Cannington, Mandurah and Northam greyhound racing tracks: Report 2 – Starting boxes and catch pens

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For Racing and Wagering Western Australia

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Executive summary

This is the second report in a series of reports prepared by UTS for Racing and Wagering Western Australia.

The purpose of this Report was to review the starting box locations and catching pens at the Cannington, Mandurah and Northam greyhound tracks.

The following observations were made:

- The catching pen area of the Northam greyhound track is small;
- The Mandurah greyhound track distance from the finish post to the catching pen is short; and
- The three WA greyhound tracks have narrow catching pen entrances (gate width).

The following recommendations were made:

- The width of the Cannington greyhound track catching pen be increased if this track is renovated.
- At an appropriate time the entrances to all three catching pens be widened;
- At an appropriate time consider relocating the Mandurah catching pen to increase the distance between the finish post and the catching pen;
- At an appropriate time consider increasing the length of the Mandurah catching pen; and
- The alignment of the catching pens aids the greyhound entry into the pen, provides the greyhound with sufficient distance to come to rest while providing sufficient area to reduce the likeihood of interference between greyhounds occurring within the pen.

Further observations and recommendation will be presented in the third and final report.

Contents

1 Introduction

1.1 General

This is the second report in a series of reports prepared by UTS for Racing and Wagering Western Australia (RWWA).

The purpose of this Report was to review the starting box locations and catching pens at the Cannington, Mandurah and Northam greyhound tracks.

1.2 Cannington greyhound track

Cannington track is located within Perth's metropolitan region that has the potential to attract race-side viewers. The track has five starts, namely: 275 m, 380 m, 520 m, 600 m and 715 m.

1.3 Mandurah greyhound track

Mandurah track is located at Kanyana Park, approximately 65 km south of Perth in close proximity to the majority of greyhound trainers. The track has four starts, namely: 302 m, 405 m, 490 m and 647 m.

1.4 Northam greyhound track

Northam track is located approximately 90 minutes drive east of Perth in a small town that has few greyhound trainers. The track has four starts, namely: 297 m, 509 m, 588 m, and 721 m.

2 Ideal starting box locations

2.1 General

It is evident that there are identifiable and specific locations at a track where greyhounds are more prone to injuries. These injury locations are present partly due to active racing variables arising from various momentary decisions made by a racing greyhound as a result of how a race is laid out and conducted. Path smoothing is major factor for greyhounds momentary decisions.

Race simulation using digitised race data reveal the race running configurations which required more attention and investigation to improve potentially unstable running conditions.

The location of starting boxes around a particular track presents potential challenges for greyhounds. Before a greyhound merges with the track there are particular probabilistic path takings for each starting box placements relative to each track. This can be seen from the greyhound veering as analysed by looking into their yaw rates[1]. The yaw rate of an individual greyhound depends on its speed, acceleration, veering capability, proximity to other greyhounds and many other factors.

It should be noted that the cross-fall out of the boxes may intensify the turning radius and yaw rate results as the ground normal force can aid in gaining greyhound momentum depending on the cross-fall designs. So, in the simulation a neutral cross-fall is considered which does not have a direct influence on the greyhound turning and yaw rate.

2.2 Cannington greyhound track

Figures 1 to 4 illustrate simulation analysis of box location performance for a racing greyhound start from Box 1. Simulation of a racing greyhound showed greyhound path taking for a given starting box alignment. In the simulation a greyhound's idealised path taking was analysed by looking into two variables namely turning radius and yaw rate. Both variables give us various information which can be included in the ideal boxes location criteria.

Figures 1 to 4 show simulated greyhound path taking of a single greyhound and corresponding turning tendency for 275 m, 380 m, 520 m, 600 m and 715 m starting box locations and alignments. The arrows perpendicular to the direction of greyhound heading show the magnitude of greyhound

[1]The *yaw rate* or the rate of change of the greyhound's heading direction or angular velocity of its rotation relative to its forward movement. The yaw rate is measured in radians per second (rad/s).

turning tendency while moving from the starting box to the track. After jumping out of the starting box the greyhounds initially turn rapidly toward the rail. Also, different distances race start locations expose different turning sequences. The most abrupt turning sequence was noticed from the 380 m distance starting box location where the turning tendency change was highly non-uniform. The 520 m and 600 m locations starts had similar performance. The 715 m box location provided the most uniform performance. Furthermore, the heading of the greyhound as indicated by the directional arrows shows that the transitions from different starting distances are clockwise while the actual race runs anti-clockwise.

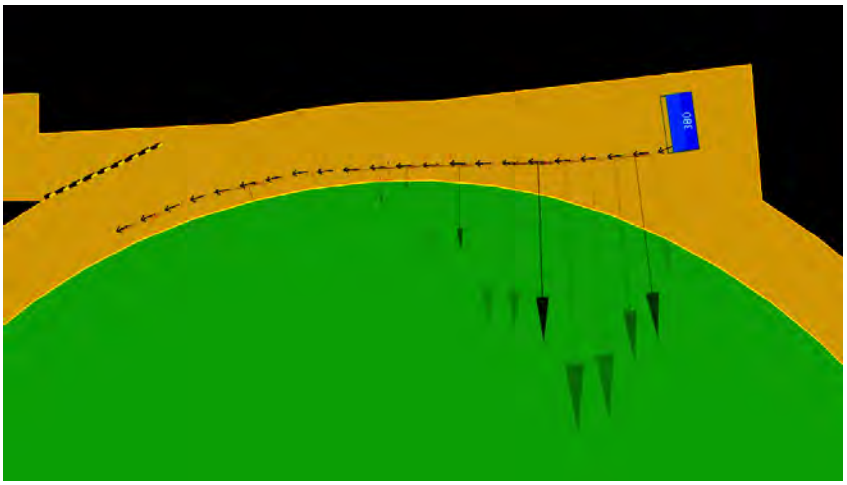

Figure 1: Simulation of greyhound path for the 380 m starting distance at Cannington greyhound track. The length of arrows depict the magnitude of Box 1 greyhound's turning tendency as a function of normal velocity component, instantaneous speed and a constant.

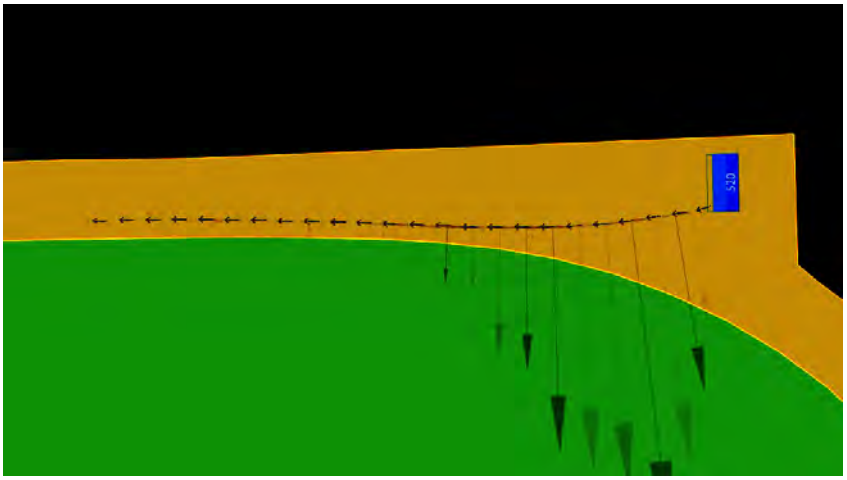

Figure 2: Simulation of greyhound path for the 520 m starting distance at Cannington greyhound track. The length of arrows depict the magnitude of Box 1 greyhound's turning tendency as a function of normal velocity component, instantaneous speed and a constant.

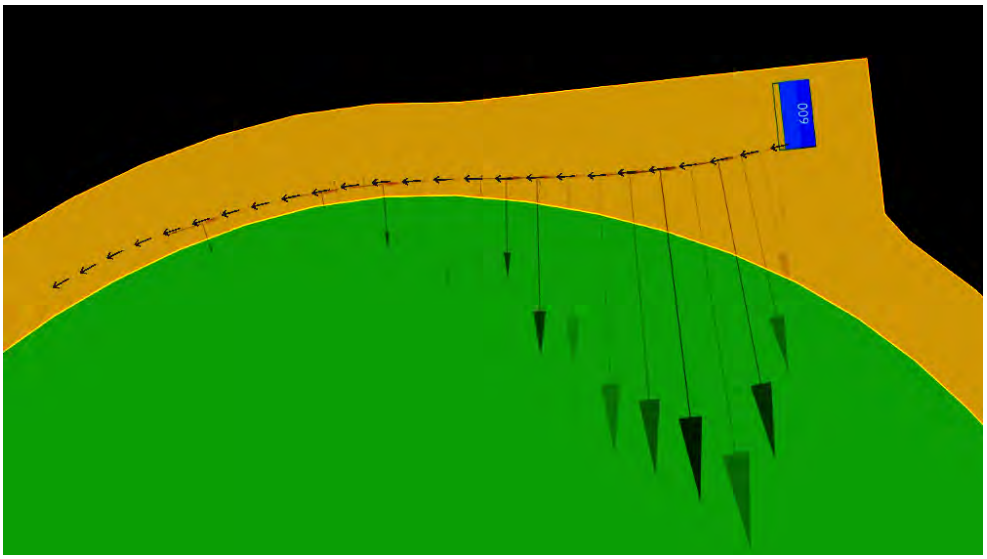

Figure 3: Simulation of greyhound path for the 600 m starting distance at Cannington greyhound track. The length of arrows depict the magnitude of Box 1 greyhound's turning tendency as a function of normal velocity component, instantaneous speed and a constant.

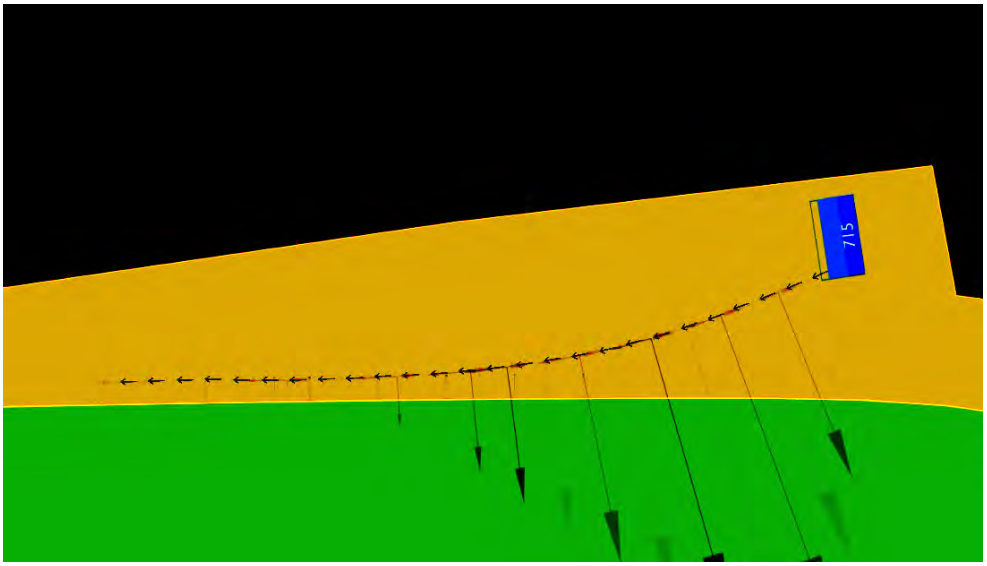

Figure 4: Simulation of greyhound path for the 715 m (and 275 m) starting distance at Cannington greyhound track. The length of arrows depict the magnitude of Box 1 greyhound's turning tendency as a function of normal velocity component, instantaneous speed and a constant.

