TECHNICAL REPORT

Boundary Risk Assessment:
Cross Street, Monk Bretton

Report Number LSUK.15-0688 V1

Client
Bellway Homes Yorkshire Ltd
2 Deighton Close
Wetherby
West Yorkshire
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Date 09/11/2015

This report contains 13 pages including 1 appendices.

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SUMMARY

To assess the potential risk of cricket balls being hit into a proposed residential development adjacent to the cricket field at Cross Street, Monk Bretton, Labosport Ltd has reviewed the proposal including distances to ascertain the risk of balls impacting the development and to advise on a proportionate mitigations strategy.

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CONTENTS

1. INTRODUCTION 3
2. SITE SPECIFICS 4
3. SITE MEASUREMENTS 6
4. ESTIMATED BALL HEIGHT 7
5. DISCUSSION 10

APPENDIX A – SITE PHOTOGRAPHS

1. INTRODUCTION

To assess the potential risk of cricket balls being hit into a proposed residential development adjacent to the cricket field at Cross Street, Monk Bretton, Labosport Ltd has reviewed the proposed site plan including distances to ascertain the risk of balls landing in the adjacent areas. Using a ball projectile model and supporting data from research undertaken, based on professional level cricket, by Labosport for the ECB the following risk assessment has been produced.

The report follows an earlier assessment (dated 06/08/2015) of the development whereby the potential risk of cricket balls being hit into the adjacent residential development was assessed and the height that a mitigating system would need to be in order to provide a suitable level of protection. Following planning advice the proposed heights of mitigation previously provided do not appear to be favourable and therefore following instruction from the client this report details information on the likelihood of cricket balls surpassing a 12 m high mitigating fence system.

As with any model and sensible risk assessment the proportionality linked to risk (comprising likelihood and severity) are included in this report.

Note: This is a desk study, Labosport have not visited the site, taken measurements or carried out a visual inspection. All measurement information has been provided by the client and any errors in measurements are not the responsibility of Labosport and this assessment is undertaken on the basis of accurate data.

2. SITE SPECIFICS

The below diagram illustrates the layout of the cricket field in relation to the proposed residential development.



South Orientation

A proposed housing development is located to the South of the cricket pitch with dwelling and gardens located next to the boundary.

Assessment to be undertaken to calculate the need for ball stop fencing at the Southern boundary.

West Orientation

A proposed housing development is located to the West of the cricket pitch with dwelling and gardens located next to the boundary.

Assessment to be undertaken to calculate the need for ball stop fencing at the Western boundary.

Other Orientations

Not required – no further comment or risk calculations undertaken for other orientations.

3. SITE MEASUREMENTS



The above diagram illustrates the minimum measured distances from the edge of the cricket square to the boundary. Note as this is a risk assessment the worst case scenarios are considered; consequently the shortest measured (and calculated) distance is used for the study.

Measured Distance	Shortest Boundary (m)
Edge of the cricket square to the Southern boundary	Circa 39 m and 40 m
Edge of the cricket square to the Western Boundary	Circa 40 m and 43 m

4. ESTIMATED BALL HEIGHT (USING THE PROJECTION MODELLING TOOL)

Previous work undertaken for the England and Wales Cricket Board ECB led to the development of a model used to estimate the distance a ball would travel and its trajectory given a specific velocity and angle.

Model limitations:

The size of a cricket ball and its estimated drag coefficient has been added to the model, this in combination with classical Newtonian Physics for the influence of air resistance and gravity have been used to predict the projectile path. However, for simplicity, there are some limitations to the model including but not limited to bat/ball restitution, atmospheric conditions, wind (speed and direction) and spin of the ball. ***Due to these limitations the model is regarded as an indicative prediction tool***.

The below table includes the total estimated distance a ball will travel for typical shots (angles and velocities) taken from assessment of in-game action ranging from 20 degrees to 50 degrees and 20 m/s (45 mph) to 50 m/s (112 mph).

Total Estimated Distance (m)		Angle (degrees)						
		20	25	30	35	40	45	50
Velocity (m/s)	20	20.70	23.24	25.82	27.22	28.04	27.84	27.10
	25	28.82	32.8	35.29	37.01	37.95	37.66	36.25
	30	37.32	41.99	44.91	46.31	47.34	46.51	45.27
	35	45.95	50.48	53.80	55.40	55.96	55.04	53.15
	40	53.71	58.79	61.82	63.62	63.73	62.73	60.24
	45	60.50	66.15	69.52	70.93	70.62	69.17	66.53
	50	67.88	73.23	76.29	77.88	77.15	75.62	72.09

Note: the trajectory for the above distances will be very different depending on the angle and velocity of shot as can be seen in the assessment below.

