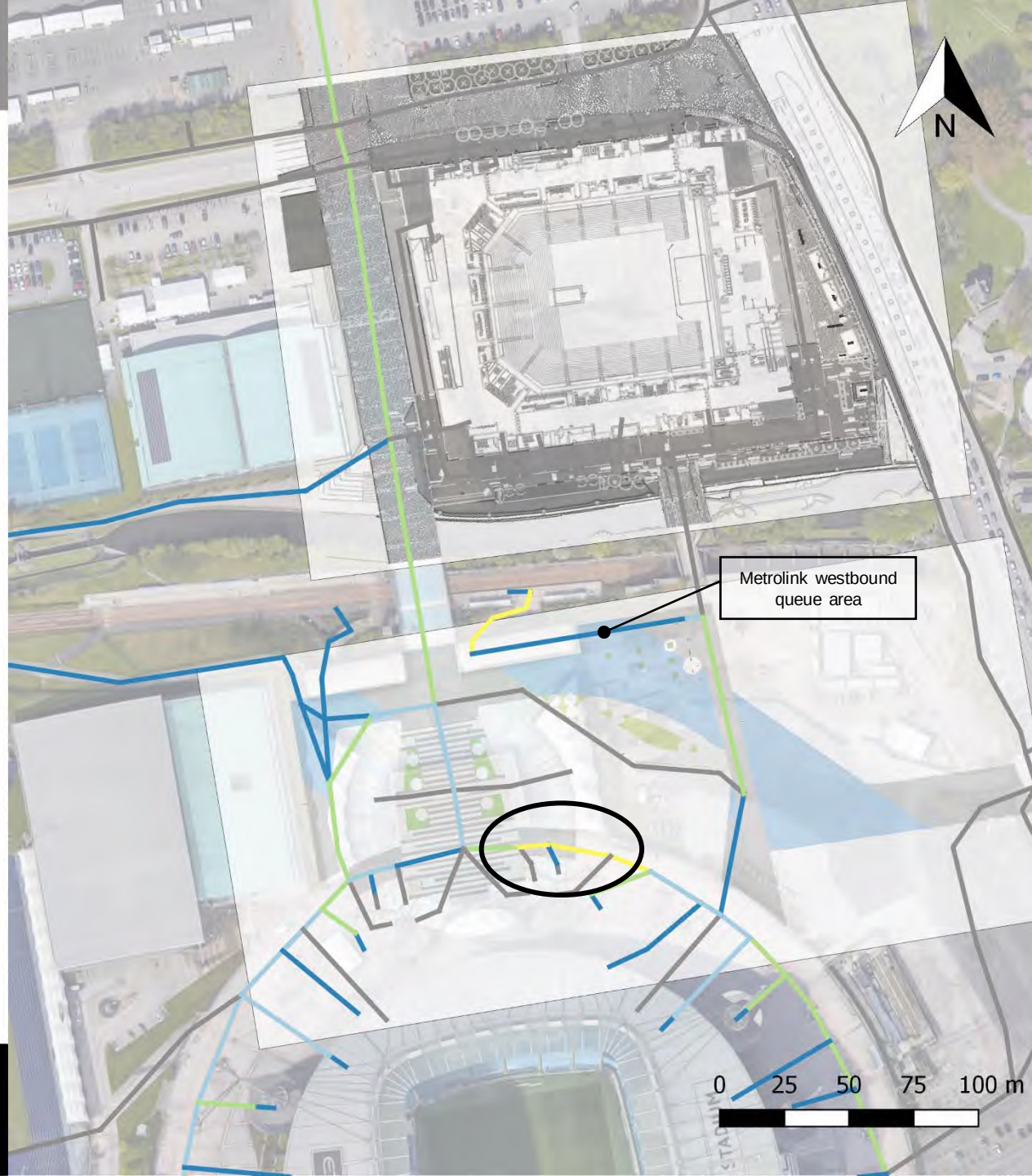
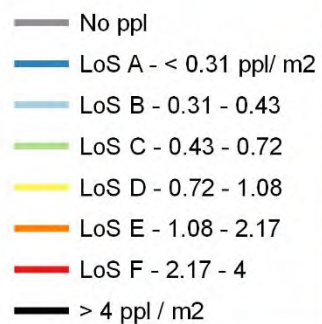


Scenario 3

Stadium Hard Egress

North Stand and Arena Max Density by Link

- LoS C is not exceeded at any circulation link except for a brief period of time to the north east of the North Stand.



Scenario 3

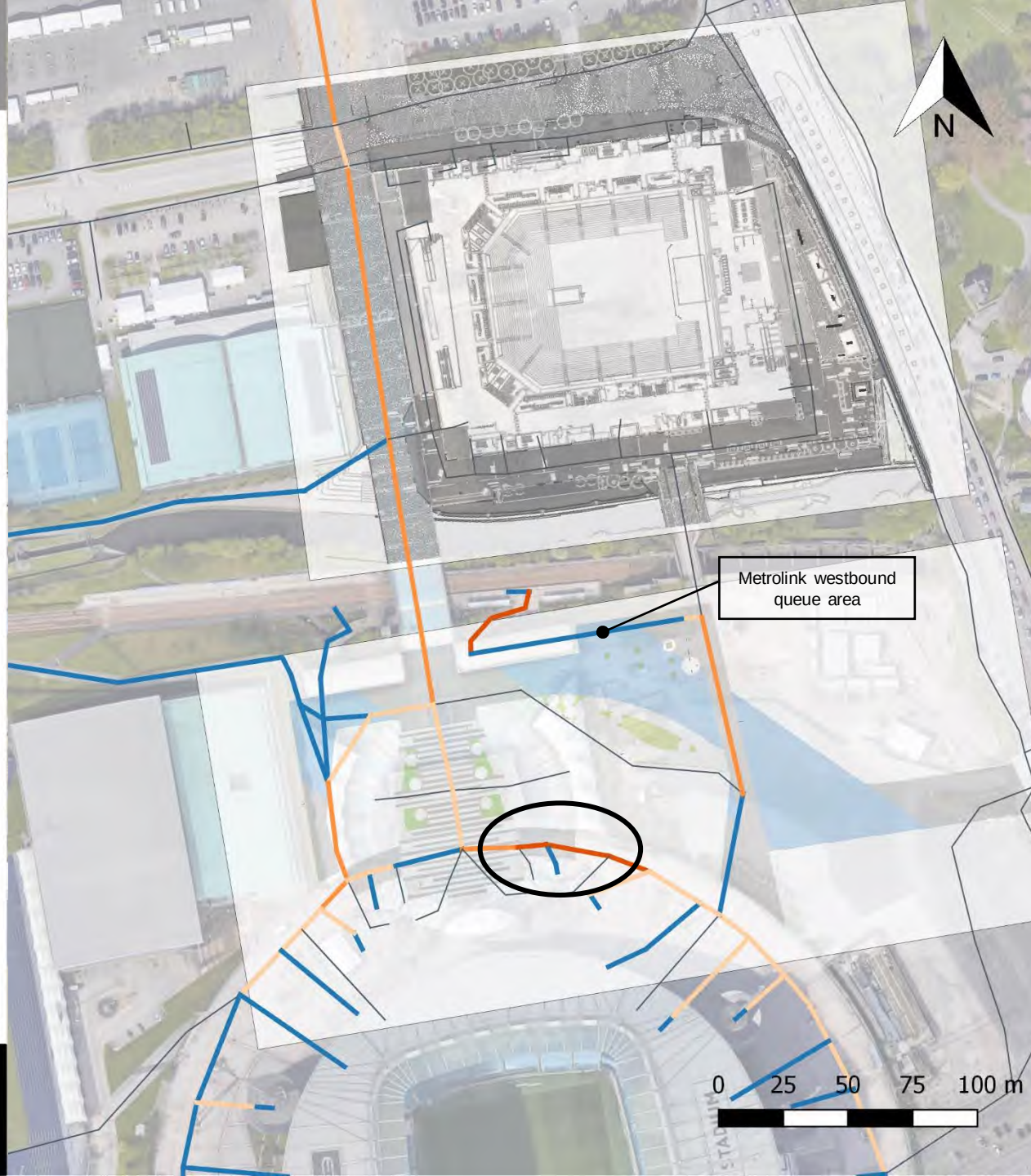
Stadium Hard Egress

North Stand and Arena Max Flowrate by Link

- Most of the area outside the North Stand will experience flowrates of up to 49 persons/minute/metre width.

Legend

—	No people
—	< 23 ppl/m/min
—	23 - 33
—	33 - 49
—	49 - 66
—	66 - 82
—	> 82 ppl/m/min



SPECTATOR EGRESS IN THE ETIHAD CAMPUS

SCENARIO 4: STADIUM EGRESS AND 30-MIN OFFSET ARENA EGRESS

Scenario 4

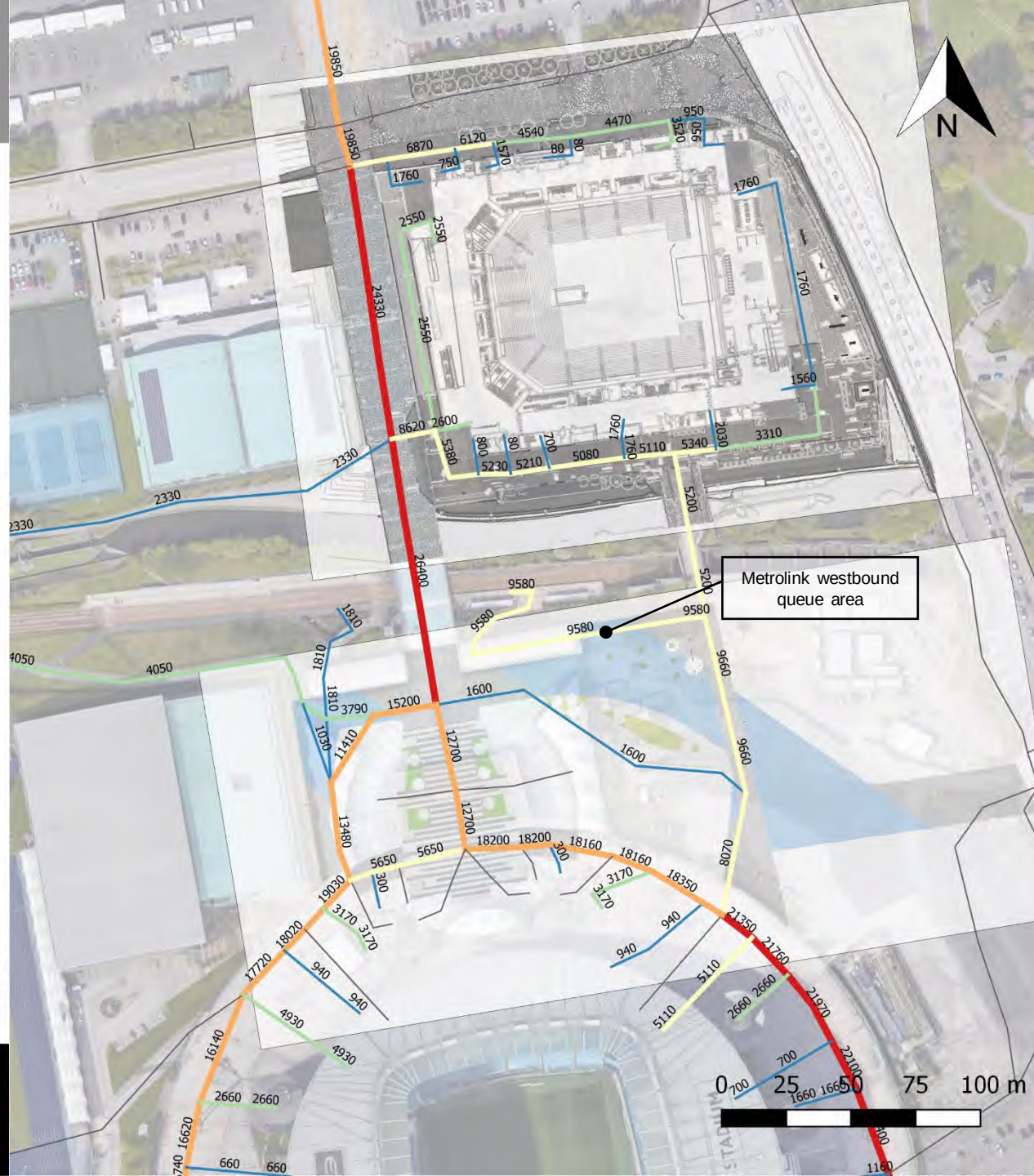
Stadium Egress and 30-min Offset Arena Egress

North Stand and Arena Static Assignment by Link

- 26,400 people use JMW
- 15,200 people use the City Square West
- 12,700 people use the City Square
- 9,580 people use the Westbound Metrolink.

Legend

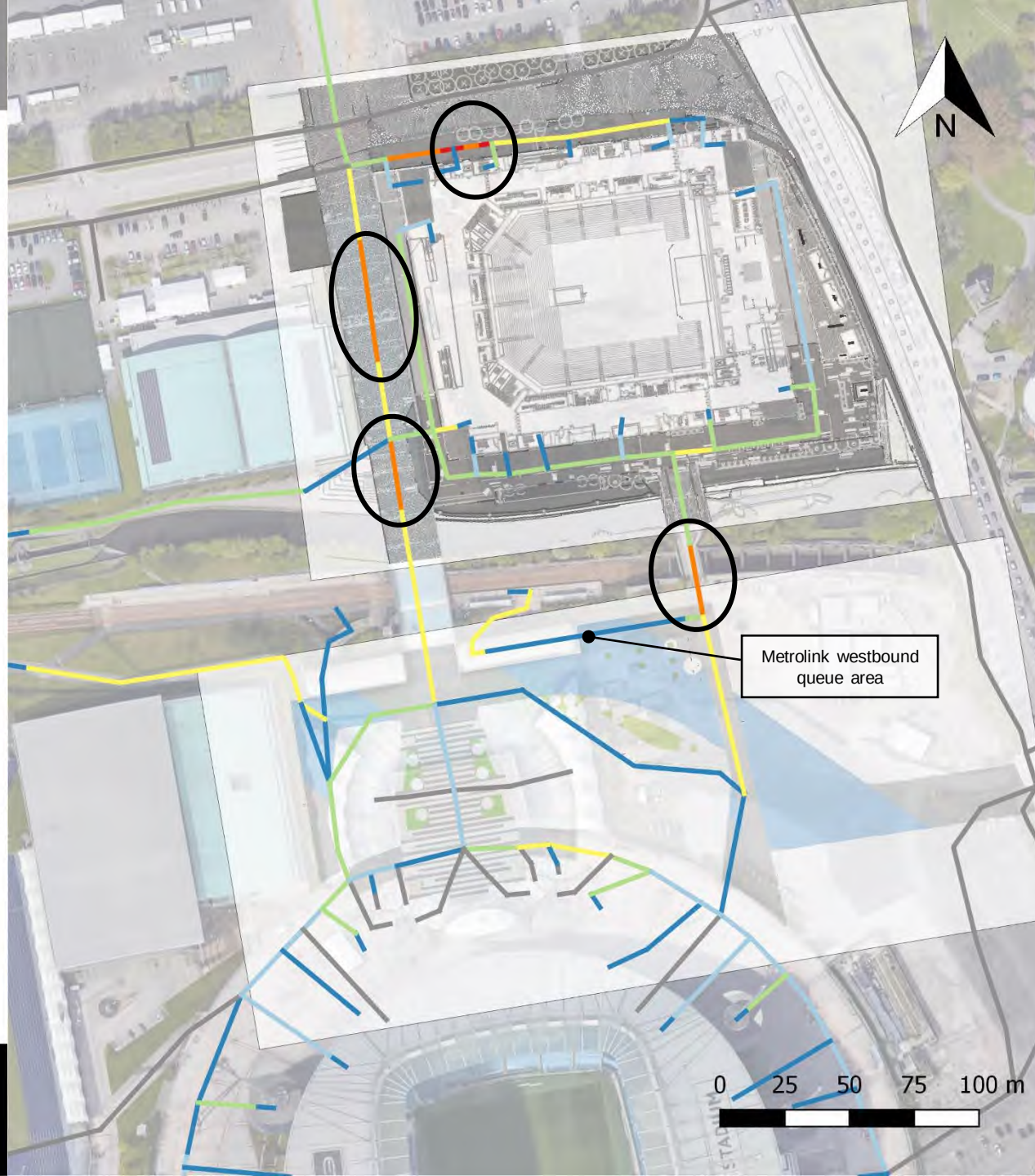
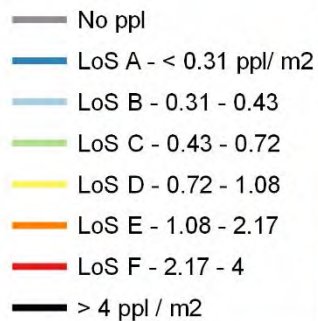
- No people
- < 2,500 ppl
- 2,500 - 5,000
- 5,000 - 10,000
- 10,000 - 20,000
- > 20,000 ppl



