

16 August 2023

|              |                  |         |                     |
|--------------|------------------|---------|---------------------|
| Project Name | MCFC North Stand | Company | Movement Strategies |
| Project No.  | 12588700         | Role    | Crowd modelling     |

### **Overview of the crowd modelling methodology for the MCFC North Stand Construction Hoarding external circulation width assessment**

This document presents an overview of the methodology used for the crowd modelling of pedestrian circulation routes around the Etihad Stadium North Stand (NS) construction hoarding on an event day. Work has been undertaken between September/October 2023 and August 2024. Stakeholders involved in the planning and delivery of the assessment include:

- Manchester City Football Club (MCFC) – project management / venue operations
- Gardiner & Theobald (G&T) – project management
- Sisk (SK) – contractors / construction site operators
- Movement Strategies (MS) – crowd modelling
- Crowd Risk Analysis Ltd (CRA) – independent reviewer
- Manchester City Council (MCC) – Building Control

### **Step 1 – Design Criteria**

Design criteria were agreed with stakeholders to set performance targets for crowd movement. Key criteria included:

- Flow rates (person / minute / metre width, ppmm) for normal operation:
  - The Guide to Safety Sports Grounds, 6<sup>th</sup> Edition<sup>1</sup> states maximum flow rates of **82 ppmm** on flat surface.
  - The project performance target was agreed at **66 ppmm**, based on comparable venues/guidance.
  - The independent reviewer requested a 20% reduction check, a flow rate of **53 ppmm**.
- Density (person / square meter)
  - The Guide to Safety Sports Grounds, 6<sup>th</sup> Edition states preferred maximum densities of **4 persons per square meter** for standing spectators.
  - The project performance target was agreed at a maximum density of **3 persons per square meter**.
  - The independent reviewer requested a check against a maximum density of **1.4 persons per square meter**.

### **Step 2 – Site Specific Parameters**

The site specific parameters were reviewed with the stakeholders, with an emphasis on MCFC's knowledge and experience of the site operation. Key criteria included:

- Arrival profile (% of spectator arriving before the event in a 15-minute period)
  - Turnstile data was interrogated and camera surveys were undertaken for four football matches. Data shows a peak arrival profile of **25% of spectators in 15 minutes**. The project performance target was agreed at **40% of spectators in 15 minutes**.
- Departure profile (% of spectator arriving in a 15-minute period)
  - Camera surveys were undertaken for four football matches. Data shows a peak departure profile of **55% of spectators in 15 minutes**. The project performance target was agreed at **75% of spectators in 15 minutes**.

<sup>1</sup> Guide to Safety at Sports Grounds, sixth edition, Sports Grounds Safety Authority, 2018

- Spectator distribution (% of people going in each direction before and after a football match):
  - Camera surveys were undertaken for four football matches to count how many persons used the pedestrian routes available. This was then compared to historic survey data available.
- Spectator population at the stadium building line
  - MCFC provided turnstile and gate information to determine how many spectators used each of the stadium entry and exit points on an event day.

### **Step 3 – Crowd Modelling**

The external pedestrian network was modelled using SENSE pedestrian modelling software. The model replicates the pedestrian network around the construction hoarding, assumes the **minimum width along each route is available** and then assigns pedestrian demand along each route based on the shortest distance between their origin point and their destination point. The model can then help identify:

- The maximum flow rate along each route (person / minute / metre width)
- The maximum density along each route (persons / square meter)
- The queue size and duration along each route.

The model outputs were shared with stakeholder to amend the proposed construction hoarding layout until the performance targets could be met and the sensitivity performance targets could be met.

### **Step 4 – Results**

The SENSE modelling outputs for a Stadium only event day are presented in '23Jun08 MCFC NS\_MS\_CRA notes on Construction Hoarding\_DRAFT.docx' (MS) issued on 8 June 2023. The 'As-Built' dimensions reference in this document are based on a site visit and measurements undertaken by MCFC on Wednesday 16 August 2023. Key findings for a Stadium only event presented in this document are:

- Spectator arrivals:
  - Peak flow rate around the construction hoarding of **50 ppm** (most routes around the hoarding at **less than 25 ppm**) for the planned and 'As-Built' layouts. These are lower rates than the independent reviewer's maximum target.
  - Densities around the construction hoarding circulation route of up to **1.1 persons per square meter**. These are lower densities than the independent reviewer's maximum target.
- Spectator departures:
  - Peak flow rate around the construction hoarding of **51 ppm** for the planned and 'As-Built' layouts. This is a lower rate than the independent reviewer's maximum target.
  - Densities around the construction hoarding circulation route of up to **1.1 persons per square meter**. These are lower densities than the independent reviewer's maximum target.
  - Metrolink Westbound service to have a similar operation to a typical match day (same spectator demand and service). Temporary queue overlay to be placed at location where the pedestrian **circulation width available is in excess of the minimum width assumed in the SENSE modelling**.
- Evacuation:
  - The peak flow rate for an emergency evacuation is **70 ppm**, on the pedestrian route by the Metrolink Westbound service. This is less than the maximum flow rate of **82 ppm** stated in The Guide to Safety Sports Grounds, 6<sup>th</sup> Edition. Some spectators exiting Exit C could be directed southbound (managing their interaction with spectators exiting other stands) in order to reduce this flow rate.