The hit angles and velocities are estimated from in-game action to cover a range of 'typical' shots ranging from 20 degrees to 50 degrees and 20 m/s (45 mph) to 50 m/s (112 mph).

The following distances have been used to calculate the height of the ball for different shot conditions as specified below.

Measured Distance	Shortest Boundary (m)
Edge of the cricket square to the Southern boundary	Circa 39 m
Edge of the cricket square to the Southern and Western boundary	Circa 40 m
Edge of the cricket square to the Western boundary	Circa 43 m
**distance from furthest stump (approx. 20 m) to the Southern boundary	Circa 60 m

** Whilst cricket is not quite a 360 degree game, balls can be hit from a number of directions with meaningful force with the exception of directly behind the batsman (approximately 60 degree angle). The area behind a batsman and shot scenario has been taken into account and the distance from furthest stump also considered as the type of shot required to hit the ball directly behind a player is uncommon and the occasional "top edge" shot resulting in this trajectory will be most likely not travel the full distance.

For each distance used in the model the height of the ball at each hit angle and velocity has been colour coded green if 12 m or less and red if above 12 m to indicate the likelihood of balls surpassing the proposed 12 m high mitigating fence system.

The basis of the shot velocity (50 m/s) is calculated on professional (1st class and international) players. Typically for community cricket clubs we undertake the assumption that 40 m/s is a suitable speed given the speed of bowling and batsman's skill when contrasted with elite players. It is on this basis that the follow recommendations have been made. Shot velocity at 45 m/s and 50 m/s included below for reference only.

Estimated Ball Height @ 39 m		Angle (degrees)						
		20	25	30	35	40	45	50
Velocity (m/s)	20	0	0	0	0	0	0	0
	25	0	0	0	0	0	0	0
	30	0	1.9	4.5	6.7	8.5	9.8	9.6
	35	3.1	6.2	9.2	12.0	14.8	17.1	18.8
	40	5.6	8.9	12.2	15.5	18.8	22.0	24.9
	45	7.4	10.8	14.2	17.9	21.6	25.4	29.1
	50	8.7	12.1	15.8	19.7	23.6	27.9	32.2

Estimated Ball Height @ 40 m		Angle (degrees)						
		20	25	30	35	40	45	50
Velocity (m/s)	20	0	0	0	0	0	0	0
	25	0	0	0	0	0	0	0
	30	0	1.0	3.6	5.9	7.7	8.8	8.4
	35	2.8	6.0	8.7	11.7	14.3	16.5	18.0
	40	5.4	8.8	12.1	15.4	18.6	21.8	24.7
	45	7.3	10.8	14.3	18.0	21.7	25.4	29.1
	50	8.7	12.2	16.0	19.8	23.8	28.1	32.4

Estimated Ball Height @ 43 m		Angle (degrees)						
		20	25	30	35	40	45	50
Velocity (m/s)	20	0	0	0	0	0	0	0
	25	0	0	0	0	0	0	0
	30	0	0	1.7	4.0	5.1	5.3	4.5
	35	1.7	4.7	7.8	10.6	13.1	15.0	15.8
	40	4.7	8.2	11.6	14.9	18.2	21.1	23.5
	45	7.0	10.6	14.3	18.0	21.7	25.4	28.5
	50	8.6	12.3	16.2	20.2	24.3	28.5	32.7

Estimated Ball Height @ 60 m		Angle (degrees)						
		20	25	30	35	40	45	50
Velocity (m/s)	20	0	0	0	0	0	0	0
	25	0	0	0	0	0	0	0
	30	0	0	0	0	0	0	0
	35	0	0	0	0	0	0	0
	40	0	0	1.6	4.3	5.6	4.1	0.1
	45	0.5	4.7	8.6	11.9	14.2	15.4	13.2
	50	4.6	9.1	13.3	17.2	20.7	23.0	22.9

See Appendix A for example trajectories

5. RISK ASSESSMENT DISCUSSION

This report has been prepared to assess the potential risk of cricket balls being hit into the adjacent residential development and the height and/or design that a mitigating system would need to be in order to provide a suitable level of protection.