Scenario 4 Stadium Egress and 30-min Offset Arena Egress

North Stand and Arena Max Density by Link

- LoS D (target LoS for egress) is not exceeded at any circulation link outside the North Stand. This is based on the surveyed egress profile, not the hard egress profile.
- JMW reaches LoS E at two different locations. This may be due to not using Alan Turing Way to reduce demand on Joe Mercer Way during the Arena egress.
- LoS E is reached once on approach to the Westbound Metrolink queue. This may be due to assumed queue density constraints of 2 persons / m² in the model.
- LoS E and F are reached outside the north side of the Arena, on Sportcity Way. This is a worst case scenario model assuming 8-min egress from the venue, and no use of Alan Turing Way.

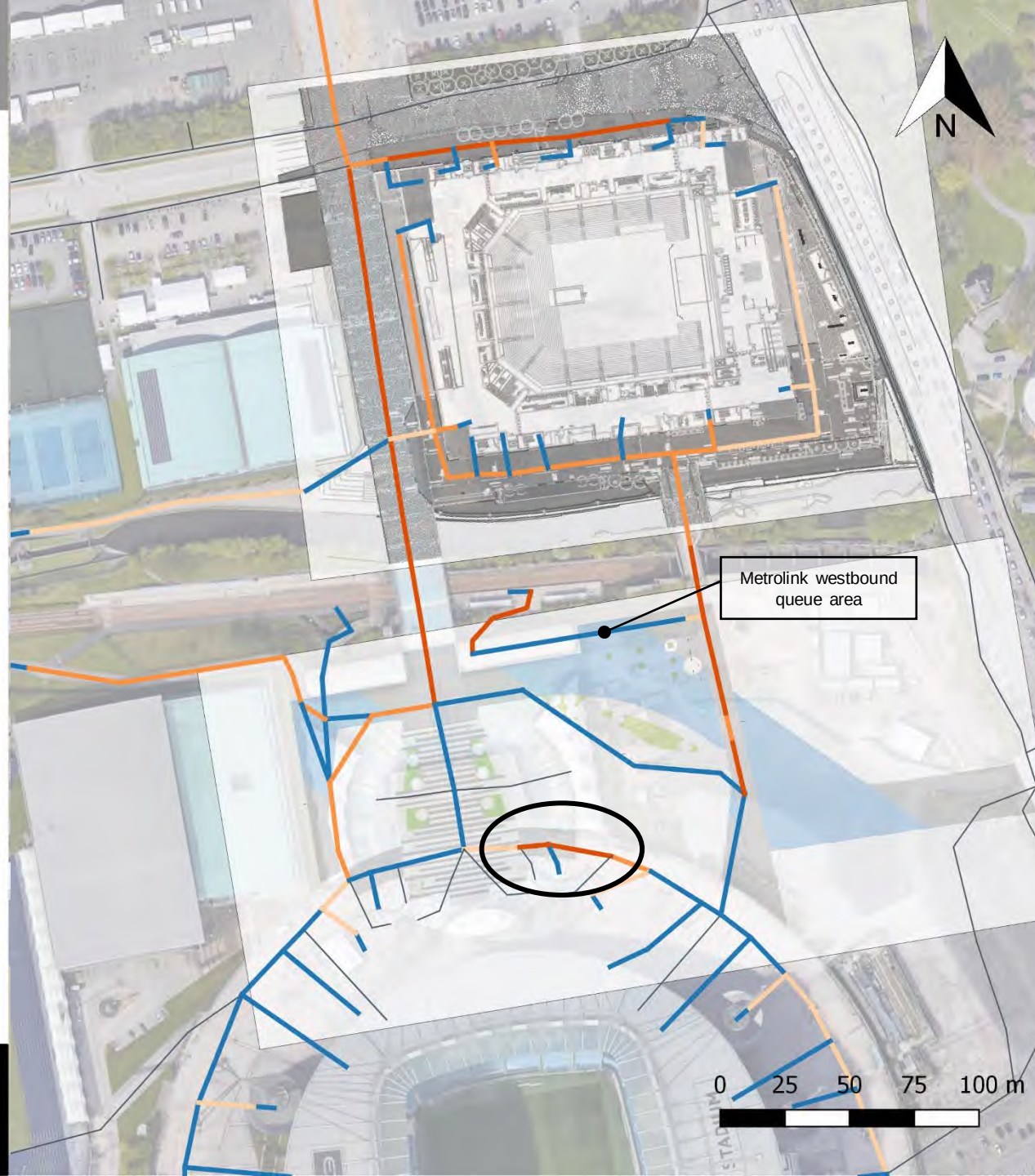
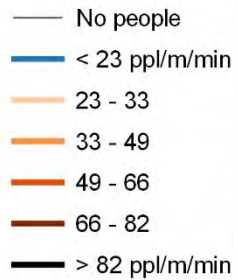


Scenario 4 Stadium Egress and 30-min Offset Arena Egress

North Stand and Arena Max Flowrate by Link

- The route outside the north east of the North Stand will experience flowrates of up to 66 persons/minute/metre width.

Legend



SPECTATOR EGRESS IN THE ETIHAD CAMPUS

SCENARIO 5A: SIMULTANEOUS STADIUM AND ARENA EGRESS

SURVEYED STADIUM EGRESS

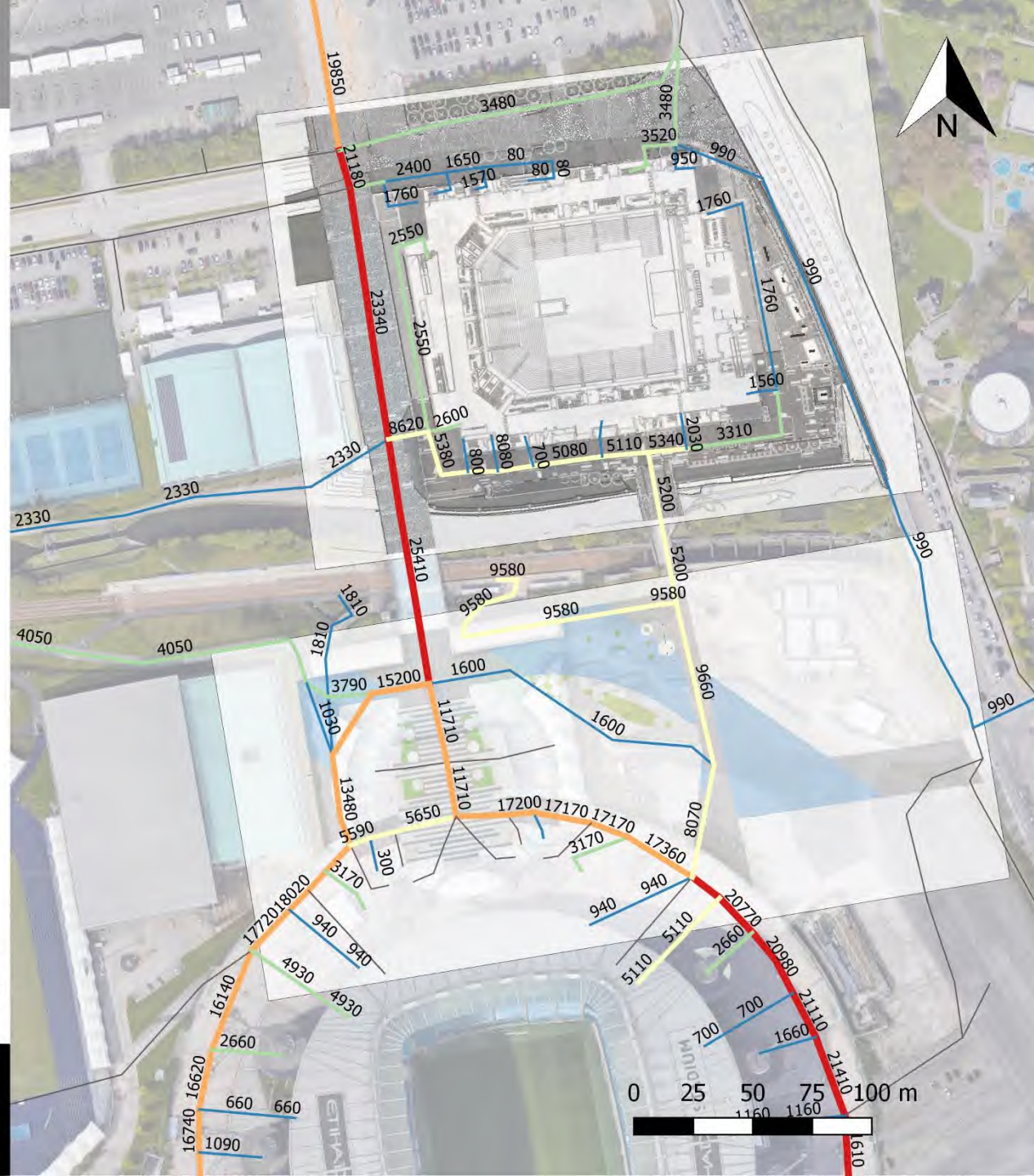
Stadium + Arena Simultaneous Egress

North Stand and Arena Static Assignment by Link

- 25,410 people use JMW.
- 15,200 people use the City Square West.
- 11,710 people use the City Square.
- 9,580 people use the Westbound Metrolink.

Legend

- No people
- < 2,500 ppl
- 2,500 - 5,000
- 5,000 - 10,000
- 10,000 - 20,000
- > 20,000 ppl



Scenario 5a

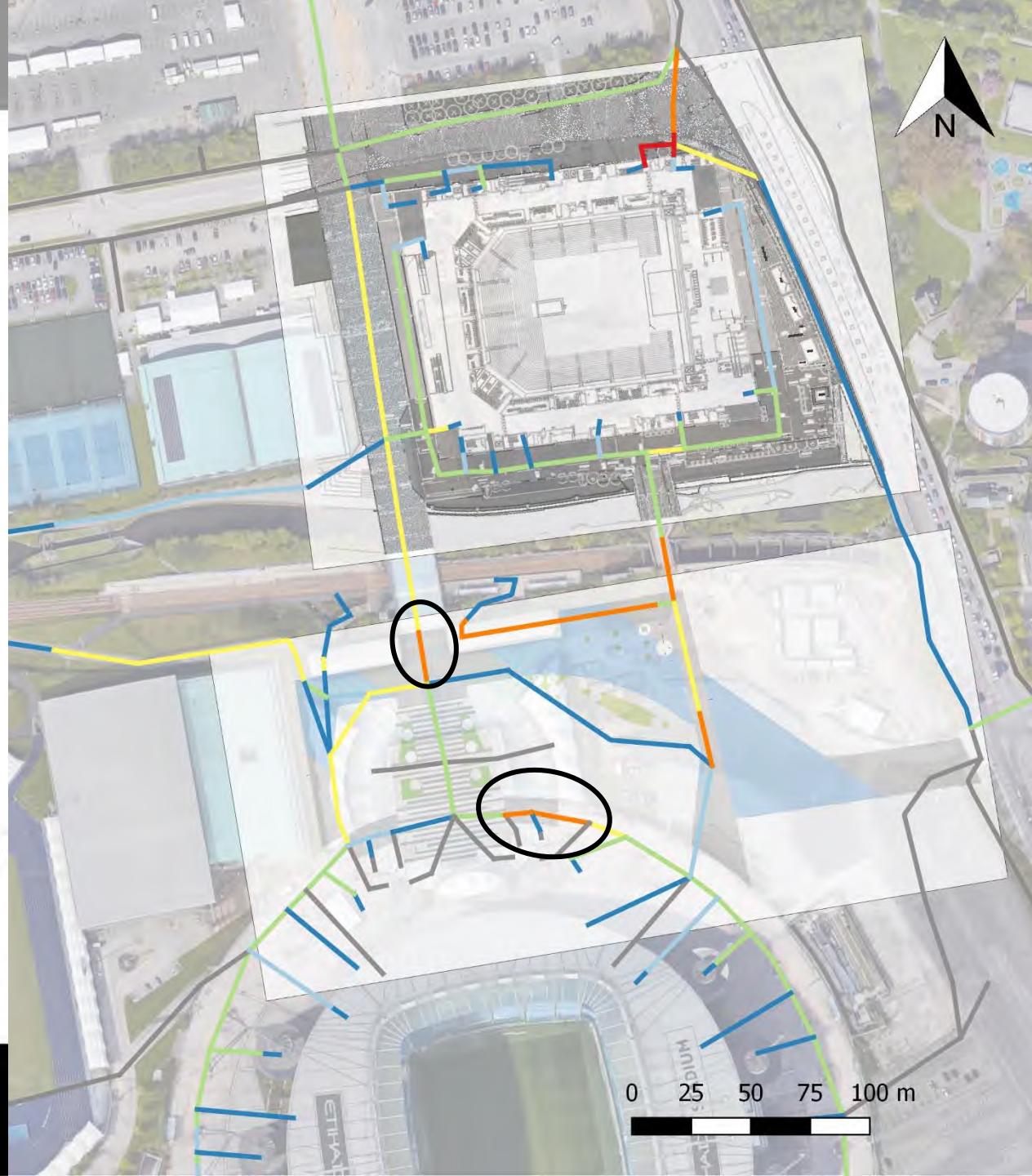
Stadium Surveged Egress + Arena Simultaneous

North Stand and Arena Max Density by Link

- LoS D (target LoS for egress) is not exceeded at any circulation link outside the North Stand except outside the north east of the North Stand.
- JMW reaches LoS E on approach to City Square.
- LoS E is reached once on approach to the Westbound Metrolink queue. This may be due to assumed queue density constraints of 2 persons / m² in the model.