Figures 5 to 9 depict turning radius versus run distance of a greyhound for the 380 m, 520 m, 600 m and 715 m (and 275 m) starting box locations and alignments. The plots tell us the smallest turning radius the racing greyhound has to make for moving from boxes to the track. For instance, for 380 m distance starting box location the smallest turning radius occurred at approximately 25 m from the starting box which equates approximately a 43 m radius. This turning radius is less than the track bend radius[2] of 51 m. The 520 m and 600 m starting box locations had turning radius of about 68 m and 50 m respectively which occurred at approximately 5 m and 34 m for the 520 m and 600 m starts respectively. For 715 m starting box location, the smallest turning radius occurred at around 12.5 m distance was approximately 50 m radius. This turning radius of greyhound is similar to the track bend turning radius. Furthermore, Figure 6 shows that there are two points where the greyhound path taking was not continuous at approximately 2 m and 25 m distances for the 380 m distance starting box location and alignment. However, the discontinuity at a 25 m distance is more likely to causally linked to a serious injury as it occurs when the greyhound would moving at a significantly higher speed.

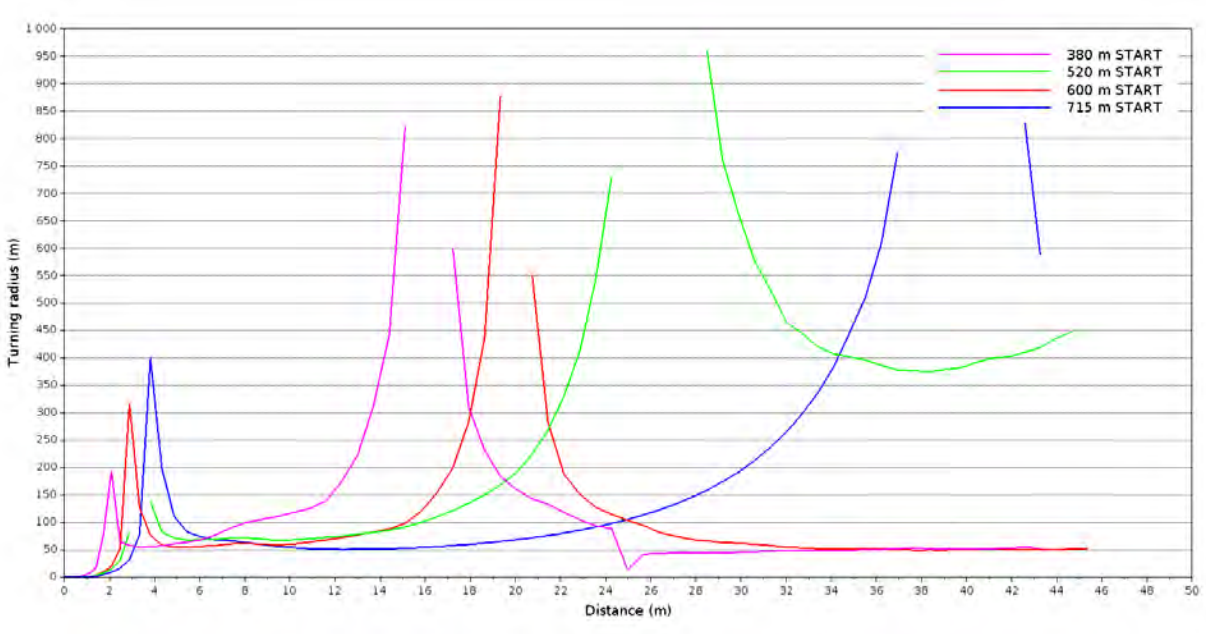

Figure 5: Greyhound turning radius for 380 m, 520 m, 600 m and 715 m (and 275 m) starting distances at Cannington track. The plots commence at the respective Starting Boxes.

[2]A 51 m radius assumes the greyhounds are 1 m off the rail as they negotiate their way around the bend.

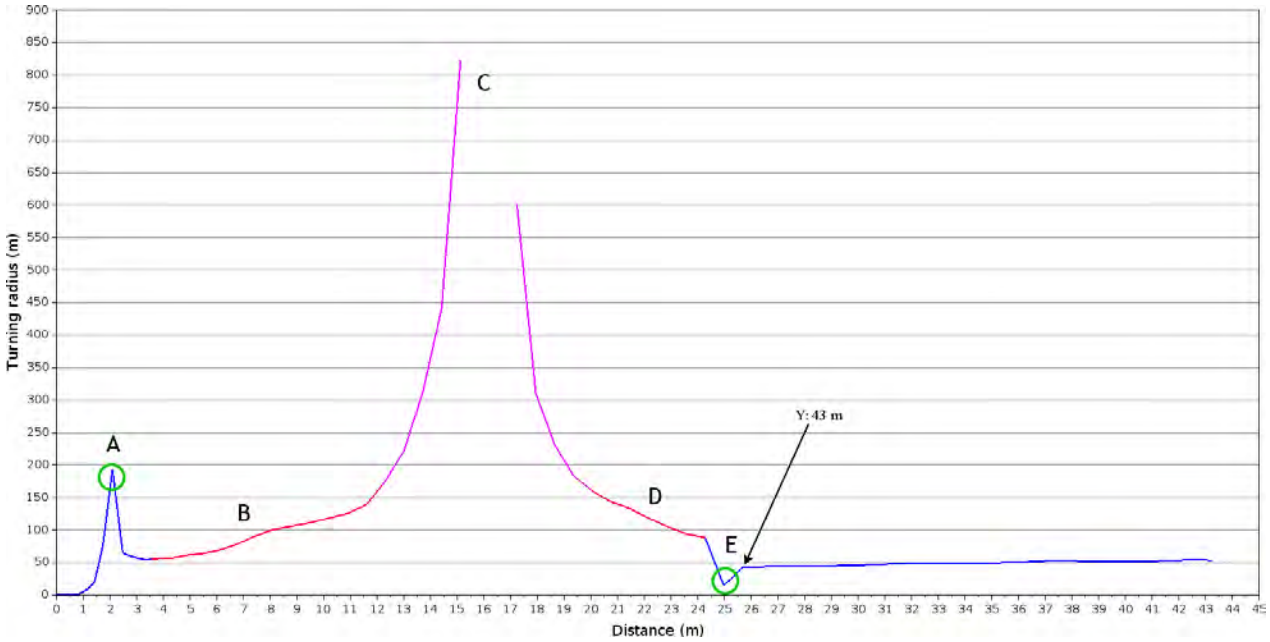

Figure 6: Greyhound turning radius for 380 m starting distance at Cannington track. The red sections indicate gradual turning while the purple sections indicate a more sharper turning. The discontinuities in the greyhound path is identified by the green circles.

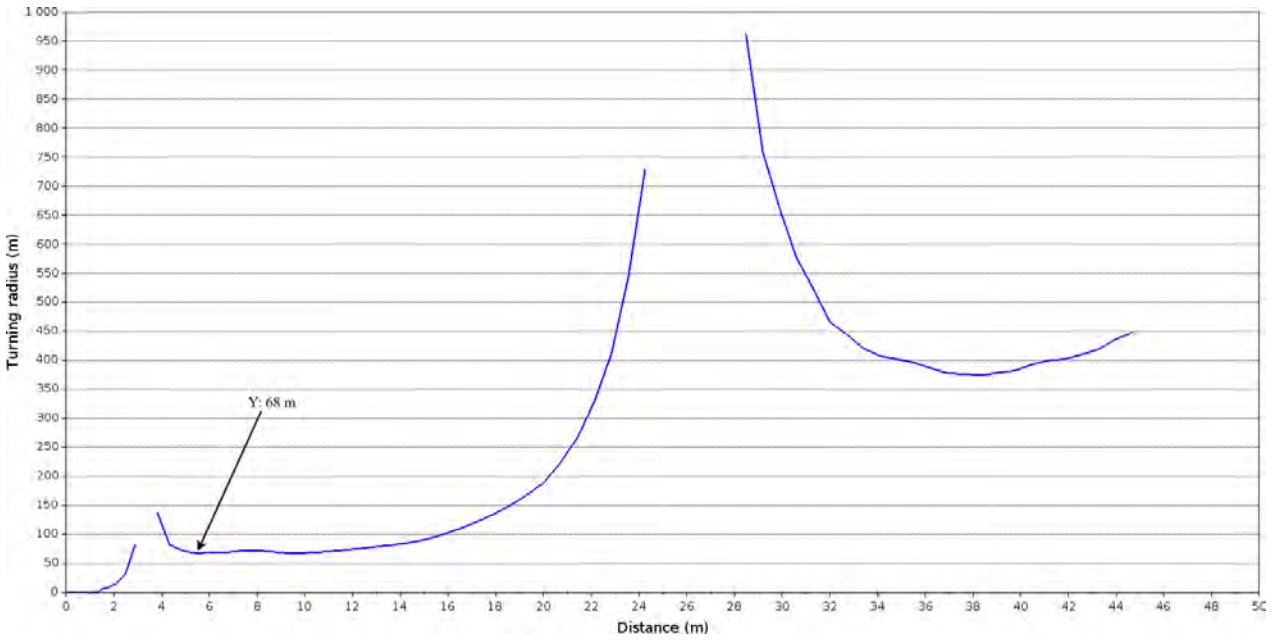

Figure 7: Greyhound turning radius for 520 m starting distance at Cannington track.

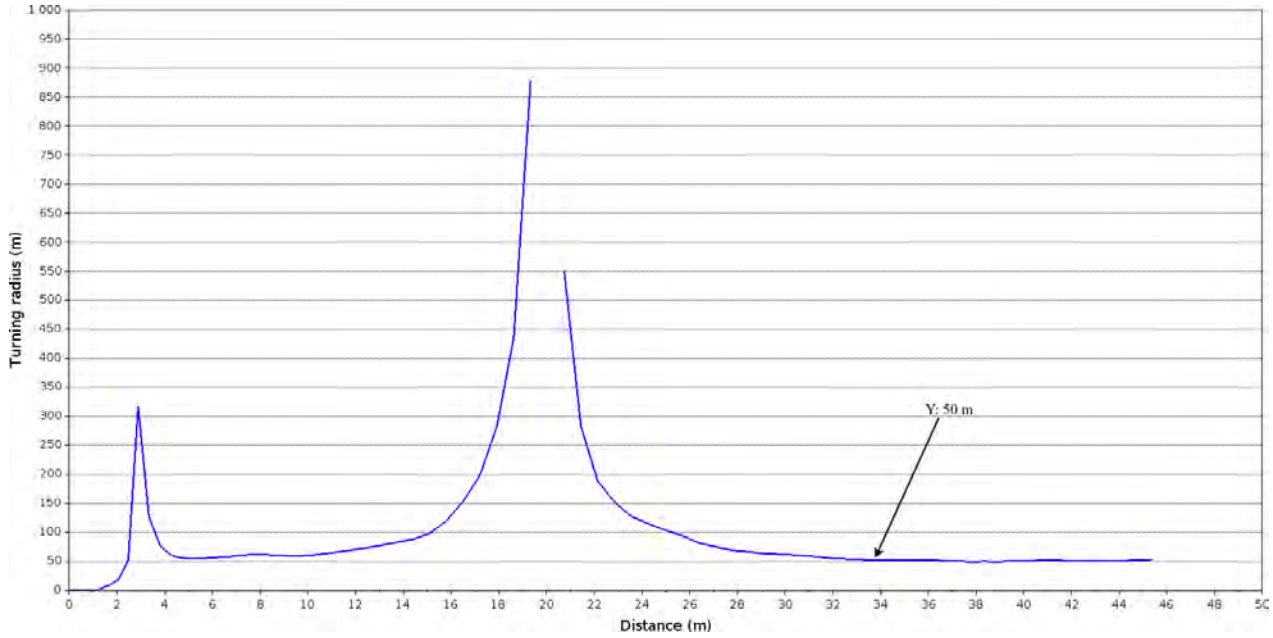

Figure 8: Greyhound turning radius for 600 m starting distance at Cannington track.