The exact frequency of shots resulting in a cricket ball being hit into the adjacent area is unknown and impossible to predict with certainty (player skills, type of game and many other factors can influence this) hence a proportionate approach needs to be taken to provide safety to these users. In reality there will always be a "freak" shot that will result in a further than expected trajectory, however, the implications of planning for this type of worst case approach would result in the closure of hundreds of cricket ground across the country hence a balanced risk mitigation strategy needs to be implemented that is proportionate. Indeed there are risks associated with many everyday activities, but plans need to be developed to reduce risk following good practical health and safety principles including a combination of likelihood and severity.

Labosport Ltd have undertaken this type of assessment for other cricket grounds over the past 3 years when there have been perceived problems with cricket balls exceeding the boundary or the influence a new development may have on an existing club. Labosport have undertaken assessments where the minimum boundary has been in the region of 35 to 40 m yet the cricket club and neighbours have been able to collectively identify a mitigation strategy to reduce risk. This indicates that based on past experience the below recommendations should be feasible for both the cricket club and developer and with approval of other relevant parties such as Sports England and the ECB.

Risks Overview/Mitigation Approach

South Orientation

The shortest distance from the edge of the cricket square to the development boundary is circa 39 m and 40 m. At this distance a cricket ball can be over 20 m in height given the above trajectory data. In addition the ball will be traveling at a velocity in excess of 20 m/s^{-1}. The model indicates that trajectories ≥ those with a hit angle of 40^{o} and a velocity of 35 m/s, and a hit angle of 30^{o} and a velocity of 40 m/s will surpass the proposed 12 m high fencing system.

The distance from furthest stump has also been used to calculate the height of the ball for different shot conditions as it is assumed that the type of shot required to hit the ball directly behind a player is uncommon and the occasional "top edge" shot resulting in this trajectory will be most likely not travel the full distance. At a distance of circa 60 m

(assumed length of the wicket is approximately 20 m) to the Southern boundary a 12 m high fence would completely remove the risk of cricket balls landing in the area beyond the boundary.

The height calculations of the ball trajectory combined with the experiential information regarding shot scenario and direction of play indicate that ball stop fencing in the region of 12 m would provide a suitable level of protection with only rare / exceptional shots going over the fencing system.

West Orientation

The shortest distance from the edge of the cricket square to the development boundary is circa 40 m and 43 m. Again, at this distance a cricket ball can be over 20 m in height given the above trajectory data. In addition the ball will be traveling at a velocity in excess of 20 m/s^{-1}. The model indicates that trajectories ≥ those with a hit angle of 40^{o} and a velocity of 35 m/s, and a hit angle of 30^{o} and a velocity of 40 m/s will surpass the proposed 12 m high fencing system.