Legend

- No ppl
- LoS A - < 0.31 ppl/ m²
- LoS B - 0.31 - 0.43
- LoS C - 0.43 - 0.72
- LoS D - 0.72 - 1.08
- LoS E - 1.08 - 2.17
- LoS F - 2.17 - 4



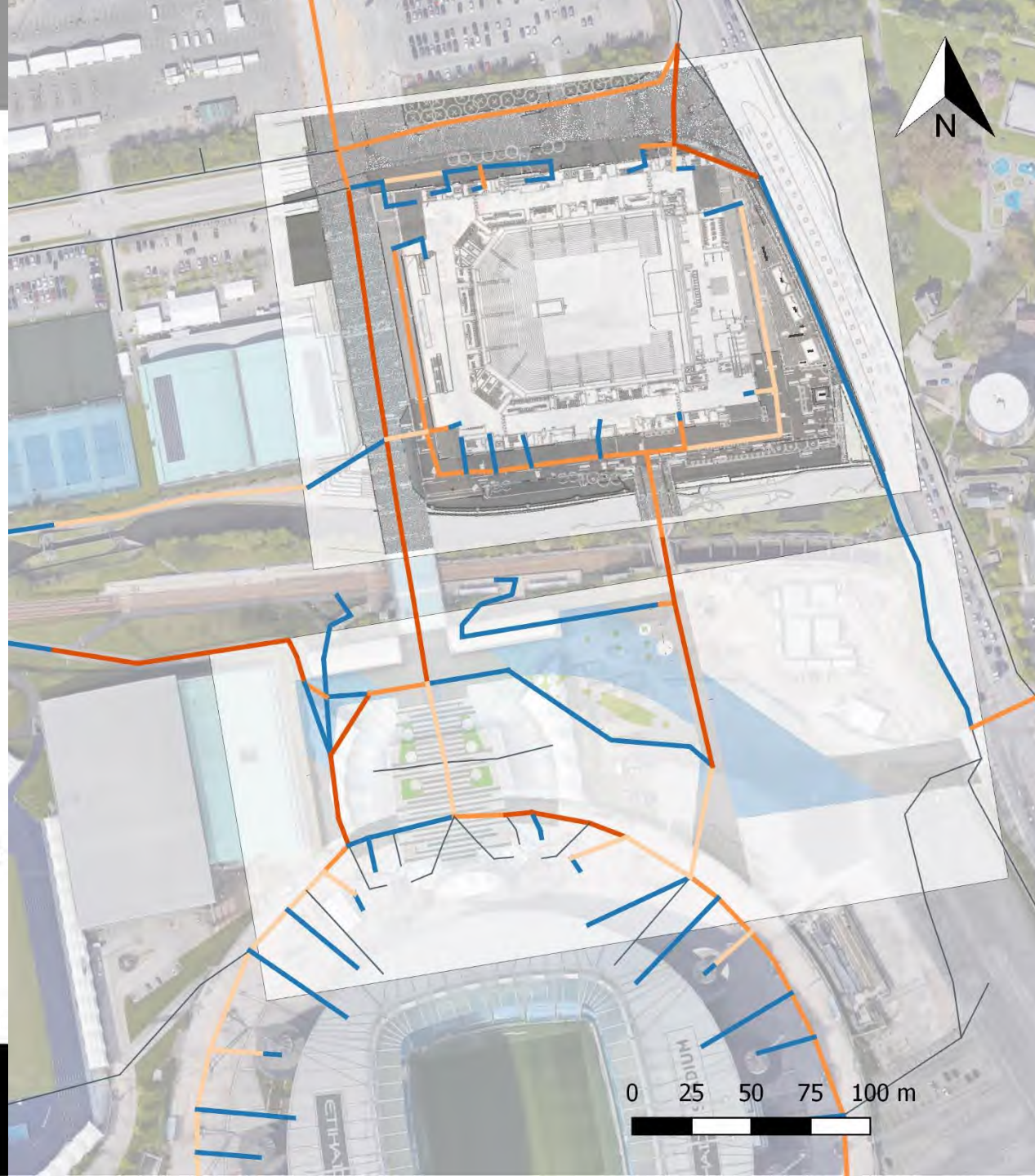
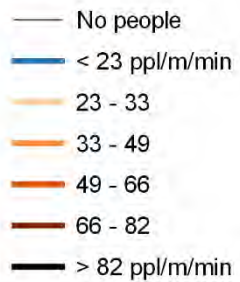
Scenario 5a

Stadium Surveyed Egress + Arena Simultaneous

North Stand and Arena Max Flowrate by Link

- Areas outside the North Stand will experience flowrates of up to 66 persons/minute/metre width.

Legend



SPECTATOR EGRESS IN THE ETIHAD CAMPUS

SCENARIO 5B: SIMULTANEOUS STADIUM AND ARENA EGRESS

HARD STADIUM EGRESS

Scenario 5b

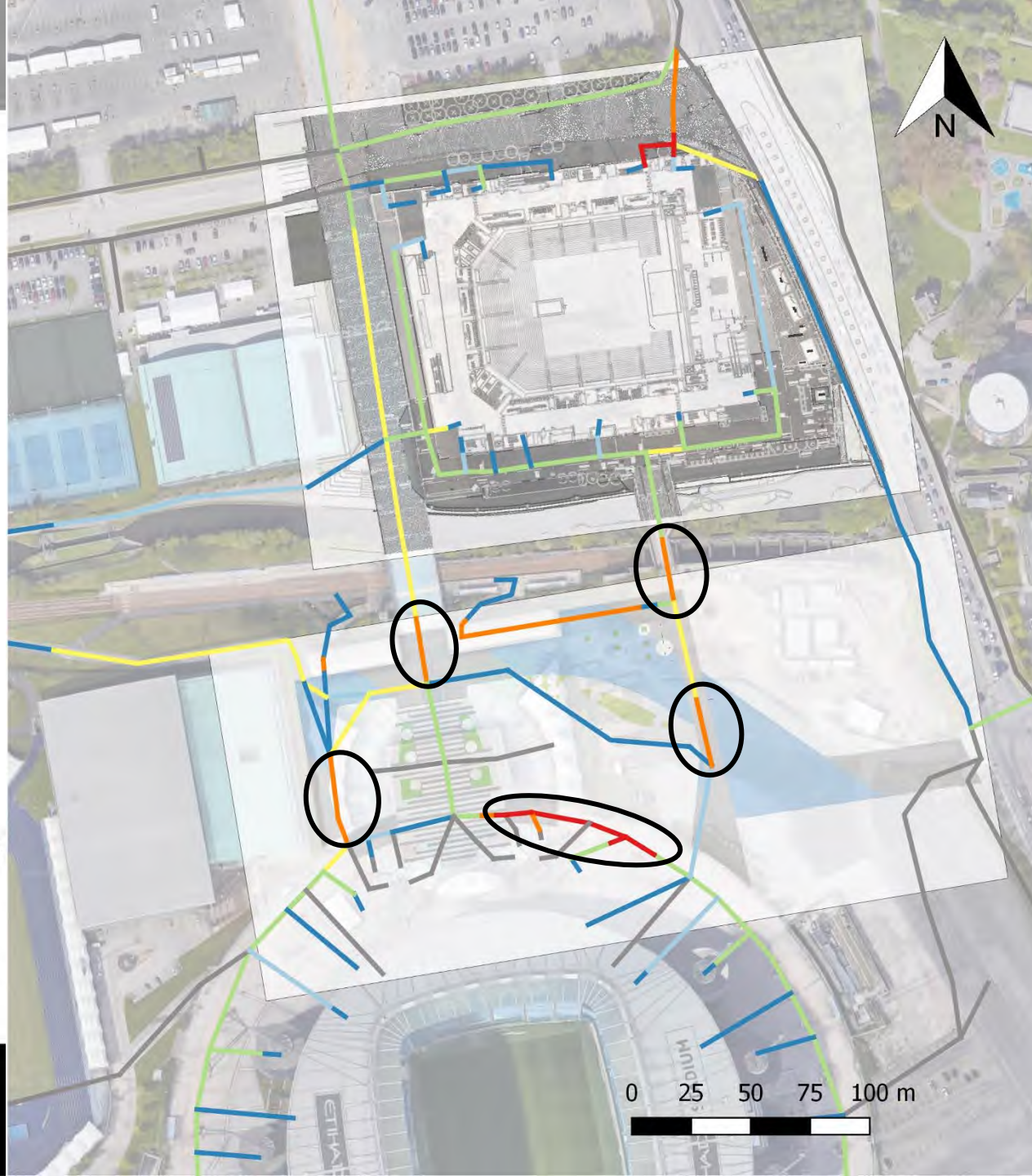
Stadium Hard Egress + Arena Simultaneous Egress

North Stand and Arena Max Density by Link

- Densities between 1.08 and 2.17 persons per m² are experienced on the approach to City Square from Joe Mercer Way and on City Square West.
- Density to the north east of the North Stand increases to 2.17 – 4 persons per m² when the hard egress profile is applied.
- High spectator densities that may require management are expected on Forge Lane Bridge as spectators depart the Arena. We understand the Arena are aware of this and are looking to have a queue management operation in place at this location.

Legend

- No ppl
- LoS A - < 0.31 ppl/ m²
- LoS B - 0.31 - 0.43
- LoS C - 0.43 - 0.72
- LoS D - 0.72 - 1.08
- LoS E - 1.08 - 2.17
- LoS F - 2.17 - 4



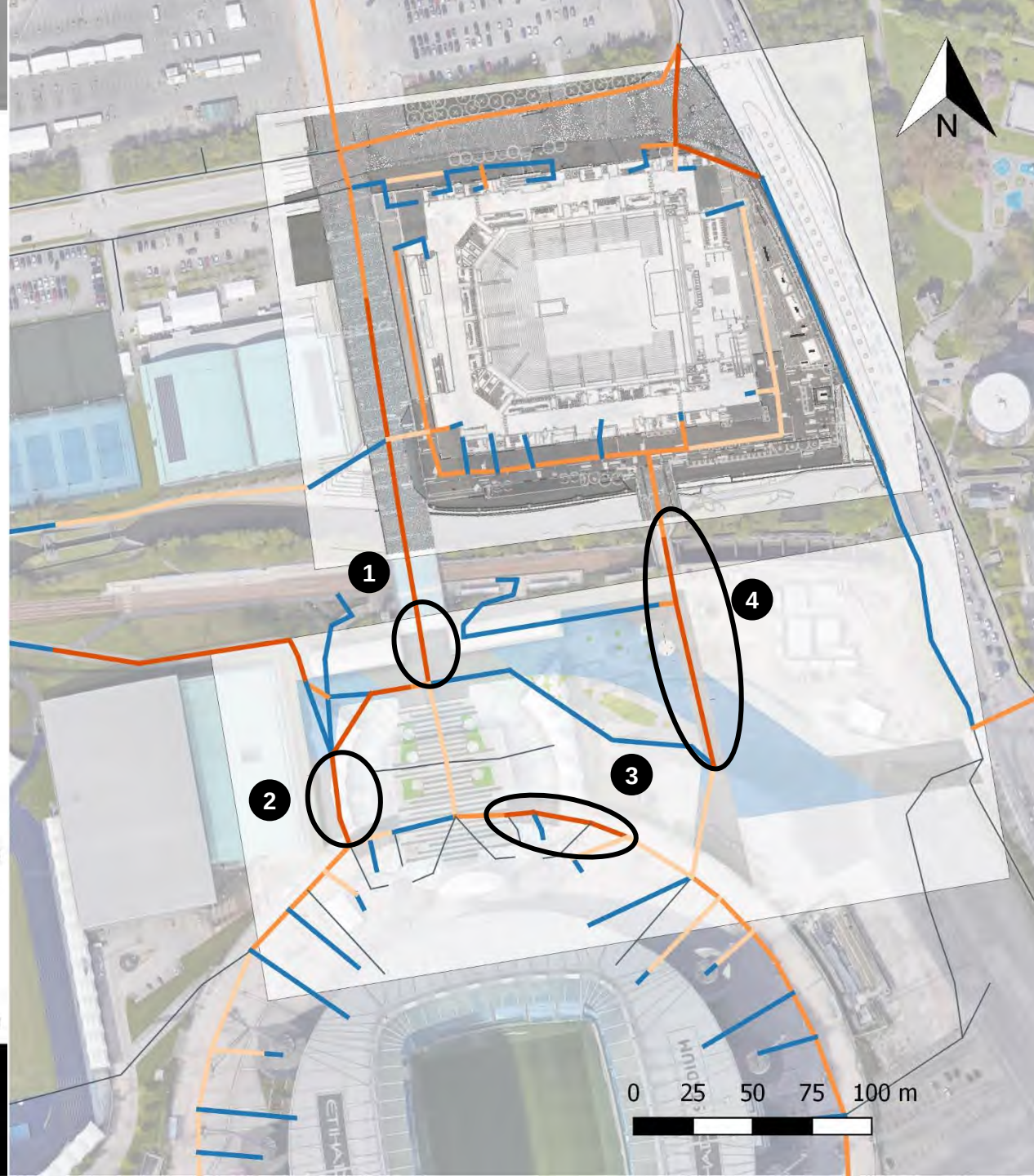
Scenario 5b

Stadium Hard Egress + Arena Simultaneous Egress

North Stand and Arena Max Flowrate by Link

- Area outside the North Stand will experience flowrates of up to 66 persons/minute/metre width.
1. The section of JMW closest to the city square is close to capacity, but does not show queuing.
 2. City Square West is also close to the target capacity.
 3. The route to the north east of the North Stand reaches maximum flowrates and may experience queuing.
 4. The approach to the Westbound queue may experience high flowrates and should be monitored.