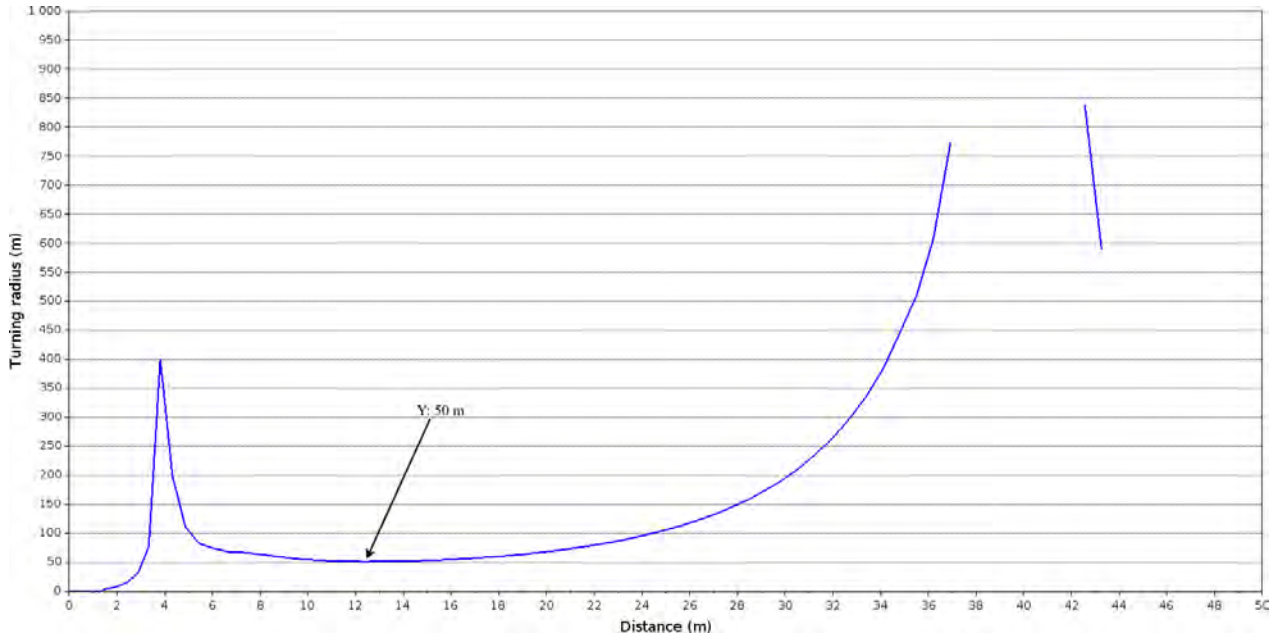

Figure 9: Greyhound turning radius for 715 m (and 275 m) starting distance at Cannington track.

Figure 10 illustrates the yaw rate (rad/s) plotted against the distance (m) out of the box for the 380 m, 520 m, 600 m, and 715 m (and 275 m) starts. The yaw rate shows greyhound turning direction and magnitude. In the graph, a positive yaw rate indicates turning anticlockwise or turning towards track inside edge. For the 380 m and 520 m distances box locations the greyhound turning was not smooth at around 26 m and 18 m respectively as depicted by the large negative dips in the pink and green plots within Figure 10 for these two distances and boxes alignments. Also, there is a large shift in greyhound turning for 380 m distance alignment at around 26 m from the boxes. The 380 m required minimum initial turning of about 0.35 rad/s and after initial turning phase, the greyhound yaw rate went through a 0.5 rad/s change over the 44 m run distance. For the 520 m, 600 m, and 715 m (275 m) distances starting box alignments initial yaw rate was more than double that of 380 m. After the initial turning phase the greyhound yaw rate went through 0.57, 0.35, and 0.29 rad/s changes for 600 m, 520 m and 715 m (and 275 m) respectively. Moreover, it took the shortest distance of about 17 m for the greyhound to merge with the track for 380 m box location as can be seen from the Figure 10 where the yaw rate changed from negative to positive. The 715 m (275 m) box alignment took longest run distance for the greyhound to align with the track chainage line followed by 520 m and 600 m boxes alignments. As the greyhounds accelerate beyond 80 m run distance a longer distance would allow the greyhounds to better cope with different situations such as track bend and greyhound congestion.

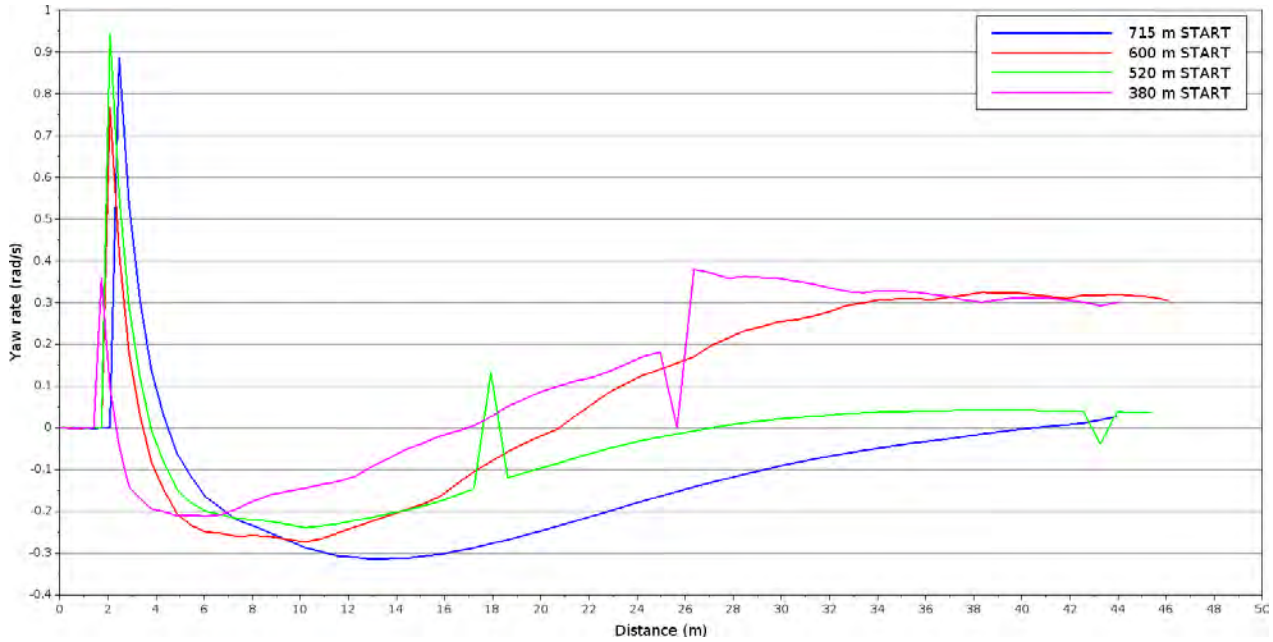

Figure 10: Greyhound yaw rate for the boxes alignments where a positive value indicates turning anticlockwise and a negative value indicates turning clockwise for 380 m, 520 m, 600 m and 715 m (275 m) starting distances at Cannington greyhound track. The plots commence at the respective Starting Boxes.

Table 1 summarises the greyhound's nominal dynamic conditions for the different starting box alignments for the Cannington greyhound track.

Table 1: Dynamic properties of boxes alignments at Cannington greyhound track.

Start	Smallest turning radius (m) (higher is better)	Instantaneous yaw rate (rad/s) (lower is better)	Sustained yaw rate (rad/s) (lower is better)	Distance to alignment with the track (m)
380 m	43	0.35	0.50	17
520 m	68	0.95	0.35	27
600 m	68	0.75	0.57	27
715 m (275 m)	50	0.88	0.29	41

2.3 Mandurah greyhound track

Figures 11 to 14 show simulated greyhound path taking of a single greyhound and corresponding turning tendency for the 302 m, 405 m, 490 m and 647 m starting box locations and alignments. As can be seen from the turning tendency sequence denoted by the perpendicular arrows, there is no abrupt change in greyhound turning tendency for all race distances and box locations. Furthermore, the most intense turning tendency was observed for 302 m, 490 m and 647 m starting box locations and alignments.

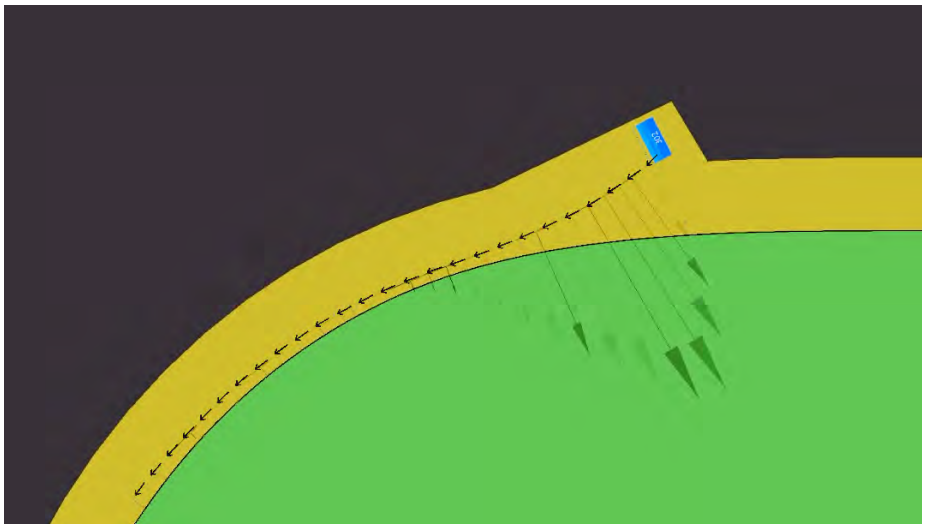

Figure 11: Simulation of greyhound path for the 302 m starting distance at Mandurah greyhound track. The length of arrows depict the magnitude of the Box 1 greyhound's turning tendency as a function of normal velocity component, instantaneous speed and a constant.

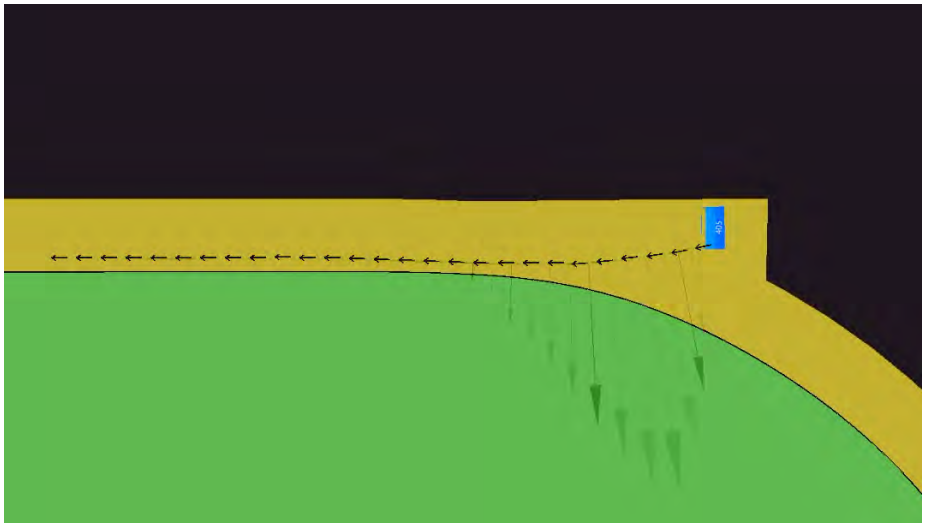

Figure 12: Simulation of greyhound path for the 405 m starting distance at Mandurah greyhound track. The length of arrows depict the magnitude of the Box 1 greyhound's turning tendency as a function of normal velocity component, instantaneous speed and a constant.