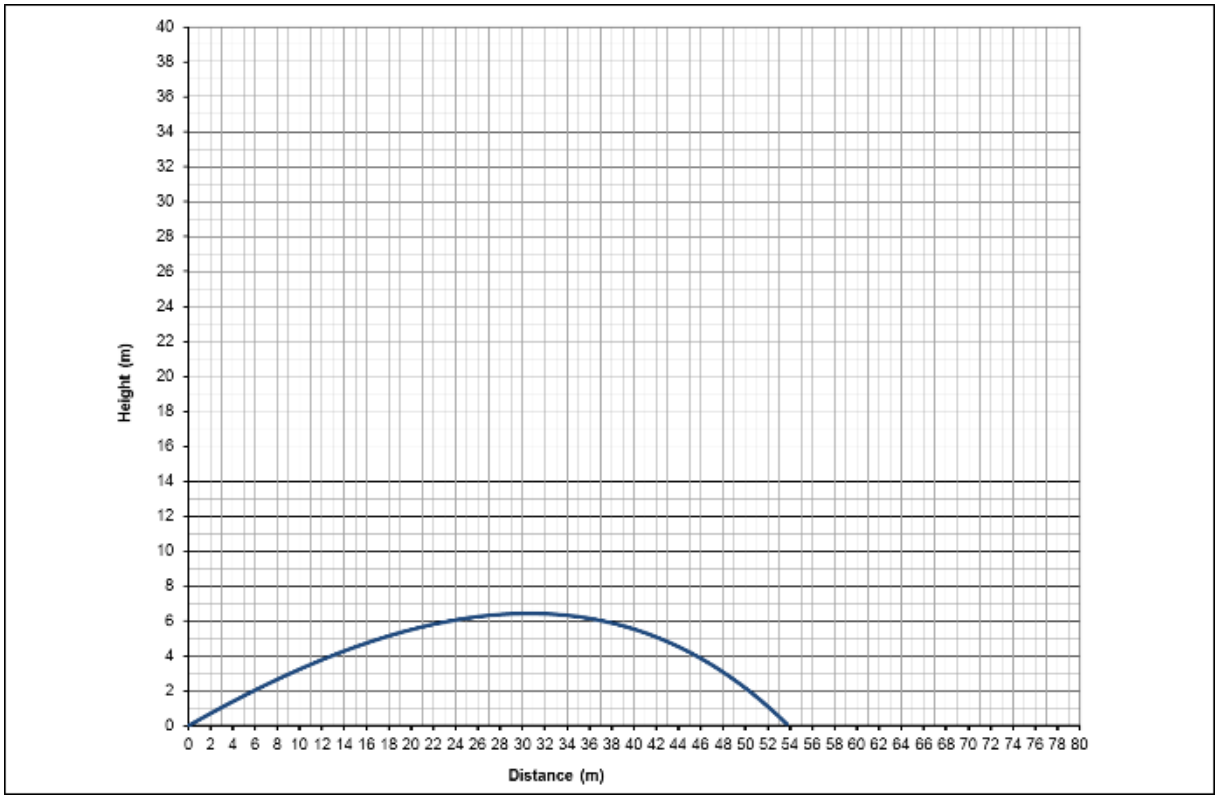
As previously discussed the exact frequency of shots resulting in a cricket ball being hit into the adjacent area is unknown and impossible to predict with certainty (player skills, type of game and many other factors can influence this) and hence a proportionate approach needs to be taken to provide an appropriate level of safety. Cricket balls likely to surpass the proposed 12 m high fencing system will be those with greater hit angles and high speeds based on the trajectory data above. It is therefore recommended that the client works with the ECB and cricket club to better determine the frequency/likelihood of these shot scenarios in particular to determine whether the proportionality linked to risk (comprising likelihood and severity) are suitably reduced with the inclusion of a 12 m high fencing system at the Western boundary.

Further notes:

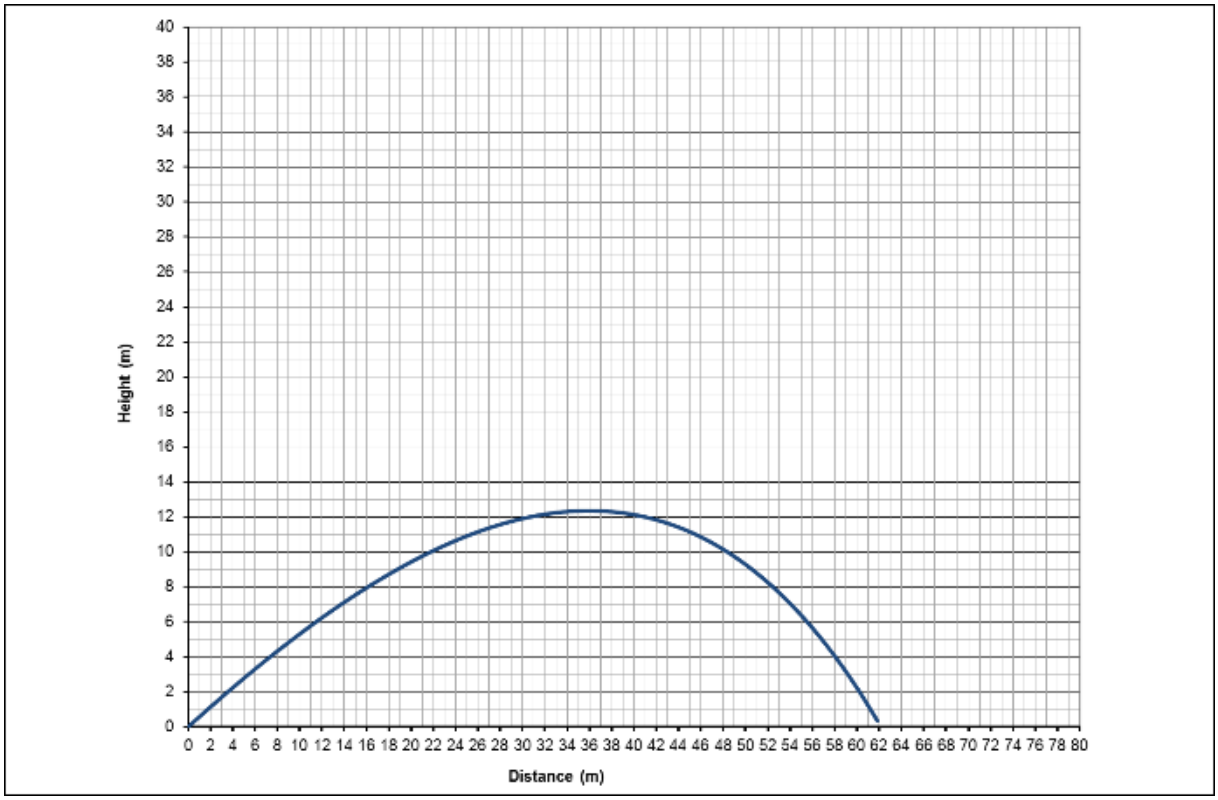
It is recommended the client discuss the plan with the England and Wales Cricket Board (ECB) or other relevant organisations such as Sport England whatever systems are proposed to improve mitigating the risk but also practicable for the cricket club's day to day use.