Legend



DYNAMIC (LEGION) MODELLING OF SCENARIO 5A

WESTBOUND METROLINK

DYNAMIC MODEL OVERVIEW

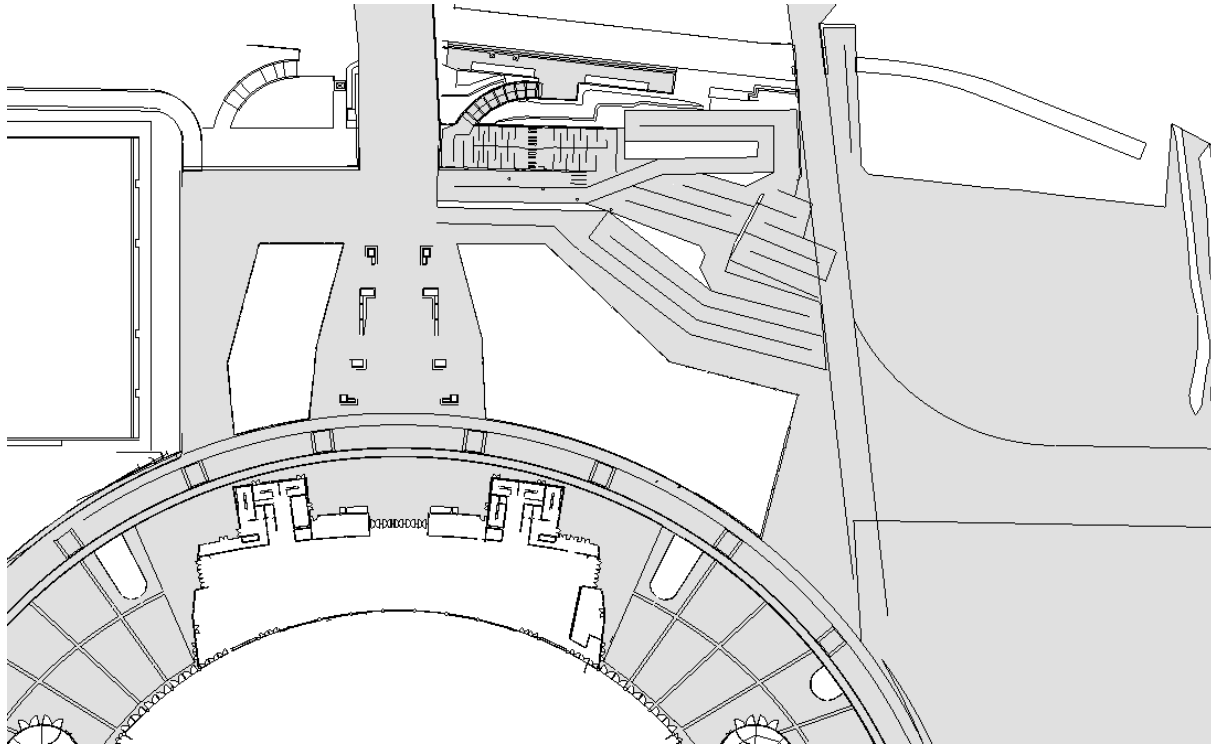


Figure 32: Westbound Metrolink Dynamic Model Extent

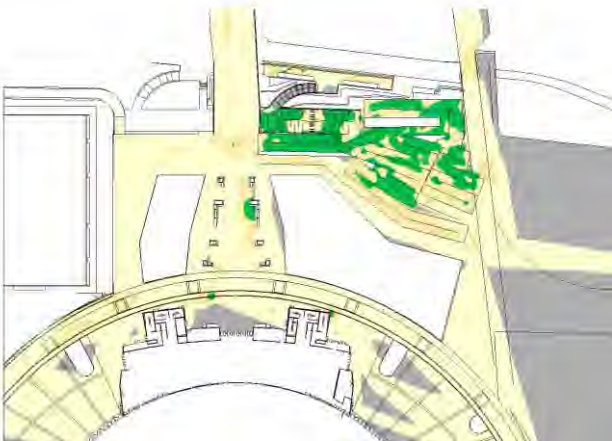
A component dynamic model of the Metrolink westbound tram stop was constructed for Stage 3 Part 1, in order to better understand the impact that temporary overlay may have on spectator movement during a Stadium and Arena Special Operation (simultaneous egress post event). It should be noted that **the queue overlay is for indicative purposes only, it is not a recommended design.**

The component model was constructed using pedestrian outputs from the SENSE model.

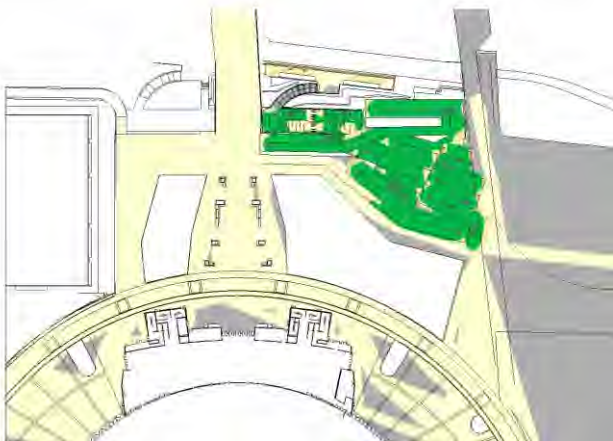
Metrolink westbound service is assumed to have a 5 minute headway and capacity for 300 persons.

The Metrolink platform is loaded with up to 300 people at a time, with the remainder of the queue being held in 5 sections numbered in Figure 32.

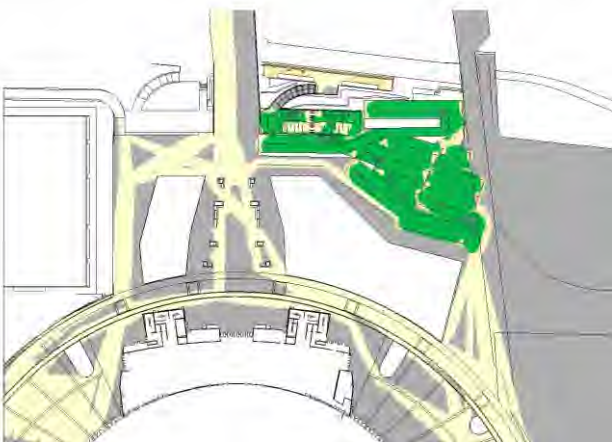
DYNAMIC MODEL OVERVIEW



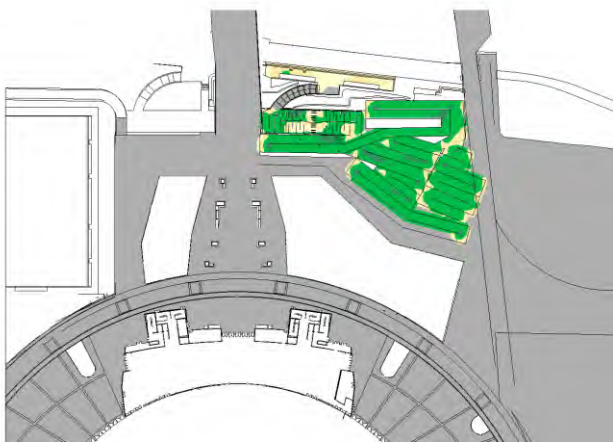
CLOSS Cumulative mean Density Map, 30 minutes



CLOSS Cumulative mean Density Map, 45 minutes



CLOSS Cumulative mean Density Map, 60 minutes



CLOSS Cumulative mean Density Map, 75 minutes

Colour	Value Range
Light Yellow	< 1 person / m ²
Yellow	1 - 2 people / m ²
Green	2 - 3 people / m ²
Dark Green	3 - 4 people / m ²
Dark Green	4 - 4.7 people / m ²
Purple	4.7 - 5.38 people / m ²
Dark Purple	> 5.38 people / m ²

The adjacent images show the cumulative mean density experienced by spectators 30, 45, 60 and 75 minutes after the end of a match at the Etihad Campus.

The dynamic modelling shows that for Scenario 4, spectators will be able to walk around a queue structure serving the Metrolink westbound service without any significant obstruction to flow.

There is some congestion observed in City Square during the initial egress period. The layout and operation of this area should be explored in more detail in Stage 4.

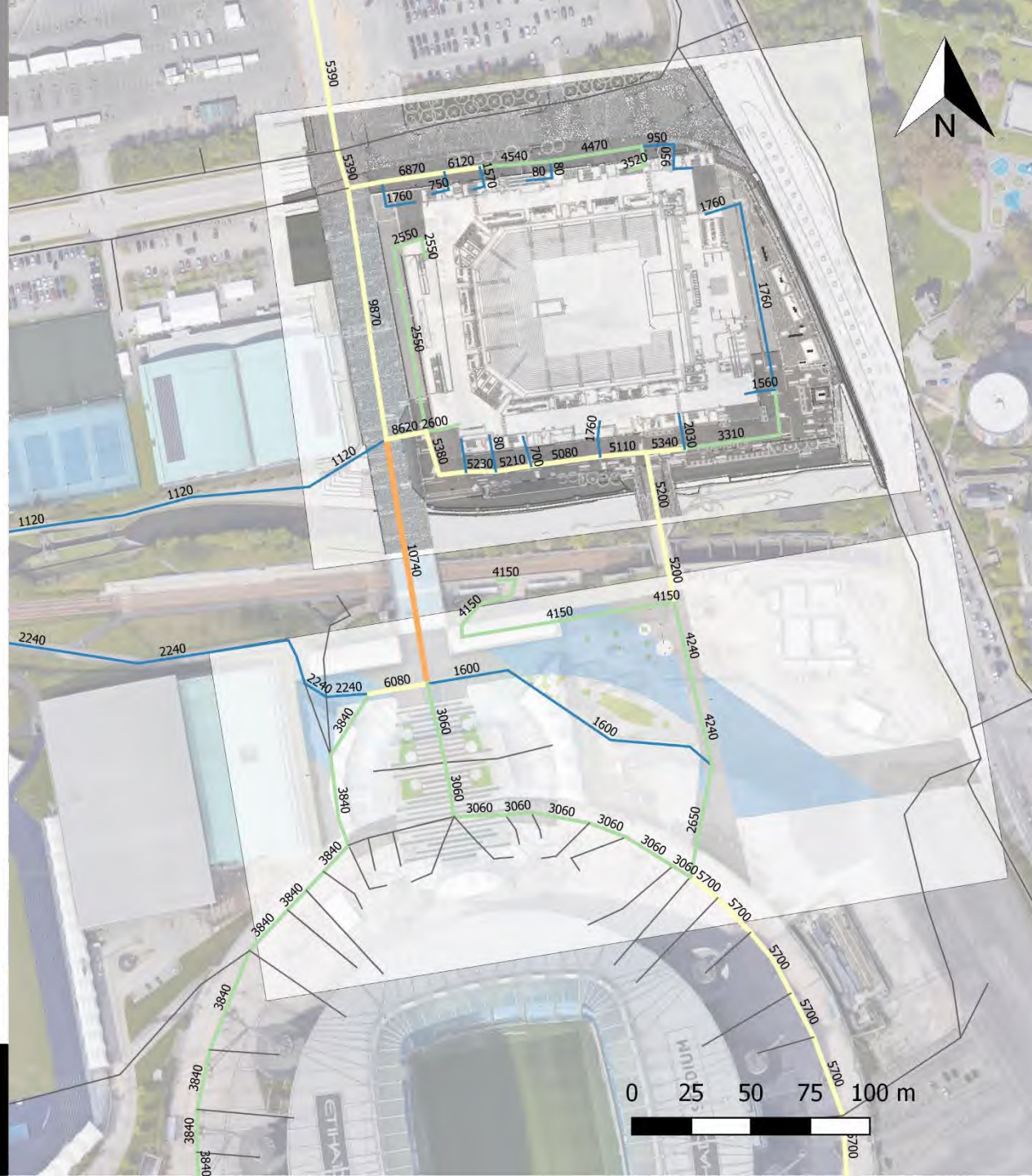
Figure 33: CLOSS Cumulative mean Density Maps

SPECTATOR EGRESS IN THE ETIHAD CAMPUS

SCENARIO 6: ARENA EGRESS

Arena Egress

- 10,740 people use JMW
- 3,840 people use the City Square West
- 3,060 people use the City Square
- 4,150 people use the Westbound Metrolink.

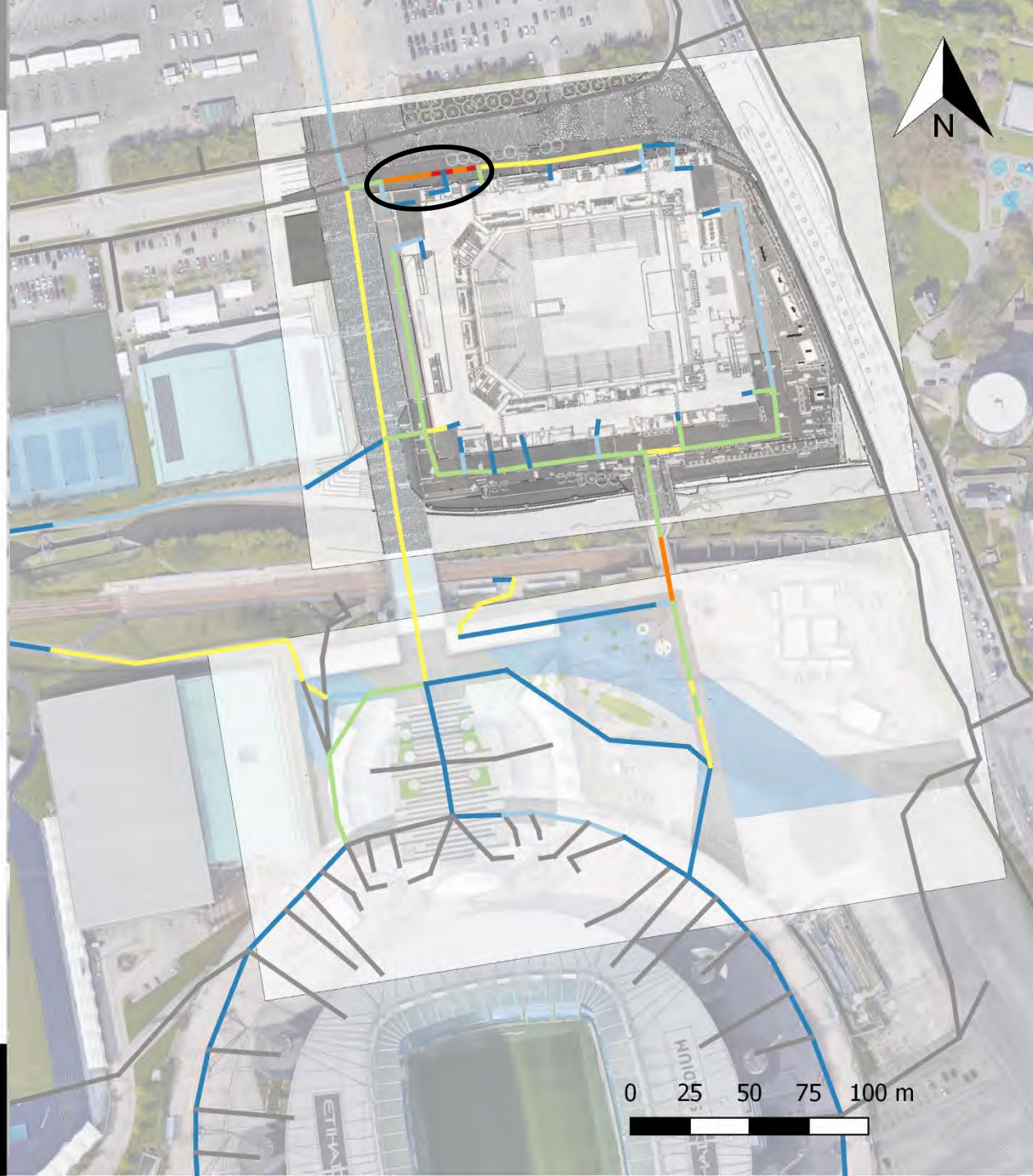
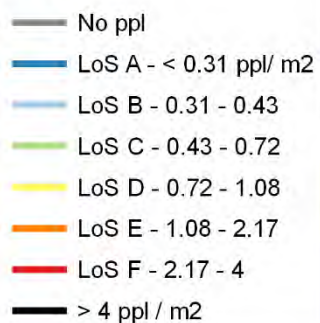


Scenario 6

Arena Egress

North Stand and Arena Max Density by Link

- LoS D (target LoS for egress) is exceeded outside the Arena as spectators try to access JMW via Sportcity Way, and on Forge Lane Bridge.
- This operation falls within the Co-Op Live Arena footprint and we understand it has been assessed using micro-simulation models.
- This is a worst case scenario assuming 8-min egress from the venue, and no use of Alan Turing Way.