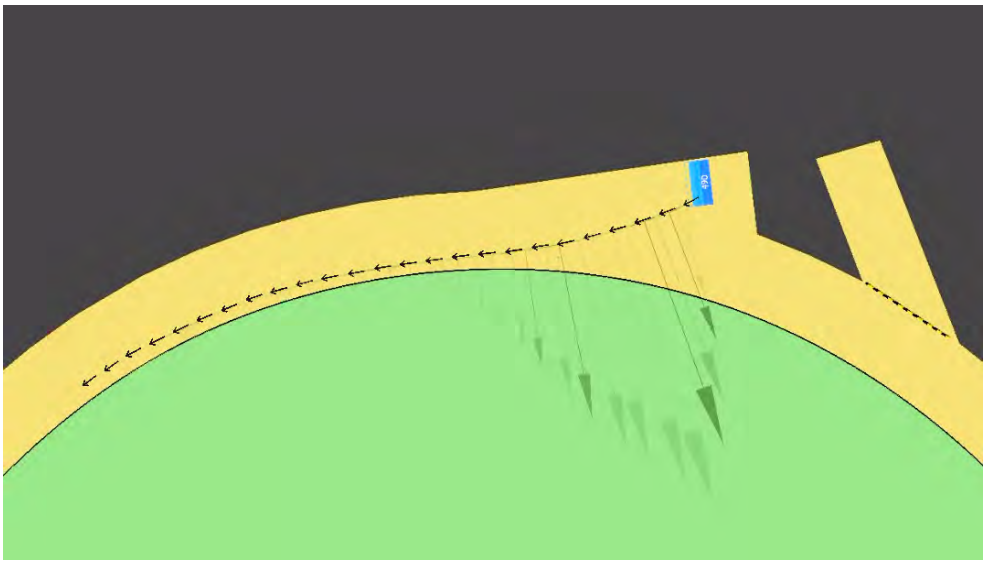

Figure 13: Simulation of greyhound path for the 490 m starting distance at Mandurah greyhound track. The length of arrows depict the magnitude of the Box 1 greyhound's turning tendency as a function of normal velocity component, instantaneous speed and a constant.

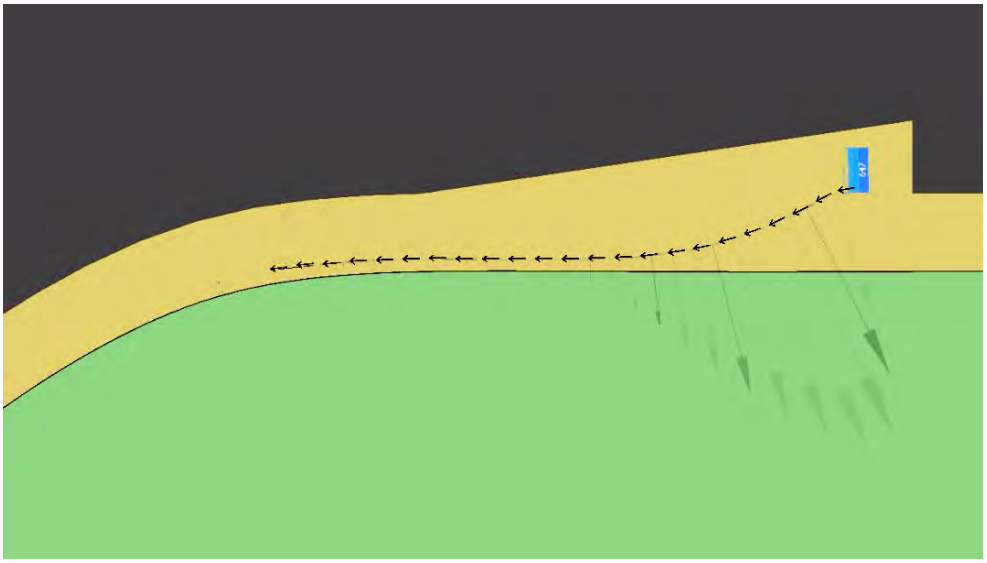

Figure 14: Simulation of greyhound path for the 647 m starting distance at Mandurah greyhound track. The length of arrows depict the magnitude of the Box 1 greyhound's turning tendency as a function of normal velocity component, instantaneous speed and a constant.

Figure 15 depicts turning radius versus run distance of a greyhound for the 302 m, 405 m, 490 m and 647 m starting box locations and alignments. The plots provide an insight with respect to the small turning radius the racing greyhound has to make when moving from boxes to the track. The 647 m distance starting box location exposes the greyhound to a turning radius which is less than 50 m. This tight radius occurs between 9 m and 19 m with a minimum at approximately 14 m from the box[3]. The 302 m, 405 m and 490 m starting box locations and alignments had similar turning radius performance for up to a distance of around 24 m from the respective boxes where the smallest turning was observed for 302 m box location and alignment of about 50 m radius. As can be seen from the figure, 302 m, 490 m and 647 m race distances alignments currently existing at Mandurah track exposing much lower turning radius than track bend radius of approximately 71 m.

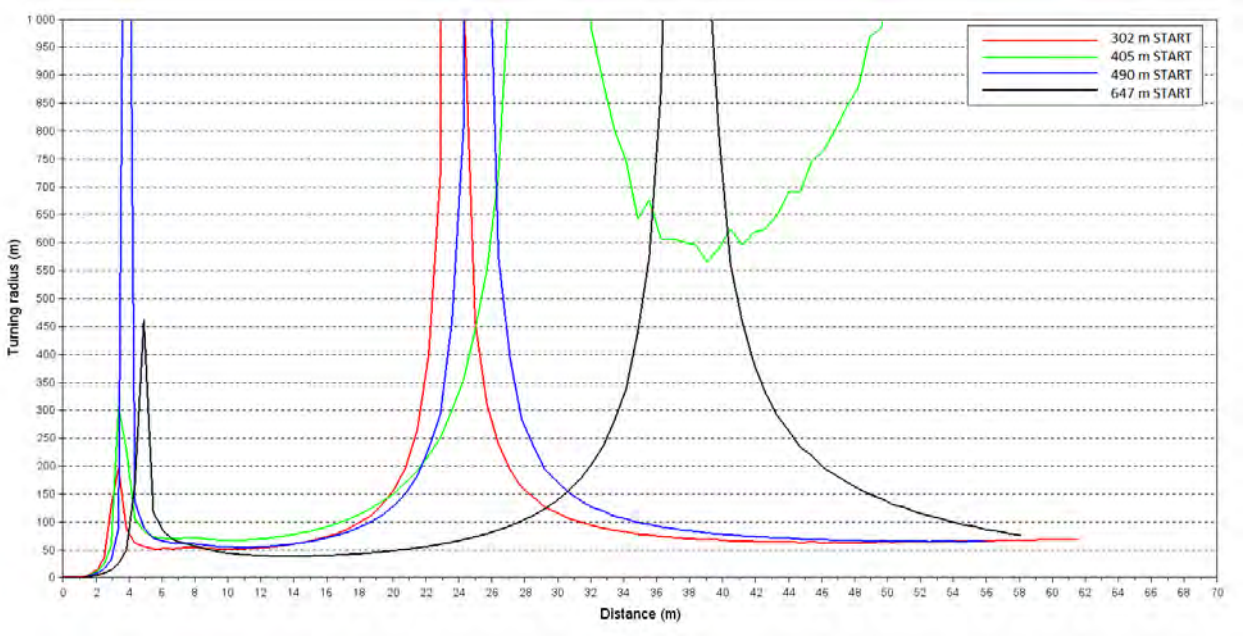

Figure 15: Greyhound turning radius for 302 m, 405 m, 490 m and 647 m starting distances at Mandurah track. The plots commence at the respective Starting Boxes.

[3]The negative affects associated with this centrifugal force on this 10 m long tight radius are moderated by the lower velocity of the greyhounds at the start of of the race.

Figure 16 illustrates yaw rate (rad/s) plotted against the distance (m) out of the box for the 302 m, 405 m, 490 m, and 647 m starts. All race distances starting box locations and alignments showed a continuous turning where the peak turning occurred from around 6 m to 14 m for the 302 m, 405 m, and 490 m start distances, and 9 m to 22 m for the 647 m starts distance. The 302 m required minimum initial turning of about 1.76 rad/s and after that, the greyhound yaw rate went through a 0.6 rad/s change over the 44 m run distance. For the 405 m and 490 m distances starting box alignments, the initial yaw rate was considerably more than that of 302 m where after the initial turning phase the greyhound yaw rate went through 0.29 rad/s and 0.58 rad/s changes respectively. The 647 m distance box alignment had the highest instantaneous yaw rate as well as an overall yaw rate change of about 4.1 rad/s and 0.67 rad/s respectively. Finally, among all the distances box alignments 405 m distance was found to be most optimal.

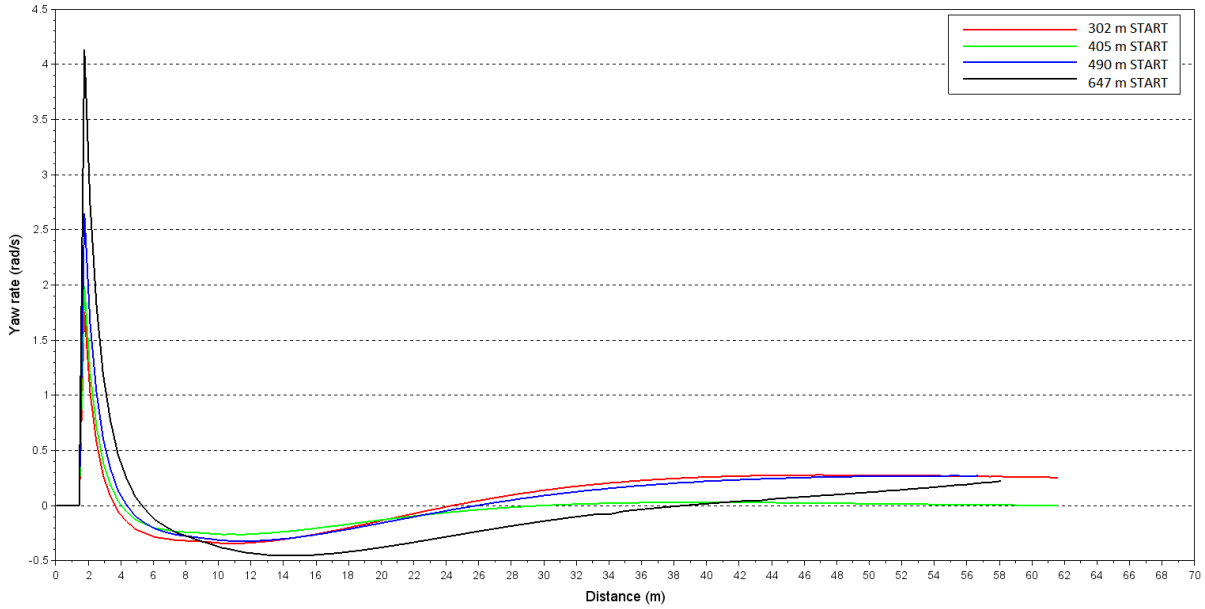

Figure 16: Greyhound yaw rate for the boxes alignments where a positive value indicates turning anticlockwise and a negative value indicates turning clockwise for 302 m, 405 m, 490 m and 647 m starting distances at Mandurah greyhound track. The plots commence at the respective Starting Boxes.