APPENDIX B – EXAMPLE TRAJECTORIES

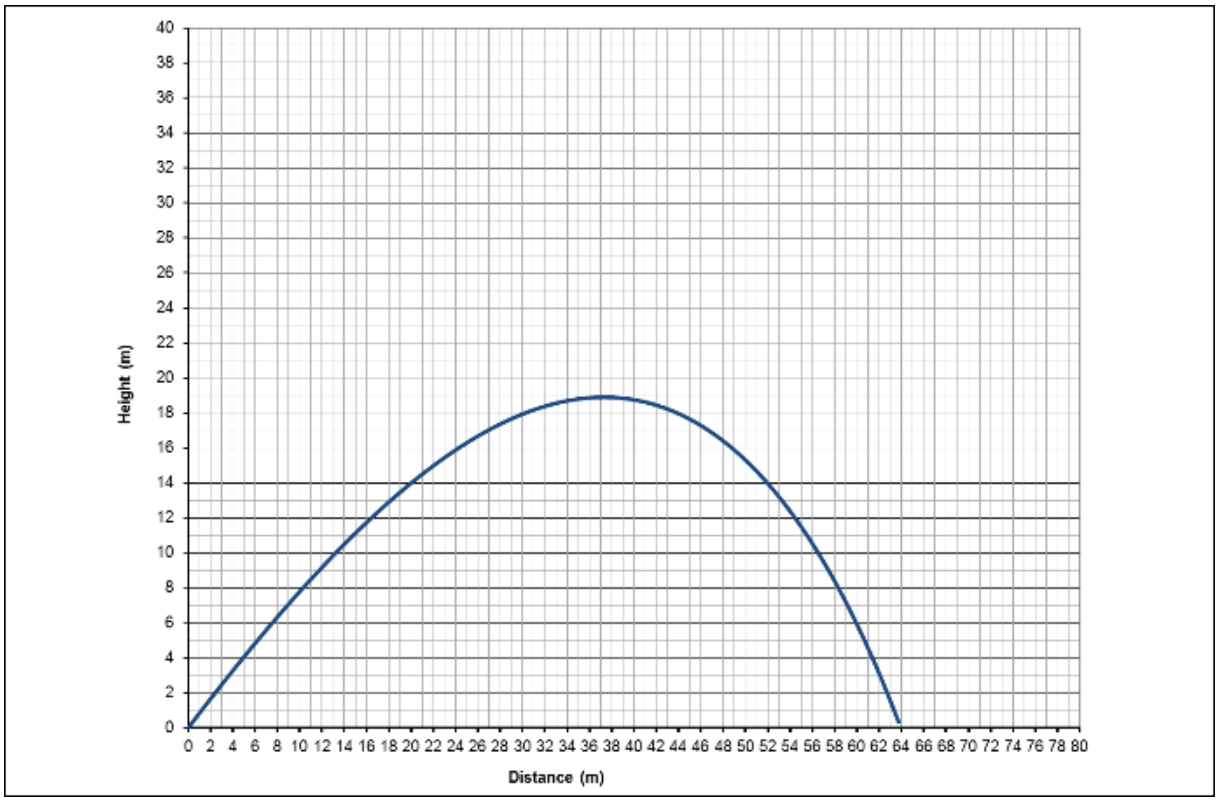
20 ° @ 40 m/s



30 ° @ 40 m/s



40 ° @ 40 m/s


Height (m)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
Distance (m)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80