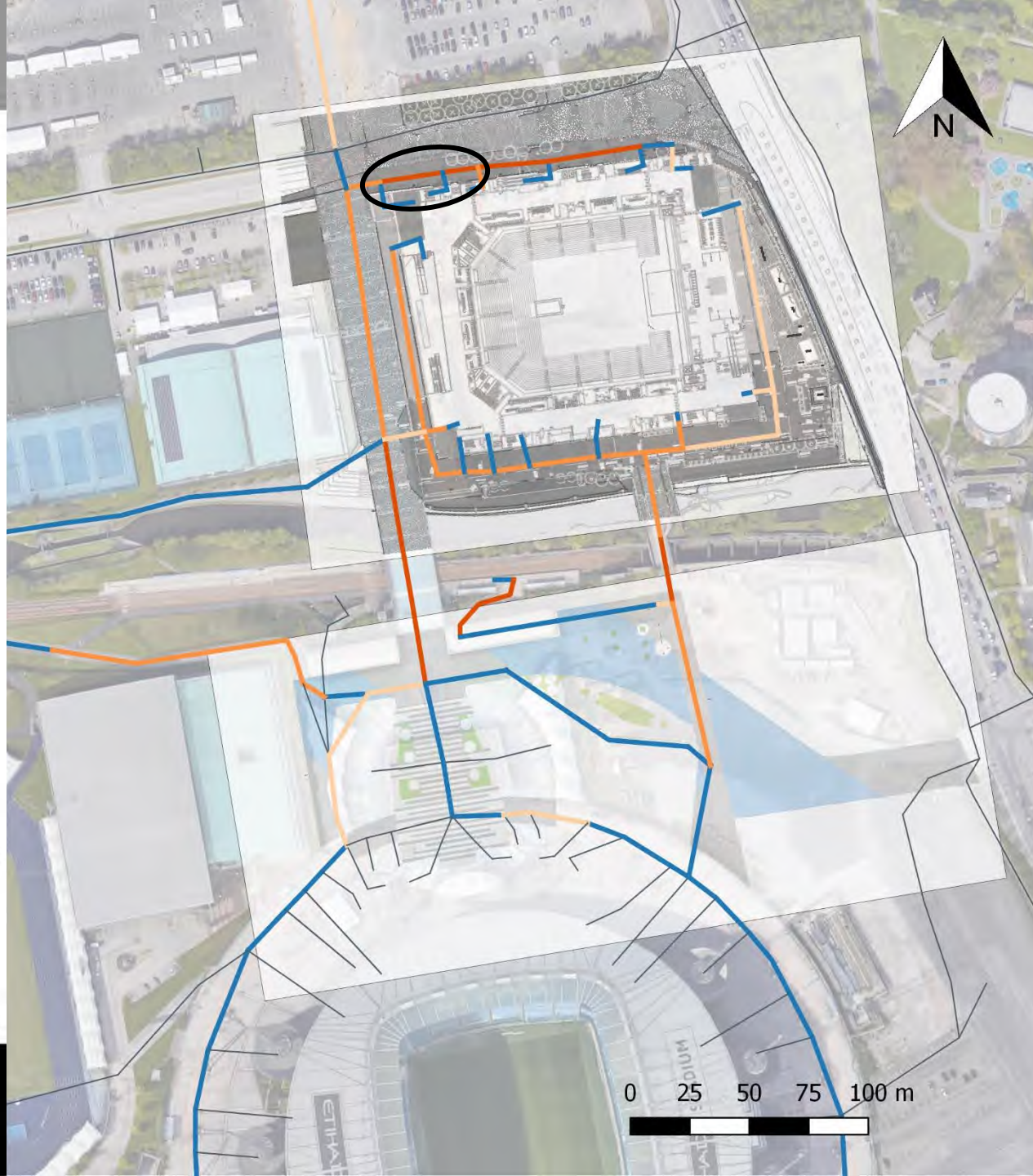
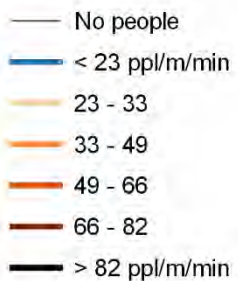
Scenario 6

Arena Egress

North Stand and Arena Max Flowrate by Link

- Area outside the North Stand will experience flowrates of up to 33 persons/minute/metre width, this is with agreed performance targets.
- High flowrates are reached as spectators try to access JMW via Sportcity Way, and on Forge Lane Bridge.

Legend





07 EMERGENCY EVACUATION

EMERGENCY EVACUATION

Available Routes

The evacuation assessment considers the seated population of the Stadium at the time of an evacuation.

For the purposes of this study, we consider a full-Stadium simultaneous evacuation, with all dispersal routes available.

All persons considered are assumed to move to a nearby exit which minimises congestion and are not assumed to decide based on a preference for onward movement (e.g. based on their travel options)

No pre-movement time is considered in the assessment. All persons included in the model are assumed to begin moving towards an exit at $t=0$.

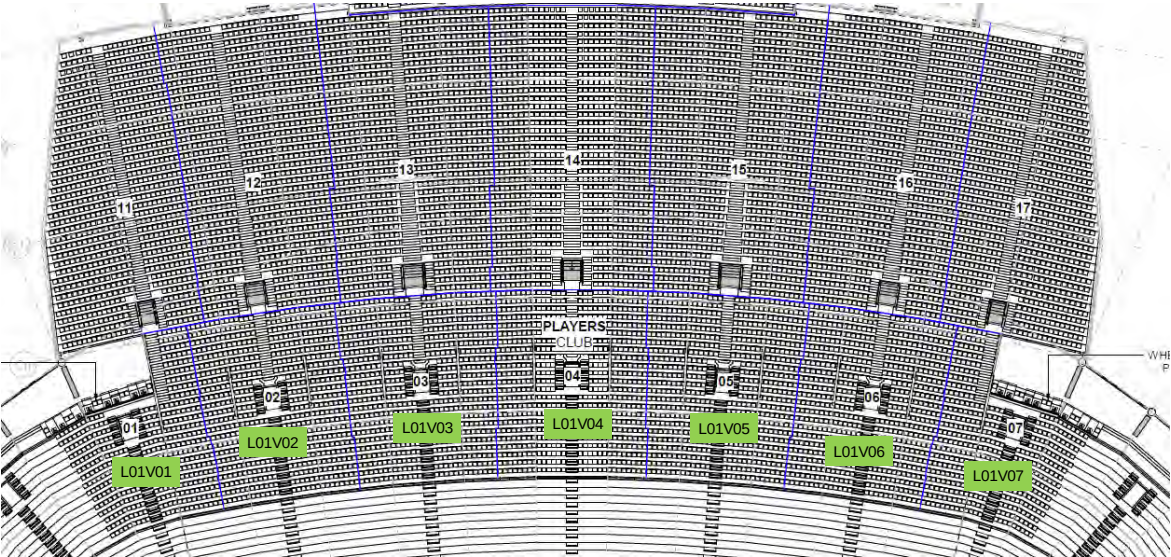
Workforce Numbers

Following discussions with MCFC and Populous, workforce numbers in the North Stand have been considered as follows:

- Level 01 has 248 staff. These will look to exit via stairs Z01A, Z01B, A01A and A01B over a 1 minute period at the start of the evacuation.
- Level 02 has 250 staff. These will look to exit via stairs Z6 and A6 over a 1 minute period at the start of the evacuation.
- Level 05 has 160 staff. These will look to exit via stairs Z6 and A6 over a 1 minute period at the start of the evacuation.

It should be noted that workforce numbers in the seating area have not been considered as part of this assessment.

LEVEL 01 SEATING AREAS



Level 01 exit times from the seating area have been assessed based on the final exit width only, not the geometry of the seating area.

The Level 01 seating area can evacuation between 04:25 and 07:00 minutes. These evacuation times should be considered against the fire profile of this area.

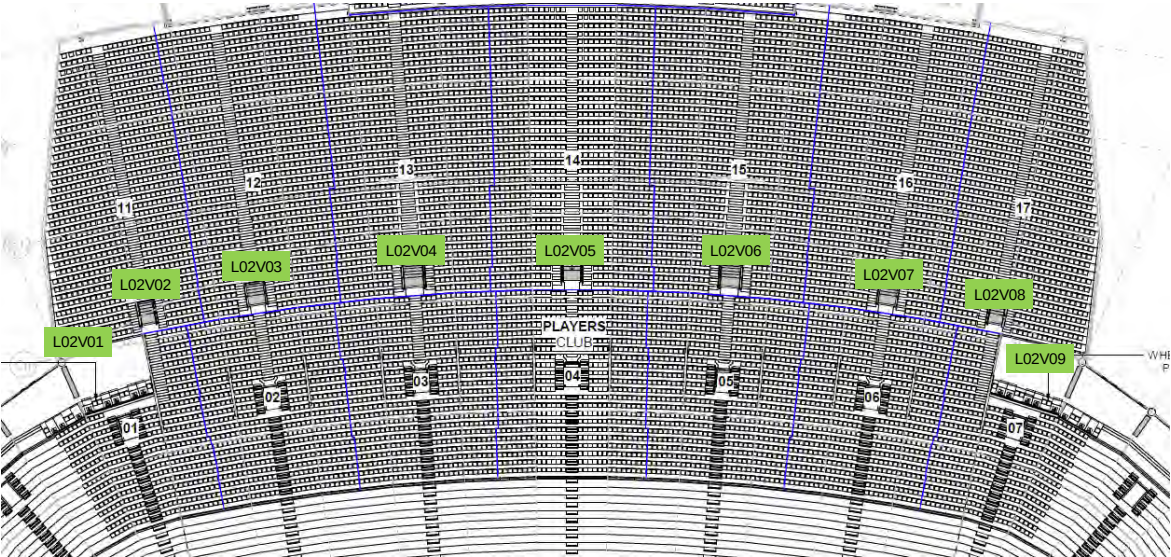
It should be noted the above does not consider workforce that may be in the seating area.

Vomitory	L01V01	L01V02	L01V03	L01V04	L01V05	L01V06	L01V07
Demand	395.00	592.00	624.00	622.00	624.00	592.00	395.00
Exit Width (m)	1.35	1.35	1.35	1.35	1.35	1.35	1.35
Exit Time	04:25	06:38	07:00	06:58	07:00	06:38	04:25

Figure 34: Level 01 seating area

Source NSE-POP-NZ-ZZ-DR-006001_Ver1.pdf

LEVEL 02 SEATING AREAS



Vomitory	L02V02	L02V03	L02V04	L02V05	L02V06	L02V07	L02V08
Demand	783.00	917.00	965.00	960.00	965.00	917.00	783.00
Exit Width (m)	1.50	1.70	2.00	1.80	2.00	1.70	1.50
Exit Time	07:54	08:10	07:18	08:04	07:18	08:10	07:54

Figure 35: Level 02 seating area

Source NSE-POP-NZ-ZZ-DR-006001_Ver1.pdf

Level 02 exit times from the seating area have been assessed based on the final exit width only, not the geometry of the seating area.

The Level 02 seating area can evacuation between 07:18 and 08:10 minutes. These evacuation times should be considered against the fire profile in this area.

Three vomitories are shown to exceed 8 minutes evacuation time, although there potentially capacity available via neighbouring vomitories. This should be reviewed by the design team.

It should be noted the above does not consider workforce that may be in the seating area.

L02V01 and L02V02 are the wheelchair viewing areas. These have capacity to evacuate in less than 1 minute.

LEVEL 04 AND 5 SEATING AREAS

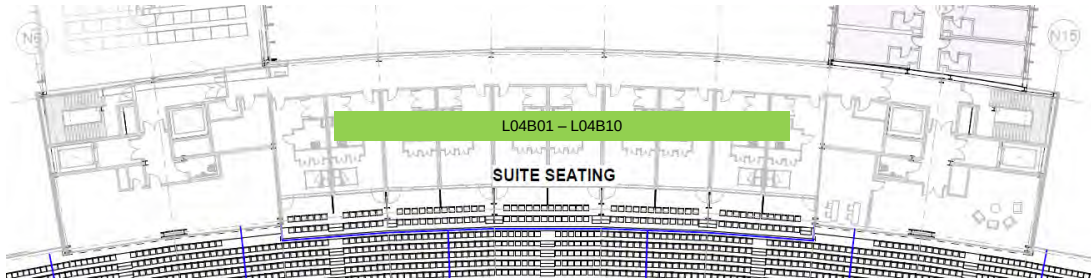


Figure 36: Level 04 seating area

Source NSE-POP-NZ-ZZ-DR-006001_Ver1.pdf

Seating areas on Level 04 accommodate 120 spectators over 10 private seating areas. They have capacity to evacuate the seating in less than 1 minute.

Seating areas on Level 05 accommodate 456 spectators exiting via four gangways. They have capacity to evacuate in approximate 1.75 minutes.

These evacuation times should be considered against the fire profile in this area.

It should be noted the above does not consider workforce that may be in the seating area.