2.4 Northam greyhound track

Figures 17 to 19 show simulated greyhound path taking of a single greyhound and corresponding turning tendency for 509 m, 588 m and 721 m (and 297 m) starting box locations and alignments. The greyhound turning tendency was not continuous while moving from the starting box to the track for all race starts as indicated by the sequence of perpendicular arrows. It appears that for all race distances the starting boxes are positioned extremely near the lure running rail.

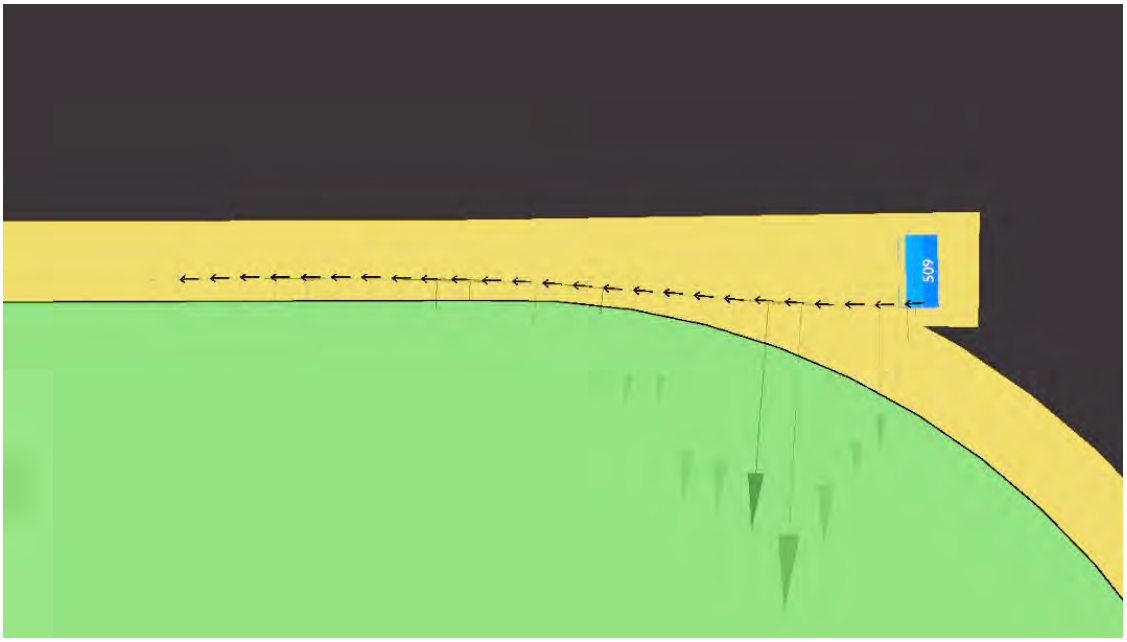

Figure 17: Simulation of greyhound path for the 509 m starting distance at Northam greyhound track. The length of arrows depict the magnitude of the Box 1 greyhound's turning tendency as a function of normal velocity component, instantaneous speed and a constant.

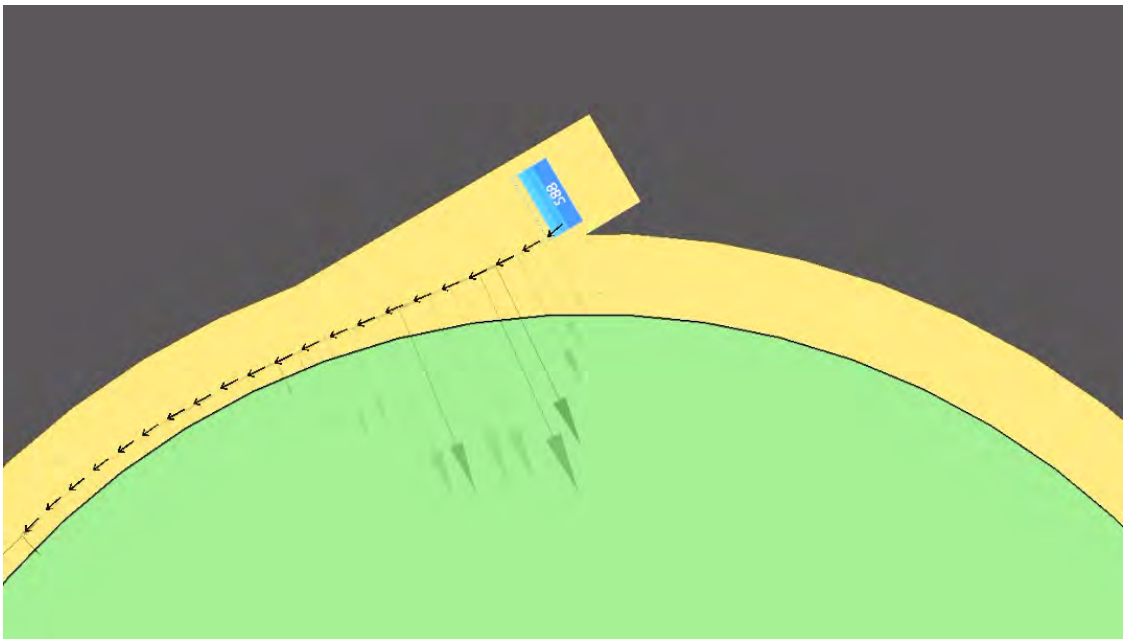

Figure 18: Simulation of greyhound path for the 588 m starting distance at Northam greyhound track. The length of arrows depict the magnitude of the Box 1 greyhound's turning tendency as a function of normal velocity component, instantaneous speed and a constant.

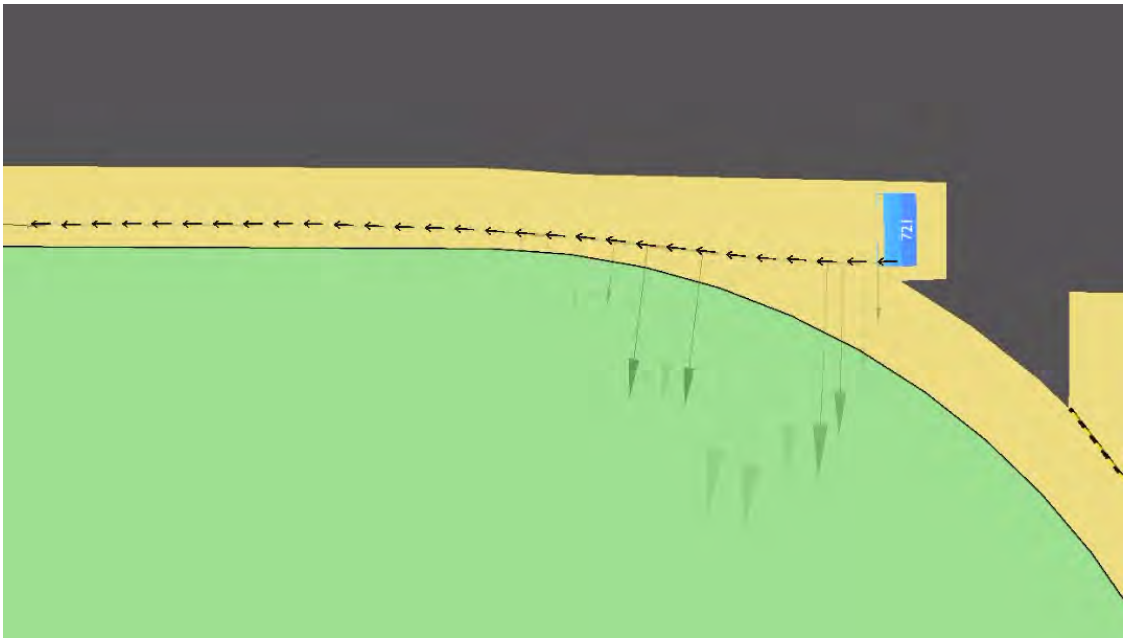

Figure 19: Simulation of greyhound path for the 721 m (and 297 m) starting distance at Northam greyhound track. The length of arrows depict the magnitude of the Box 1 greyhound's turning tendency as a function of normal velocity component, instantaneous speed and a constant.

Figures 20 depicts turning radius versus run distance of a greyhound for the 509 m, 588 m and 721 m (and 297 m) starting box locations and alignments. There is an instantaneous turning radius for all starting distances which is of a similar magnitude to the track bend radius. Both 509 m and 721 m (and 297 m) starting distances box alignments had similar turning radius performance while the turning radius for 588 m distance box alignment was more intense and prolonged as it continued until the greyhounds exist the first turn.

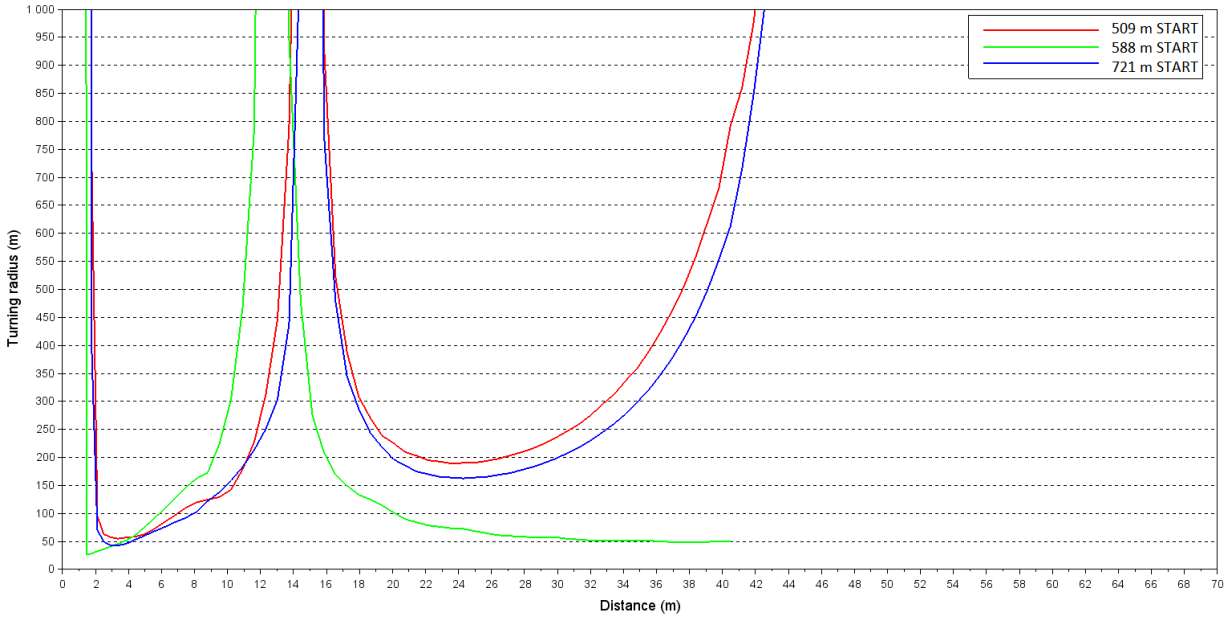

Figure 20: Greyhound turning radius for 509 m, 588 m and 721 m (and 297 m) starting distances at Northam track. The plots commence at the respective starting boxes.