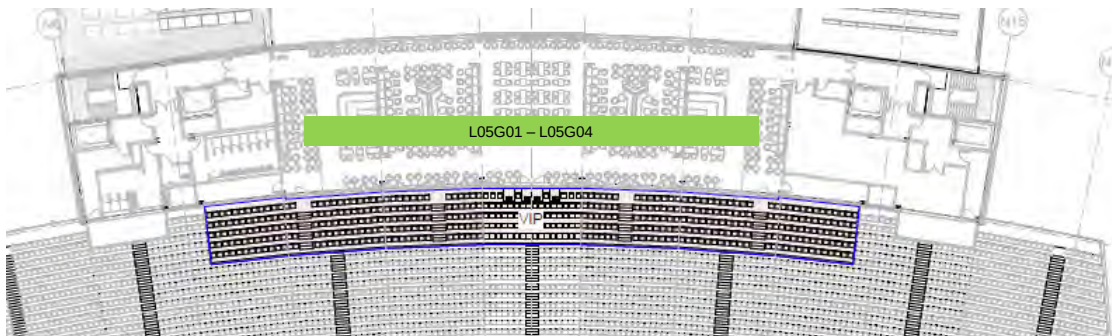


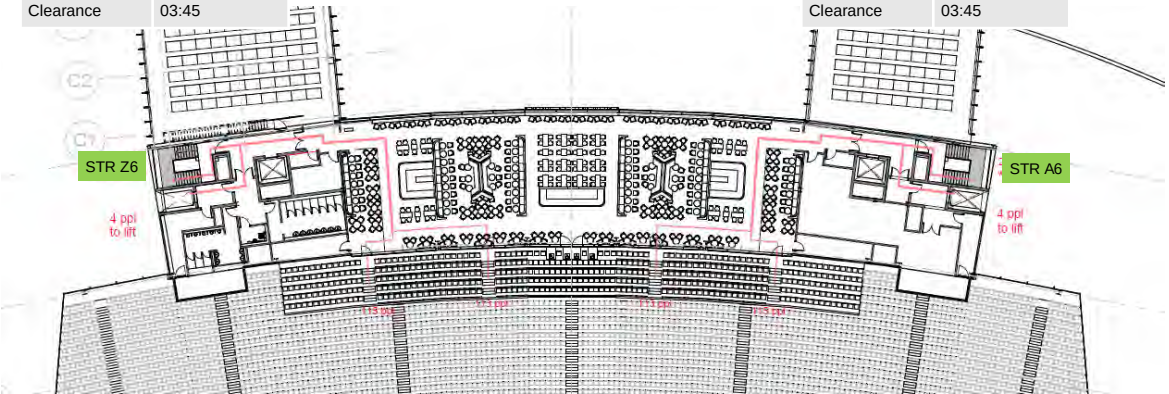
Figure 37: Level 05 seating area

Source NSE-POP-NZ-ZZ-DR-006002_Ver1.pdf

LEVEL 05 – SPECTATOR CIRCULATION ON EVACUATION (STATIC ASSESSMENT)

STR Z6	
Demand	308
Stair Width	1.30 metres
Stair Capacity	85 pers/min
Max Queue	65 pers
Max Delay	<1 min
Clearance	03:45

STR A6	
Demand	308
Stair Width	1.30 metres
Stair Capacity	85 pers/min
Max Queue	65 pers
Max Delay	<1 min
Clearance	03:45



Level 05 accommodates 616 persons, including spectators and workforce. For the purpose of this assessment it has been assumed that the stairs will be the constraint to flow.

These exit via 2 x 1.3m wide stairs on the east and west side of the stand.

There may be some localised queuing of up to 65 persons, with maximum individual delays of less than 1 minutes.

It should be noted that lifts have not been considered as part of the evacuation route.

Figure 38: Level 05 concourse during evacuation

Source: NSE-POP-NS-05-DR-A-000505_Ver2.pdf

LEVEL 04 – SPECTATOR CIRCULATION ON EGRESS ROUTES (STATIC ASSESSMENT)

STR Z6	
Demand	60
Stair Width	1.30 metres
Stair Capacity	85 pers/min
Max Queue	60
Max Delay	<1.5 mina
Clearance	04:20

STR A6	
Demand	60
Stair Width	1.30 metres
Stair Capacity	85 pers/min
Max Queue	60
Max Delay	<1.5 mina
Clearance	04:20

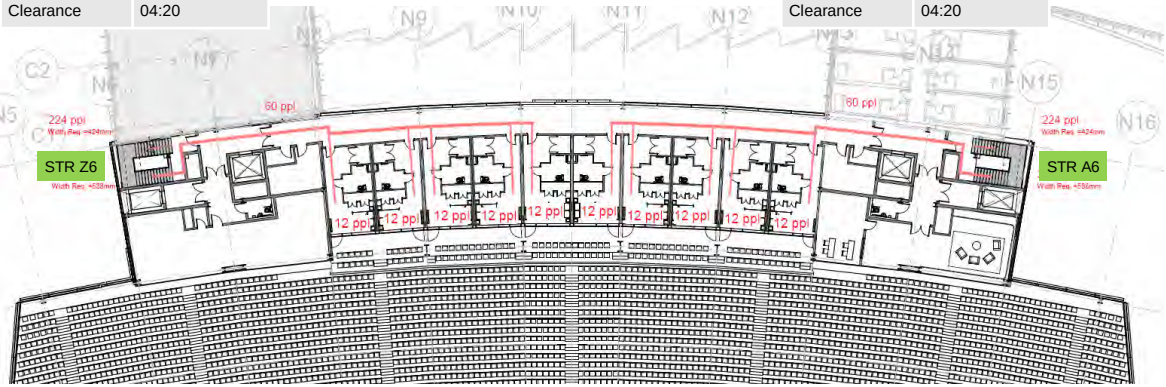


Figure 39: Level 04 concourse during evacuation

Source: NSE-POP-NS-04-DR-A-000504_Ver2.pdf

Level 04 accommodates 120 persons, including spectators and workforce. For the purpose of this assessment it has been assumed that the stairs will be the constraint to flow.

These exit via 2 x 1.3m wide stairs on the east and west side of the stand. The same stairs that serve Level 05.

There may be some localised queuing of up to 60 persons, with maximum individual delays of less than 1.5 minutes.

This is based on the aggregate demand using the stair, assuming the stair is at capacity with demand from the level above.

A micro-simulation model could provide more detail on how spectators would merge in the stair core, and relative impact across the concourses serving each level.

It should be noted that lifts have not been considered as part of the evacuation route.

LEVEL 02 – SPECTATOR CIRCULATION ON EGRESS ROUTES (STATIC ASSESSMENT)

STR Z2		STR Z3		STR Z4		STR Z5		STR Z6	
Demand	783	Demand	779	Demand	813	Demand	770	Demand	125
Stair Width	1.50 metres	Stair Width	1.50 metres	Stair Width	1.50 metres	Stair Width	1.50 metres	Stair Width	1.30 metres
Stair Capacity	99 pers/min	Stair Capacity	99 pers/min	Stair Capacity	99 pers/min	Stair Capacity	99 pers/min	Stair Capacity	85 pers/min
Max Queue	0	Max Queue	0	Max Queue	75 pers	Max Queue	0	Max Queue	125 pers
Max Delay	0	Max Delay	0	Max Delay	0.75 mins	Max Delay	0	Max Delay	<3 mins
Clearance	08:25	Clearance	08:35	Clearance	08:35	Clearance	08:35	Clearance	05:55

Level 02 accommodates 6,572 persons, including spectators and workforce. For the purpose of this assessment it has been assumed that the stairs will be the constraint to flow.

These exit via a series of stairs. Following discussions with Populous, it has been assumed that only workforce exit via the stair cores to the north of the stand (STR Z6 and STR A6).

Stair cores serving spectators are shown as experiencing some localised queuing. This may result from the assumptions on spectator assignment to stairs and will likely be accommodated by spare demand in neighbouring stairs.

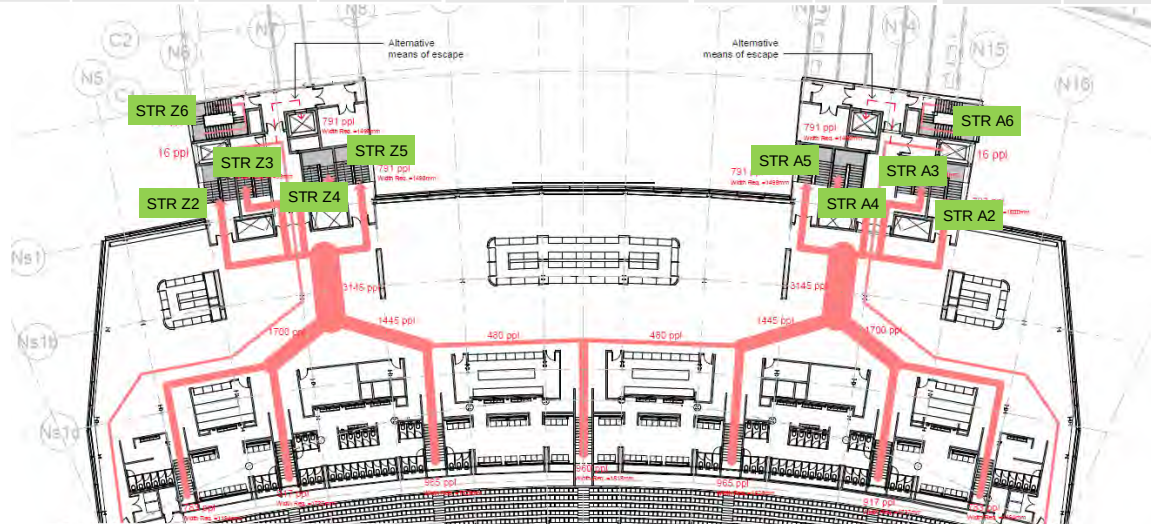
The 2 x 1.3m wide stairs to the north of the stand (STR Z6 and STR A6) also serves Level 04 and Level 05.

There may be some localised queuing of up to 125 persons, with maximum individual delays of less than 3 minutes.

This is based on the aggregate demand using the stair, assuming the stair is at capacity with demand from the levels above.

A micro-simulation model could provide more detail on how spectators would merge in the stair core, and relative impact across the concourses serving each level.

It should be noted that lifts have not been considered as part of the evacuation route.



STR A2		STR A3		STR A4		STR A5		STR A6	
Demand	783	Demand	779	Demand	813	Demand	770	Demand	125
Stair Width	1.50 metres	Stair Width	1.50 metres	Stair Width	1.50 metres	Stair Width	1.50 metres	Stair Width	1.30 metres
Stair Capacity	99 pers/min	Stair Capacity	99 pers/min	Stair Capacity	99 pers/min	Stair Capacity	99 pers/min	Stair Capacity	85 pers/min
Max Queue	0	Max Queue	0	Max Queue	75 pers	Max Queue	0	Max Queue	125 pers
Max Delay	0	Max Delay	0	Max Delay	0.75 mins	Max Delay	0	Max Delay	<3 mins
Clearance	08:25	Clearance	08:35	Clearance	08:35	Clearance	08:35	Clearance	05:55

Source: NSE-POP-NS-02-DR-A-000502_Ver2.pdf

Figure 40: Level 02 concourse during evacuation

LEVEL 01 – SPECTATOR CIRCULATION ON EGRESS ROUTES (STATIC ASSESSMENT)

STR Z6		STR Z1A		STR Z1B		RAMP X	
Demand	0	Demand	530	Demand	529	Demand	2,781
Stair Width	1.30 metres	Stair Width	1.35 metres	Stair Width	1.35 metres	Stair Width	3.55 metres
Stair Capacity	85 pers/min	Stair Capacity	89 pers/min	Stair Capacity	89 pers/min	Capacity	261 pers/min
Max Queue	0	Max Queue	20	Max Queue	20	Max Queue	740 pers
Max Delay	0	Max Delay	<1min	Max Delay	<1min	Max Delay	<3.00 mins
Clearance	0	Clearance	07:30	Clearance	07:30	Clearance	10:45

Level 01 accommodates 4,092 persons, including spectators and workforce. For the purpose of this assessment it has been assumed that the stairs will be the constraint to flow.

These exit via a series of stairs closest to the seating area (STR Z1A, Z1B, A1A, A1B) and via ramps serving the West Stand (Ramp X) and the East Stand (Ramp C). It has been assumed no one used STR Z6 and STR A6, which serve Levels 2, 4 and 5.

The stairs on Level 01 are shown as experiencing some localised queuing and delays of less than 1 minute.

Spectators accessing the ramps will meet with demand from other stands also looking to exit via these routes. For the purpose of this assessment, it has been assumed that demand from other stands will exit evenly over an eight minute period.

Ramps are shown as experiencing maximum queues of 740 – 870 persons, with maximum individual delays of less than 3.25 minutes.

The queue area requirements at these locations will need to be considered as part of the Stage 4 design.

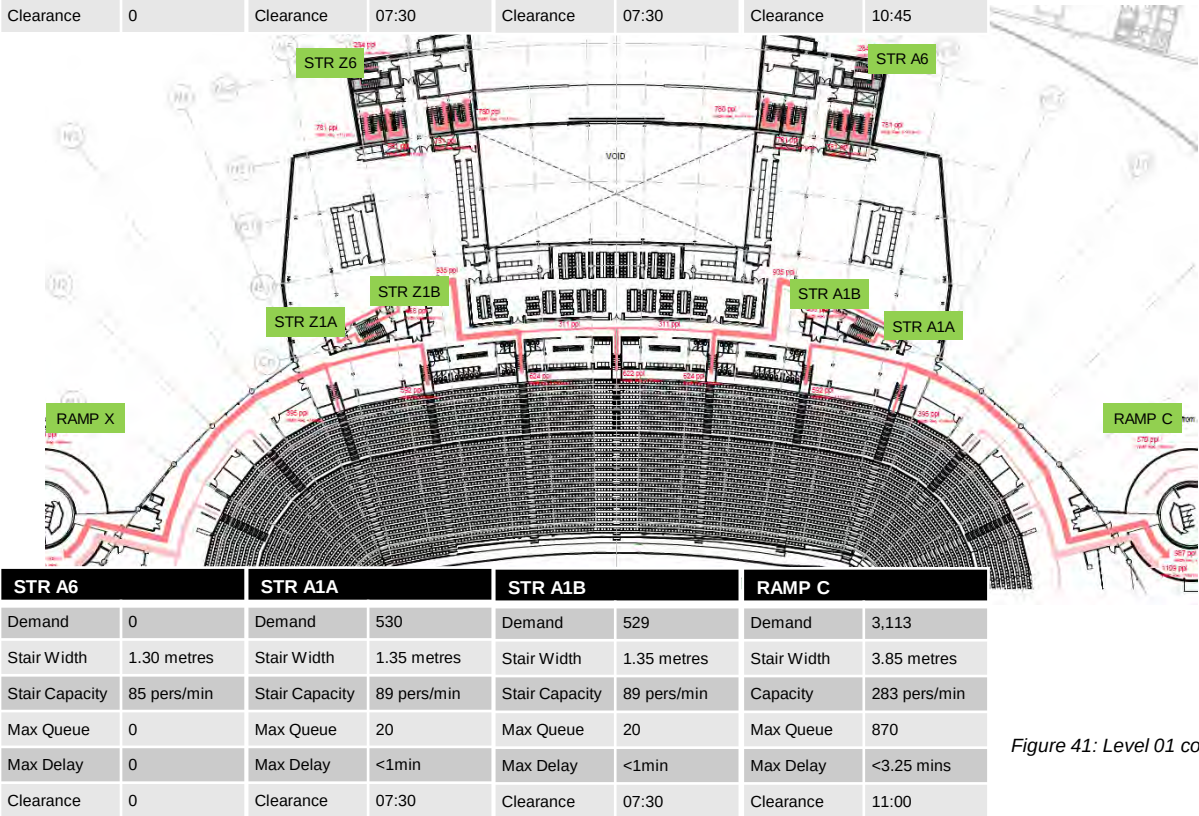


Figure 41: Level 01 concourse during evacuation

Source: NSE-POP-NS-01-DR-A-000501_Ver2.pdf

LEVEL 00 – SPECTATOR CIRCULATION ON EGRESS ROUTES (STATIC ASSESSMENT)

Exit Z0		Exit Z1		Exit Z3		Exit X	
Demand	3,145	Demand	1,059	Demand	509	Demand	2,781
Exit Width	5.00 metres	Exit Width	3.10 metres	Exit Width	1.90 metres	Exit Width	4.80 metres
Exit Capacity	410 pers/min	Exit Capacity	254 pers/min	Exit Capacity	155 pers/min	Exit Capacity	393 pers/min
Max Queue	0	Max Queue	0	Max Queue	0	Max Queue	0
Max Delay	0	Max Delay	0	Max Delay	0	Max Delay	0
Clearance	09:05	Clearance	08:00	Clearance	06:25	Clearance	11:15

Level 00 serves at the final exit route from the North Stand building line. There is no demand associated with the North Stand Expansion using this route. For the purpose of this assessment it has been assumed that the exits will be the constraint to flow.