Figure 21 depicts yaw rate (rad/s) plotted against the distance (m) out of the box for the 509 m, 588 m and 721 m (and 297 m) starts. All race starting box locations and alignments showed a continuous turning. The 588 m start had maximum instantaneous yaw rate out of the box with a yaw rate of about 0.3 rad/s. Also, there was a 0.55 rad/s change over the 24 m run distance. For the 509 m and 721 m starting box alignments, the instantaneous yaw rate out of the box was similar where the yaw rate went through roughly 0.32 rad/s and 0.35 rad/s changes respectively. Among all the race distances the 588 m start box alignment showed the most dramatic rate of change of yaw rate indicating hazardous alignment of the box. It is recommended that racing from the 588 m start be phased out or limited.

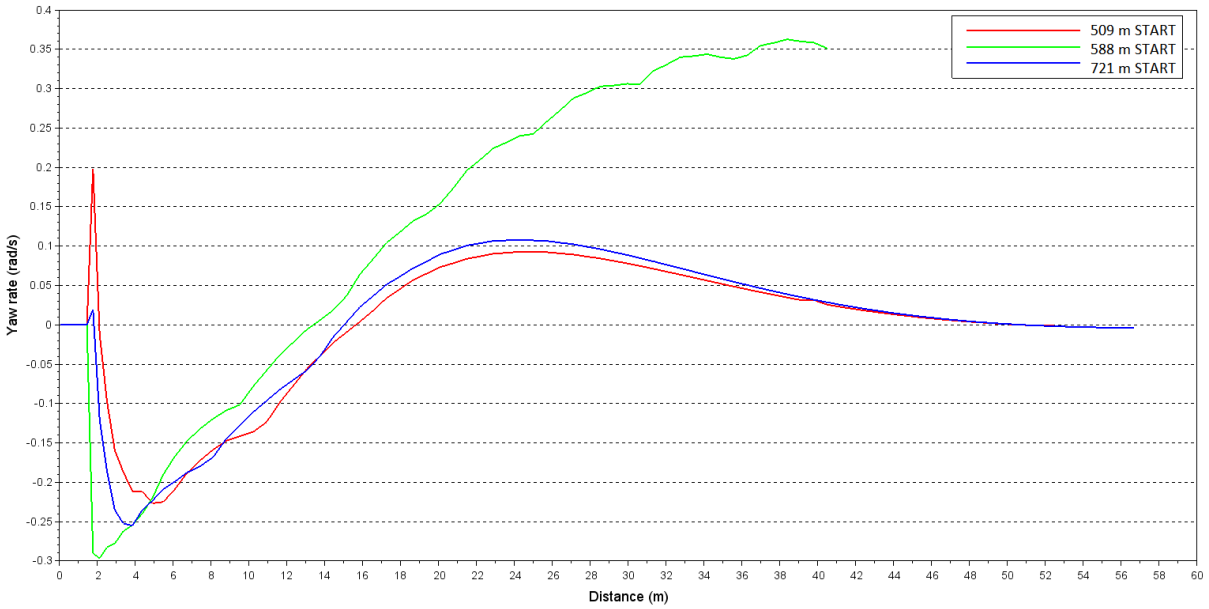

Figure 21: Greyhound yaw rate for the boxes alignments where a positive value indicates turning anticlockwise and a negative value indicates turning clockwise for 509 m, 588 m and 721 m (and 297 m) starting distances at Northam greyhound track. The plots commence at the respective starting boxes.

3 Catch pen location, orientation and size

3.1 General

The primary task of the catching pen is to provide a smooth stopping location for the greyhounds at the end of each race.

The catching pen form a vital element of a system that is designed to transition the greyhound from a speed of more than 16 m/s at the Finish Post to 0 m/s. This system includes the lure and the lure driver. It also include the track between the Finish Post and the catching pen.

Ideally, a catching pen allows adequate physical clearance to accommodate all the greyhounds as well as facilitating the controlled decrease in speed of greyhounds in injury free environment while they await collection by their handlers. The location, orientation and size of a catching pen has strong influence on whether the catching provides a safe environment for the exhausted greyhounds after the finish of each race.

The location, orientation and size factors are analysed in this section.

Figure 22 depicts three critical dimensions for a catching pen. The black dashed line indicates available distance inside a catching measured from the middle of the catching pen gate to the rear of the catching pen. The green dashed line represents the narrowest width inside a catching pen. These two dimensions are strong determining variable in determine how an average greyhound will problematically react to a catching pen.

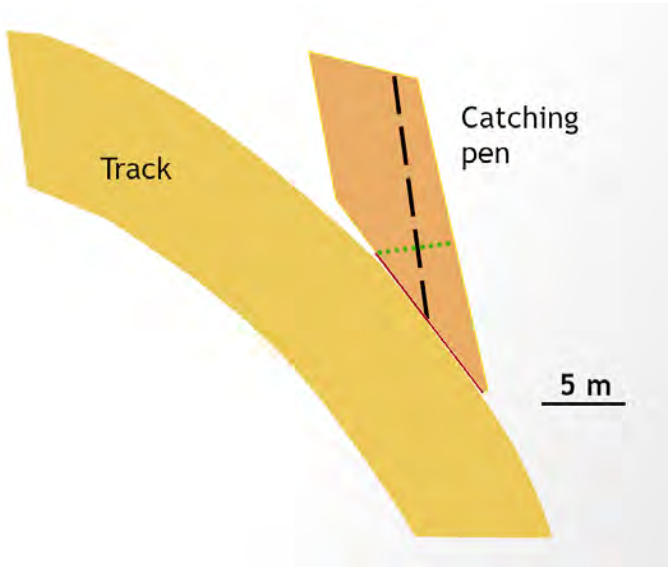

Figure 22: Catching pen dimensions used in this report. The black dashed line indicates available distance inside a catching measured from the middle of the catching pen gate to the rear of the catching pen. The green dashed line represents the narrowest width inside a catching pen. The red line represents the length of the catching pen gate.

3.2 Cannington greyhound track

Figure 23 depicts a diagram of the Cannington track catching pen where the red line indicates the catching pen gate. The total area inside the catching pen is around 90 m. The length of the catching pen gate is approximately 7 m and being wider than track width. The entrance to the Cannington track catching pen is narrow measuring approximately 4.1 m. The catching pen is located approximately 105 m after the Finish Post. This distance allows an adequate time for the greyhounds to slow down.

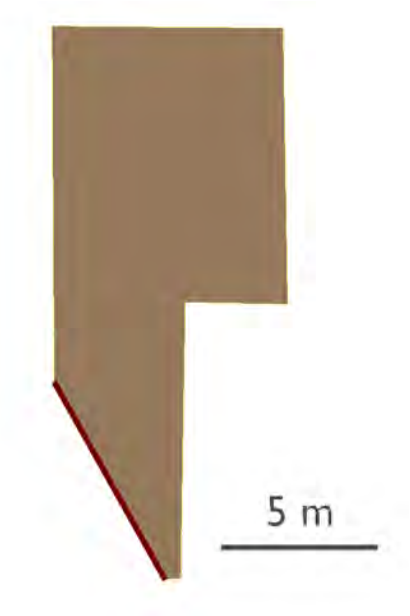

Figure 23: Catching pen at Cannington greyhound track.

At the finish post depending the location of the catching pen may not be immediately visible to the greyhound due to obscuring of their line of sight. This is demonstrated in Figure 24 for the Cannington catching pen location a greyhounds line of the sight (blue lines for the fourth and fifth greyhound) for the catching pen is not blocked by the track inside rail when its distance to the catching pen is approximately 31 m. Moreover, at approximately 28 m distance to the Cannington track catching pen a greyhound heading would be fully aligned with the catching pen. Thus, this 28 m distance was used for calculating greyhound speed and deceleration for the catching pen.

The lure is accelerated away from the lead winning greyhound when the race is finished. In a relatively short time the lure is made not visible to the greyhounds as a disincentive to chance. Both

the rapid acceleration of the lure and the change in the pitch of the sound of the lure momentarily motivate leading greyhounds to run faster. This momentary increase in the greyhound's speed was assumed to be negligible when calculating the negative acceleration into the catching pen.

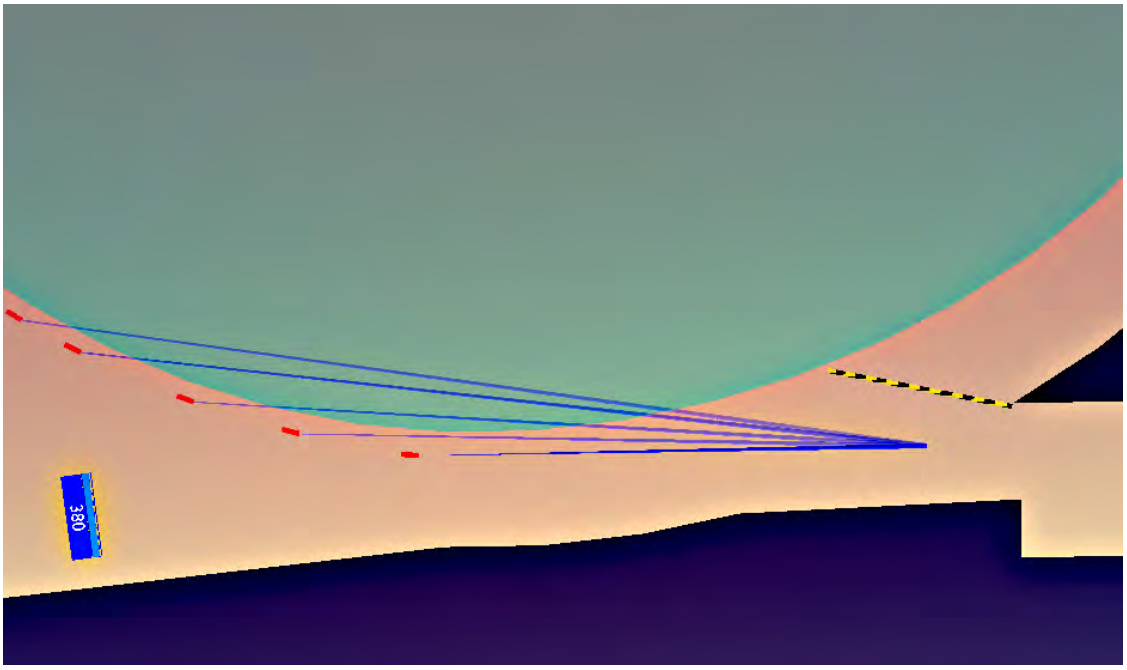

Figure 24: Greyhounds approaching the catching pen and their corresponding line of sight to the catching pen at Cannington greyhound track. When the greyhound distance to catching pen is approximately 28 m was used for greyhound speed calculation at Cannington greyhound track.

As a greyhound approaches the catching pen it needs to slow down within the available distance. While doing so the greyhounds effective weight is increased by the negative acceleration in the heading direction which is opposed to the forward driving force as depicted in Figure 25. For a greyhound, the increased effective weight is experienced as a normal reaction force from the track ground by the front limb as depicted in the diagram in Figure 26. By modelling a greyhound's path to the catching pen in the final phase where the greyhound has to negative acceleration as shown in Figures 27 and 28 the track ground's normal reaction force for the greyhound was calculated. Furthermore, a cosine function was applied for deriving greyhound deceleration profile from the greyhound's speed model where the greyhounds' speed model was synthesised from the race data. Figure 29 depicts greyhound's catching pen negative acceleration profile for 715 m race distance. Figure 30 depicts track elevation[4] and grade[5] in the direction of greyhound heading as a greyhound moves towards the catching pen at Cannington.

[4]The difference in track height (altitude) between the track segments in the direction of greyhound heading.
[5]The slope between the track consecutive segments in the direction of greyhound heading.

Figure 25: A greyhound's effective weight while not turning.

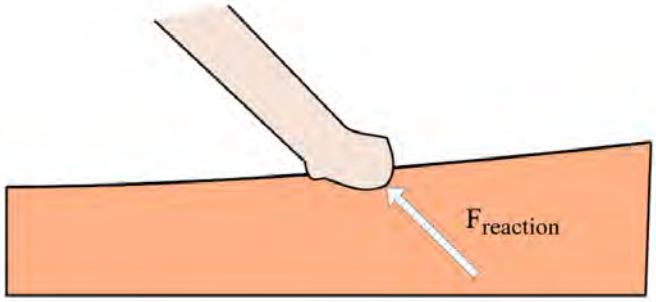

Figure 26: A greyhound's paw is responsible for taking reactionary force from the track ground.

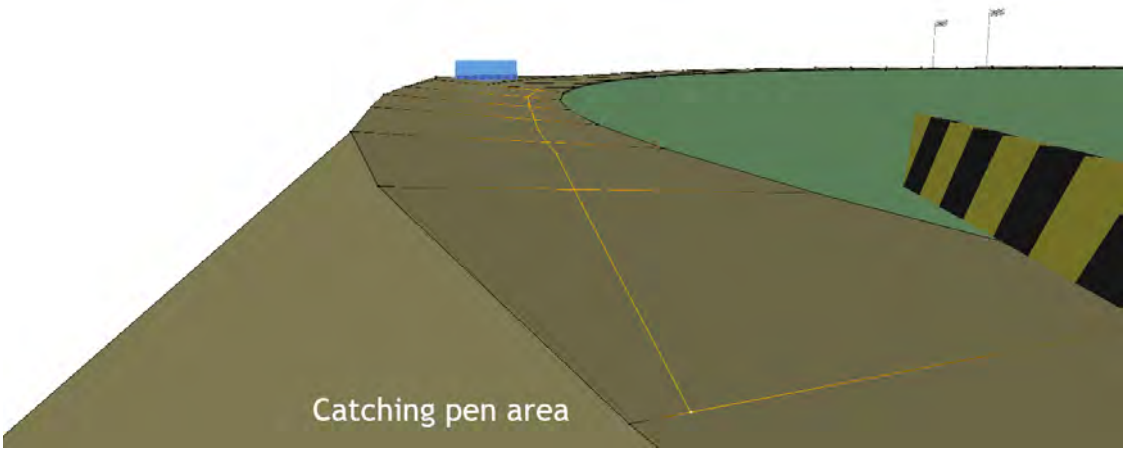

Figure 27: A greyhound's path towards the catching pen at Cannington track (when viewed from the catching pen toward the approaching greyhound).

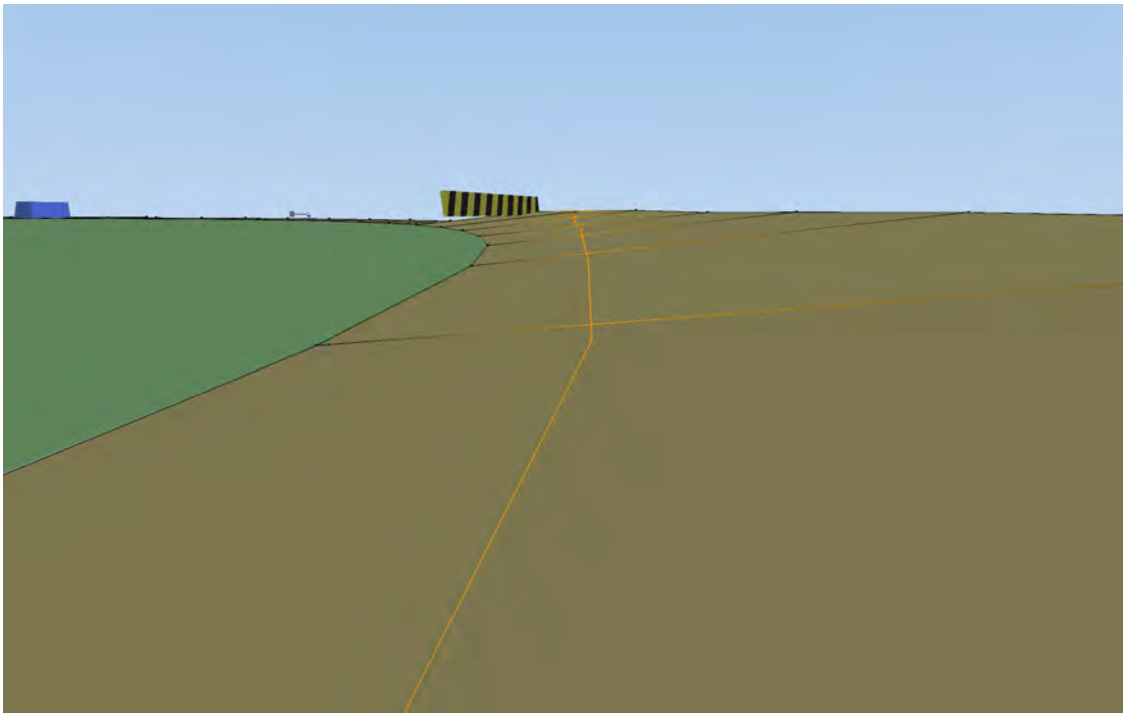

Figure 28: A greyhound's path towards the catching pen at Cannington track (when viewed from the greyhound looking forward to the catching pen).

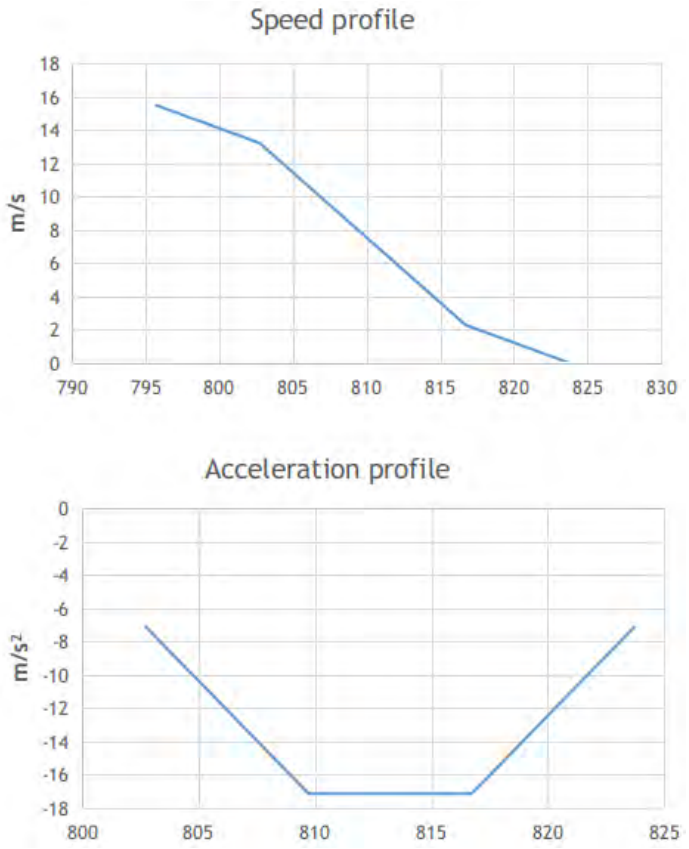

Figure 29: A greyhound's speed and deceleration while approaching the catching pen for 715 m starting distance at Cannington track. The plots commence at approximately 28 m distance to catching pen at Cannington track.

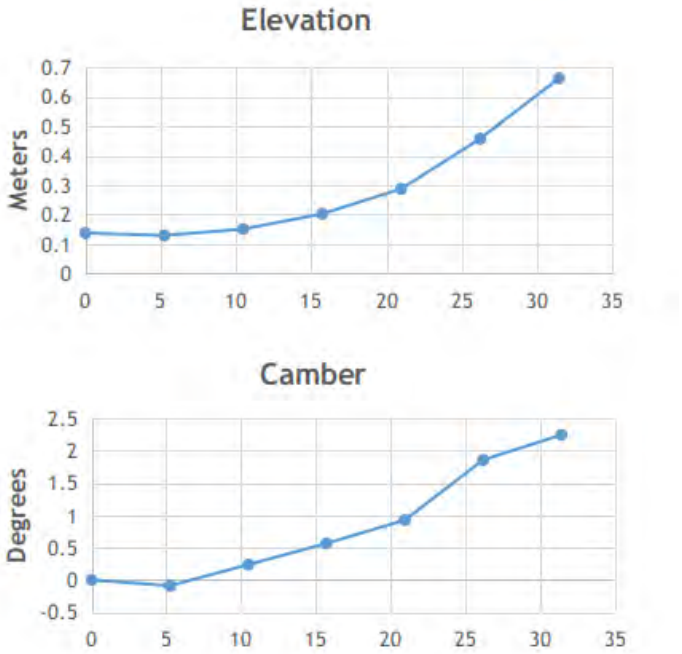

Figure 30: Track elevation and grade in the direction of greyhound heading while approaching the catching pen by a greyhound at Cannington track. The plots commence at approximately 32 m distance to catching pen at Cannington track.

As can be seen from Figure 31, the maximum normal reaction force due to a greyhound's decreasing speed as they approach the catching pen occurred for 275 m distance race while the minimum was for 715 m distance. Also, noticeable the normal reaction force due to negative acceleration of a greyhound is more than double of greyhound's weight[6] at stationary. This confirms a greyhound would experience an approximate momentary force that is twice of its weight due to increased effective weight from the decreasing speed.