All exits are shown as having capacity to accommodate pedestrian flows.

It should be noted that Exit Z0 and Exit A0 are close to capacity based on maximum flow rates.

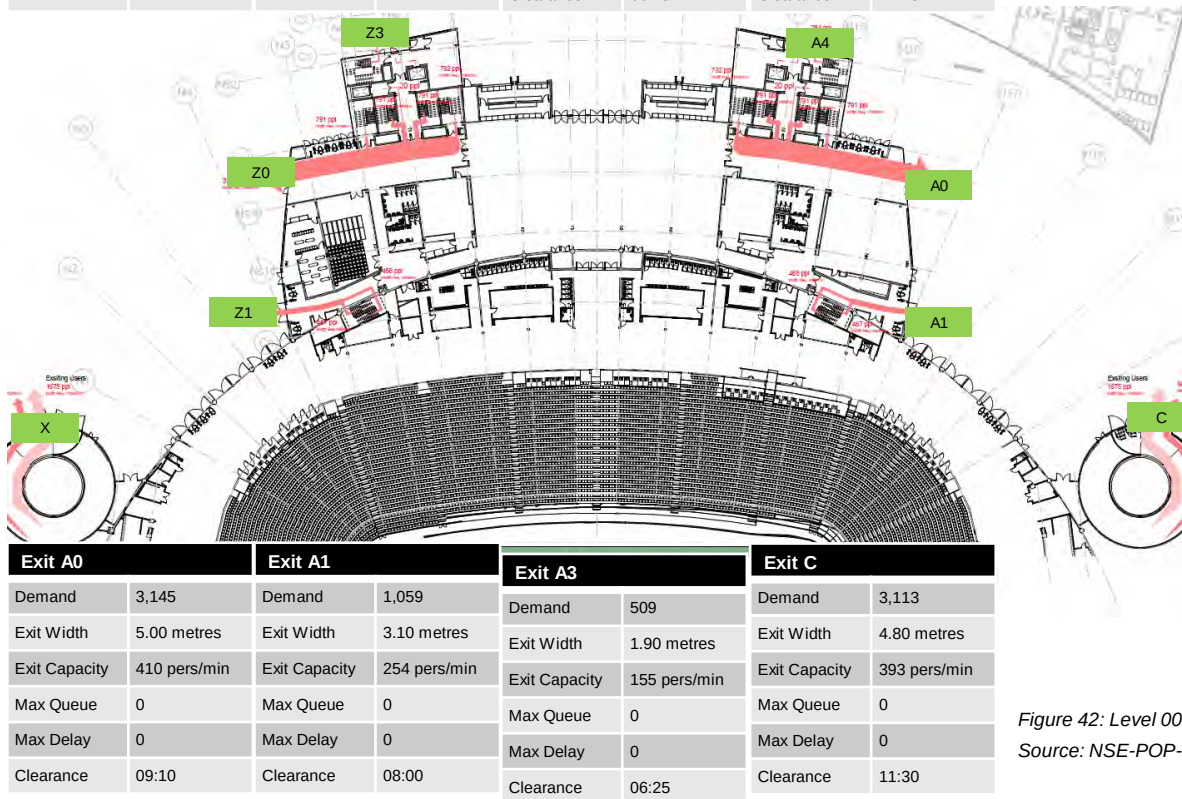


Figure 42: Level 00 concourse during evacuation
Source: NSE-POP-NS-00-DR-A-000500_Ver2.pdf

EMERGENCY EVACUATION

SCENARIO 7: STADIUM EVACUATION

Scenario 7

Stadium Evacuation

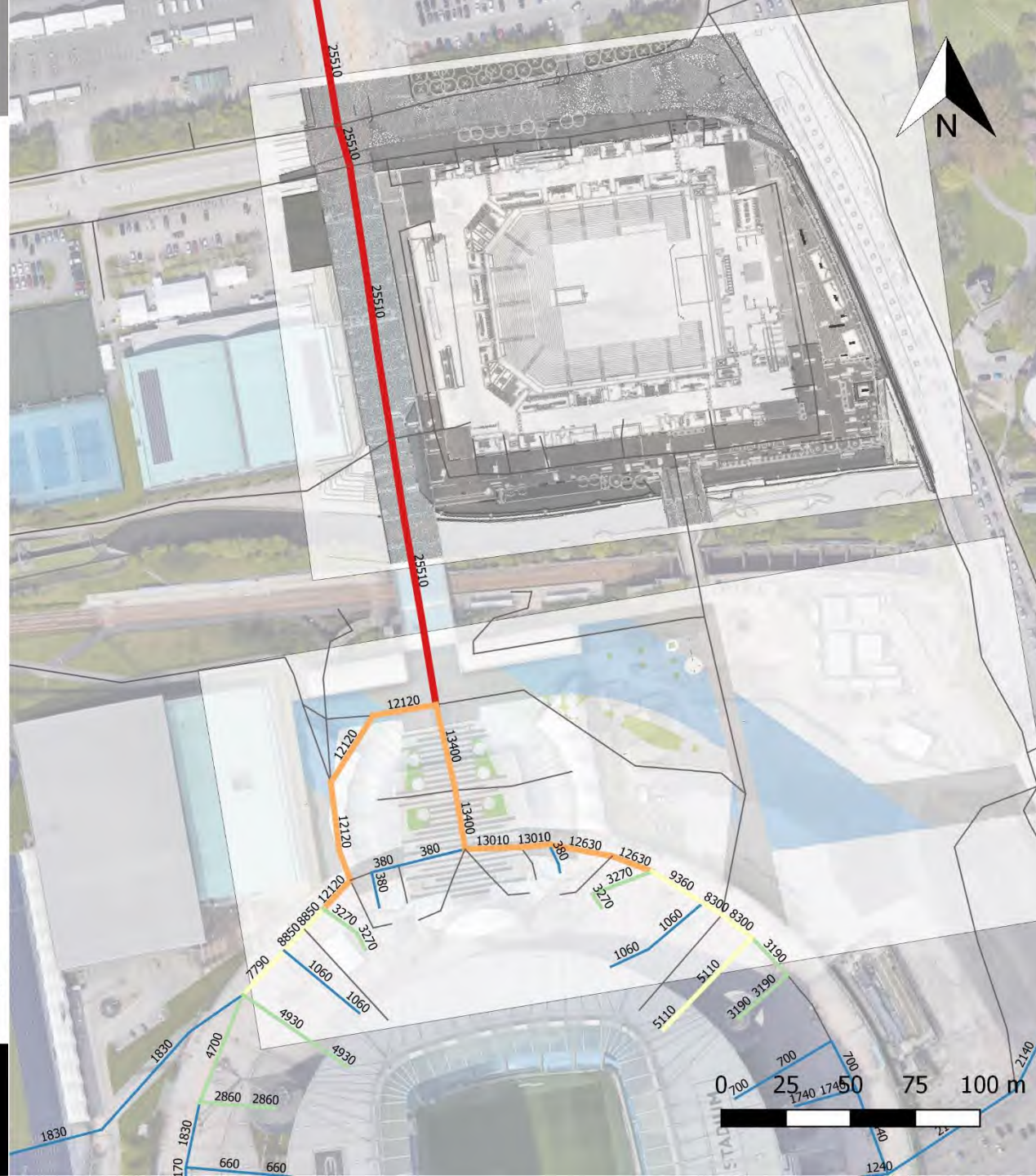
North Stand and Arena Static Assignment by Link

- 25,510 people use JMW
- 12,120 people use the City Square West
- 13,400 people use the City Square

The SENSE model routes are calculated by shortest distance. East City Square is not used for this scenario because there's no demand for the Westbound Metrolink. In reality, spectators would likely use it this route to reach JMW in an emergency scenario.

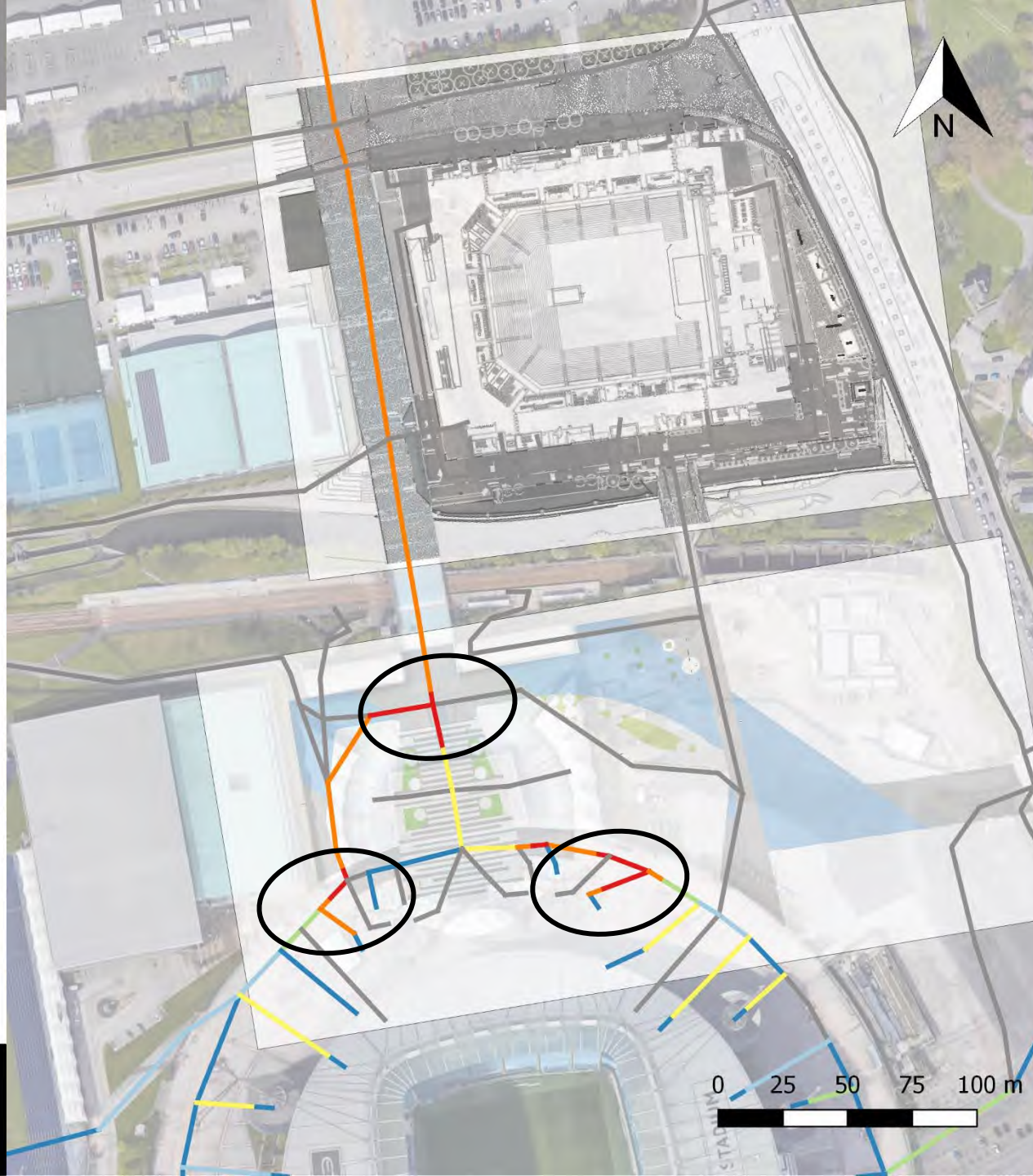
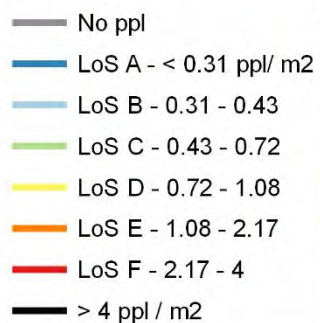
Legend

- No people
- < 2,500 ppl
- 2,500 - 5,000
- 5,000 - 10,000
- 10,000 - 20,000
- > 20,000 ppl



North Stand and Arena Max Density by Link

- High densities on the West and East of the North Stand are due to the assumed routing, width available and where spectator emerge from the building line.
- High densities might also occur on the approach to JMW from the Stadium.
- It may be required to revisit how spectators are distributed / managed during an evacuation as part of the Stage 4 assessment.



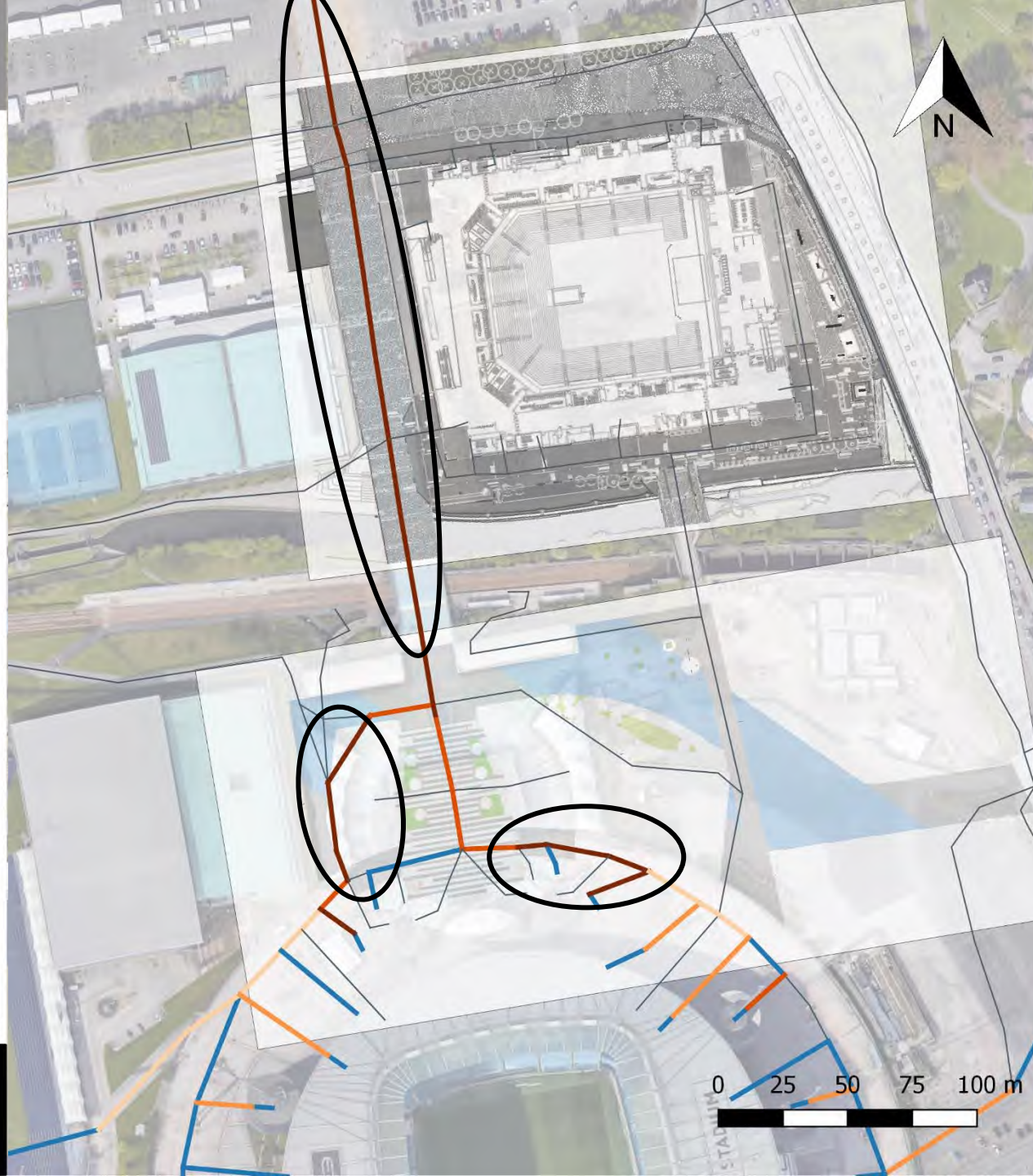
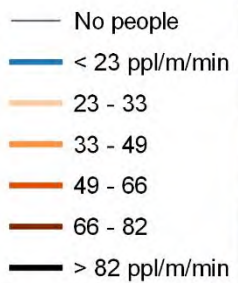
Scenario 7

Stadium Evacuation

North Stand and Arena Max Flowrate by Link

- Area outside the North Stand will experience flowrates of up to 82 persons/minute/metre width.
- The JMW will experience flowrates of 82 persons/minute/metre throughout.

Legend

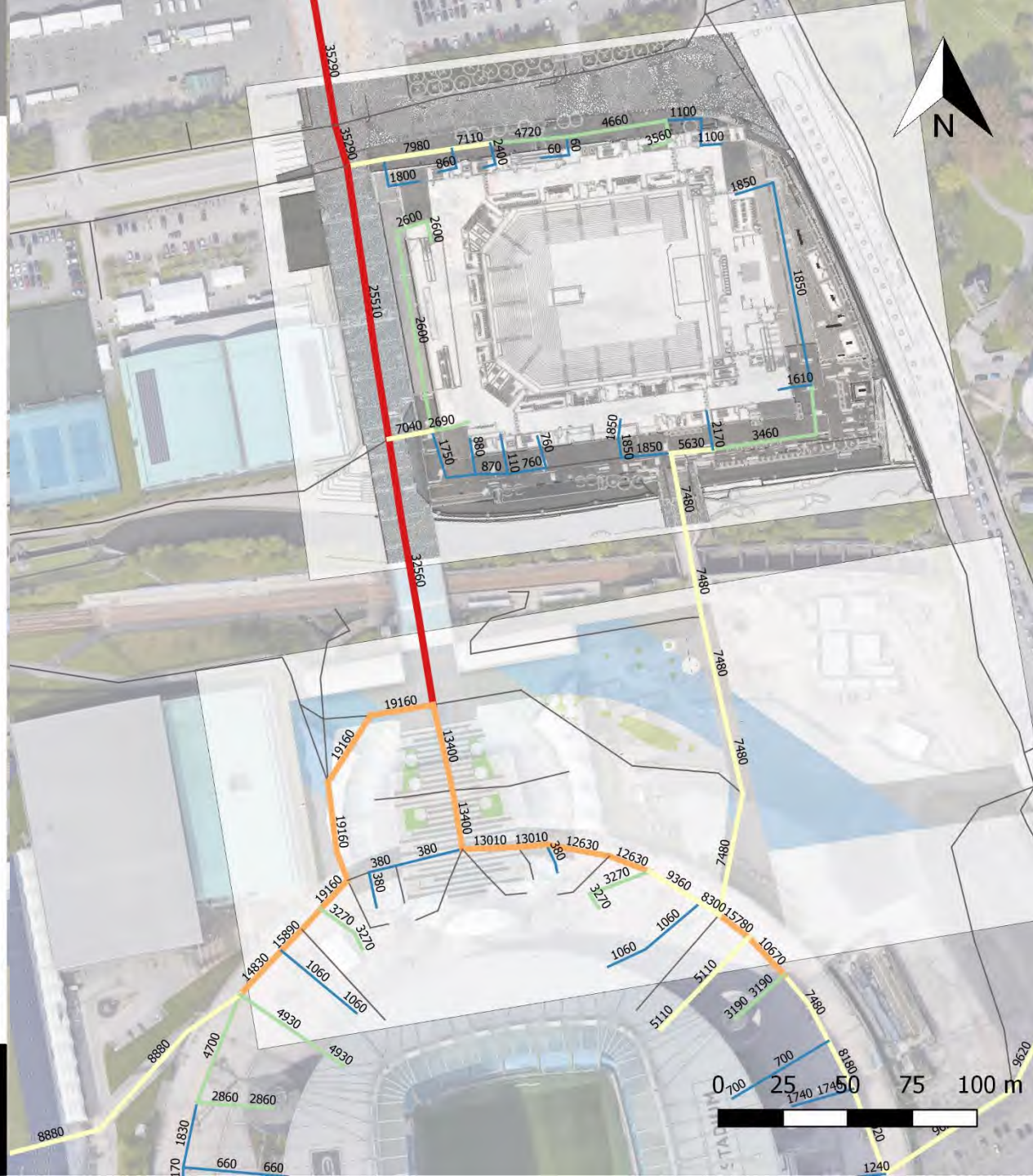


EMERGENCY EVACUATION

SCENARIO 8: **SIMULTANEOUS STADIUM AND ARENA EVACUATION**

Simultaneous Stadium and Arena Evacuation

- This scenario assumed each venue operate their evacuation strategy independently, dispersing away from the building they have exited, without considering the other venue.
- For this operational approach a demand of 32,560 is expected to need to make use of JMW.
- It is also assumed that the Arena does not make use of the exit onto Alan Turing Way.

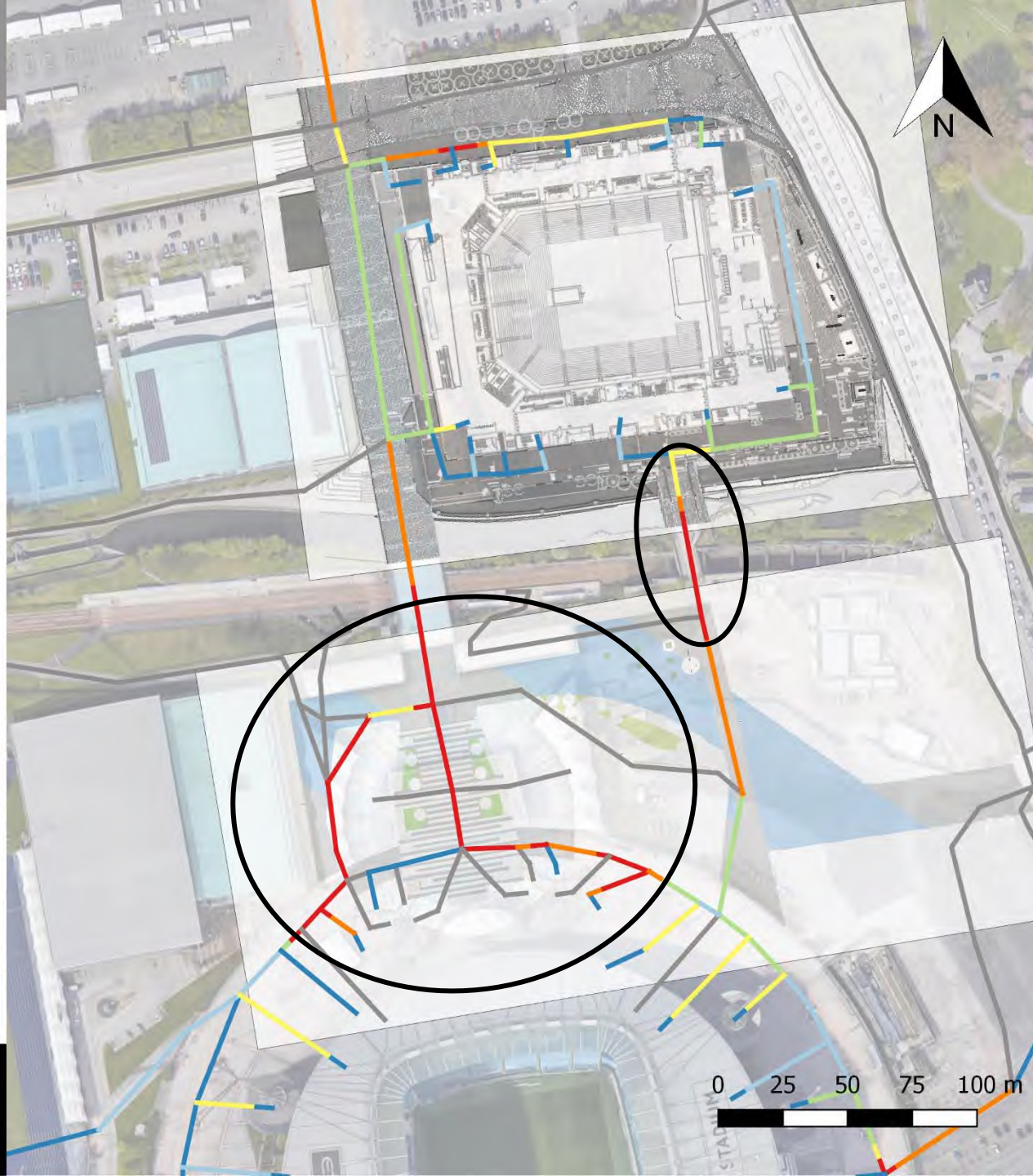
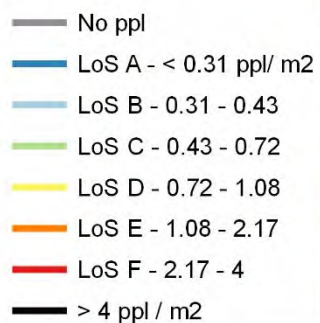


Scenario 8

Simultaneous Stadium and Arena Evacuation

North Stand and Arena Max Density by Link

- Very high density is expected on Forge Lane bridge. No demand from the Arena is directed towards Alan Turing Way, meaning not all possible exits are utilised during evacuation.
- The merging of pedestrian flows moving away from the Arena to the south, and away from the Stadium to the north is likely to lead to congested crowd conditions in City Square and outside the North Stand.
- An evacuation strategy should be developed for days when events are taking place at both Stadium and Arena.



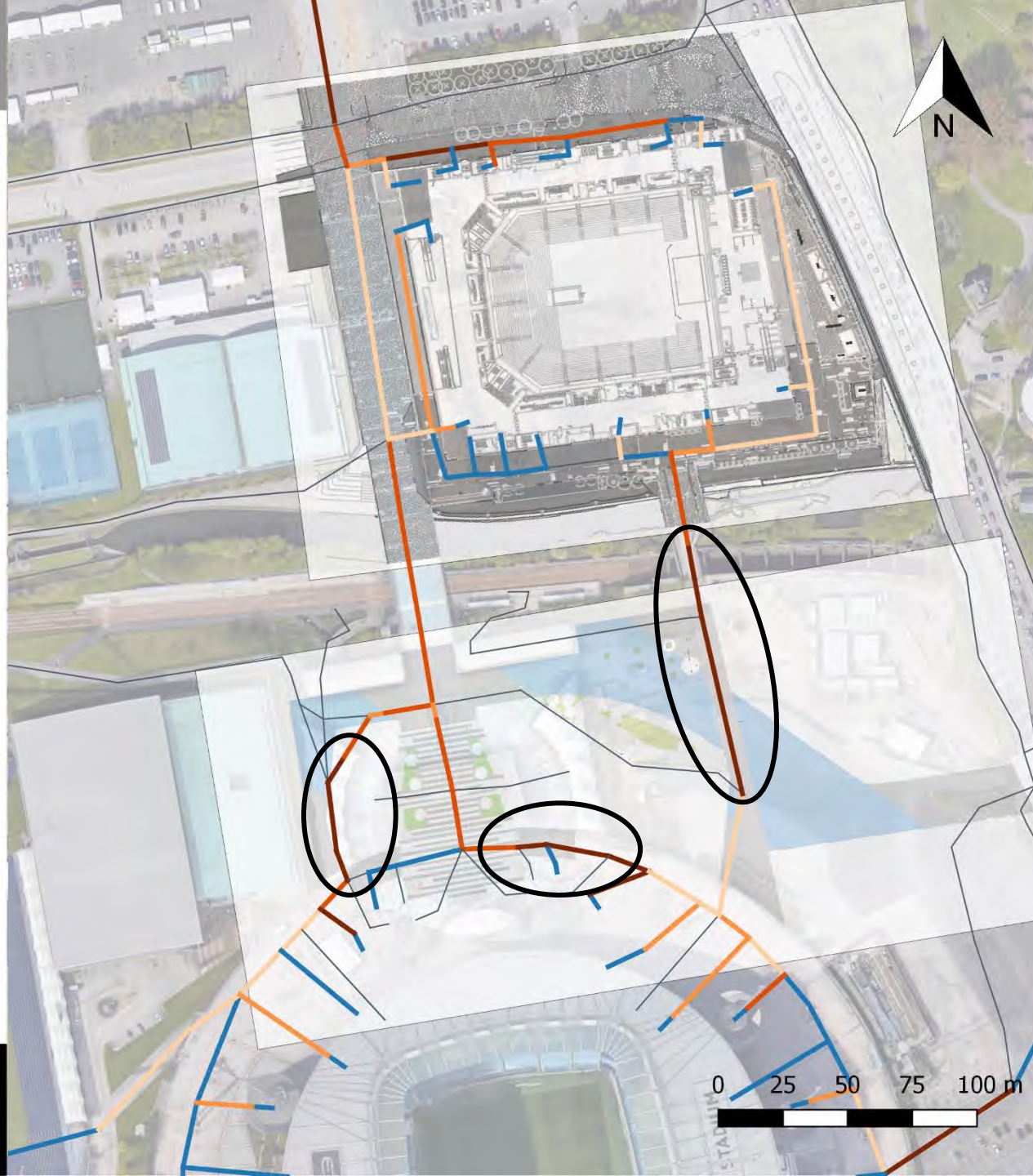
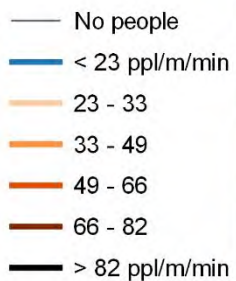
Scenario 8

Simultaneous Stadium and Arena Evacuation

North Stand and Arena Max Flowrate by Link

- Area outside the North Stand will experience flowrates of up to 82 persons/minute/metre width.
- Flowrates are constrained to 66 persons/minute/metre for bi-directional flows to account for interactions between individuals and reduction in effective width.

Legend



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