[6]When modelled with a greyhound mass of 32 kg

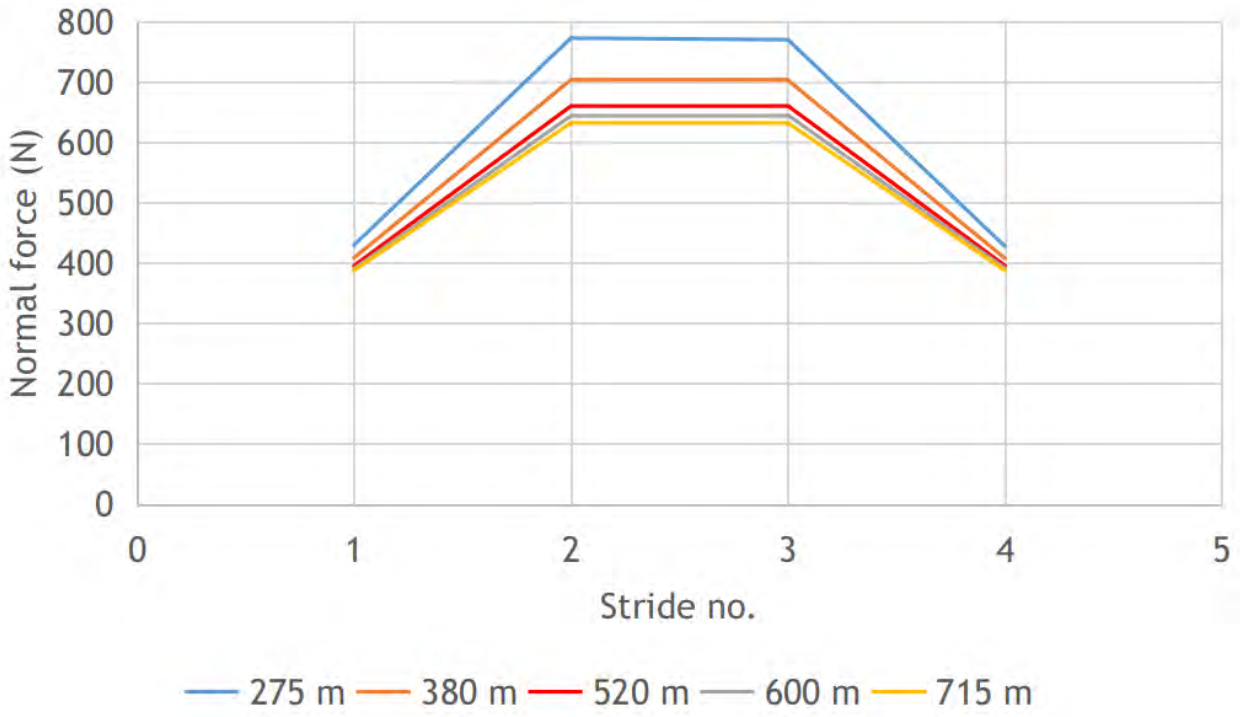

Figure 31: Normal reaction force versus stride number while approaching the catching pen by a greyhound for 275 m, 380 m, 520 m, 600 m and 715 m starting distances at Cannington track.

3.3 Mandurah greyhound track

Figure 32 depicts a diagram of the Mandurah track catching pen where the red line indicates the catching pen gate. The length of the catching pen gate is approximately 8.5 m and is wider than track width. The entrance to the Mandurah track catching pen is narrow measuring approximately only 5.5 m. The catching pen is located approximately 74 m after the Finish Post. This distance is considered too short for the greyhounds to slow down in a safe manner.

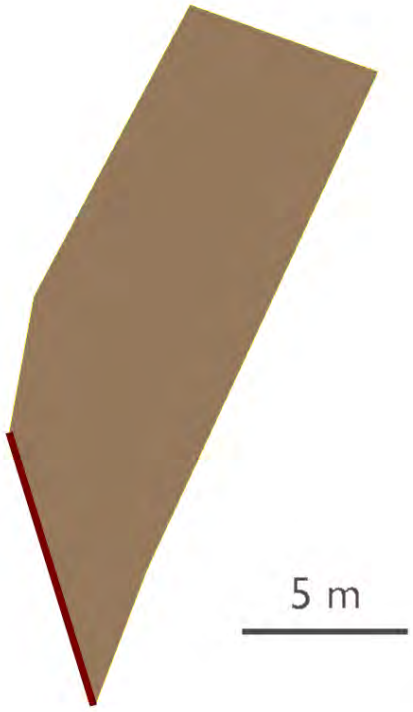

Figure 32: Catching pen at Mandurah track.

As can be seen from Figure 33, the maximum normal reaction force due to a greyhound's decreasing speed as they approach the catching pen occurred for 302 m starting distance race while the minimum was for 647 m starting distance. These forces which are due to negative acceleration of a greyhound are more than greyhound's nominal weight[7] when they are stationary. Also, compared to Cannington track the forces required for greyhounds to slow down at Mandurah track are lower due to a longer slow down distance which is available at Mandurah track. This is due to the estimated shorter slow down distance[8] which is available at Mandurah track.

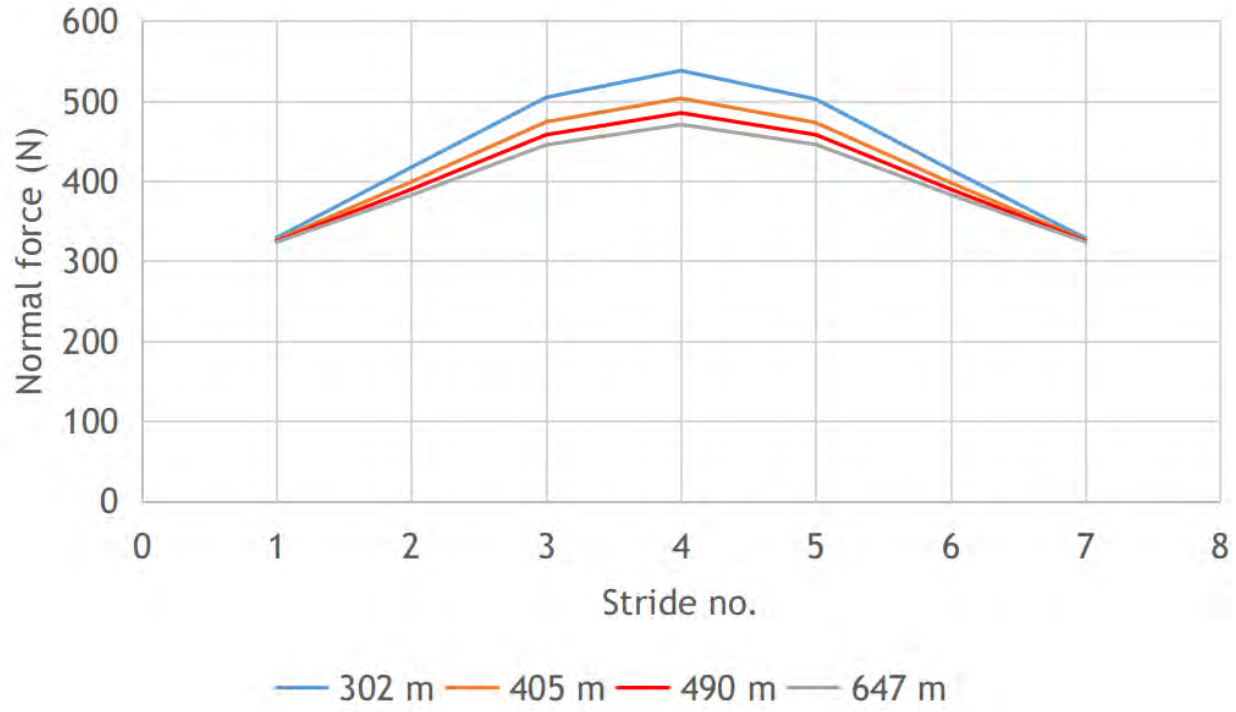

Figure 33: Normal reaction force versus stride number while approaching the catching pen by a greyhound for 302 m, 405 m, 490 m and 647 m starting distances at Mandurah track.

[7]When modelled with a greyhound mass of 32 kg.

[8]The slow down distance is the distance available to the greyhound for slowing down. For the Mandurah greyhound track this is approximately 42 m. It is different to the distance from the Finish Post to the gate which for Northam is approximately 74 m.

3.4 Northam greyhound track

Figure 34 depicts a diagram of the Northam track catching pen where the red line indicates the catching pen gate. The total area inside the catching pen is around 54 m. The length of the catching pen gate is approximately 7 m and being wider than track width. The entrance to the Mandurah track catching pen is narrow measuring approximately 5 m. The catching pen is located approximately 115 m after the Finish Post. This distance allows adequate time for the greyhounds to slow down.

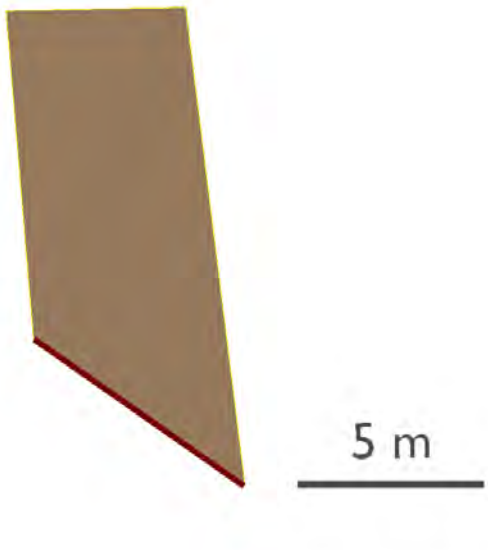

Figure 34: Catching pen at Northam track.

As can be seen from Figure 35, the maximum normal reaction force due to a greyhound's decreasing speed as they approach the catching pen occurred for the 297 m starting distance while the minimum was for the 721 m starting distance. These forces which are due to negative acceleration of a greyhound are more than double of greyhound's nominal weight[9] when they are stationary. Also, compared to Cannington and Mandurah tracks the forces required for greyhounds to slow down at Northam track is significantly higher. This is due to the estimated shorter slow down distance[10] which is available at Northam track.

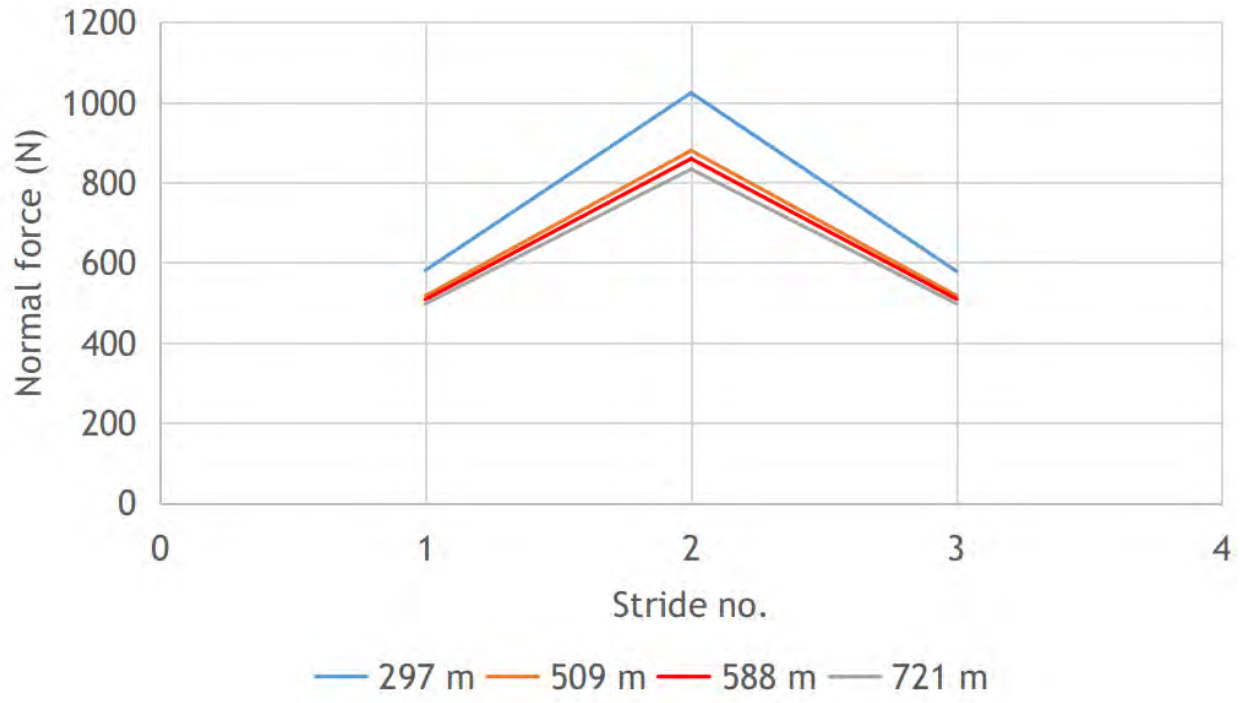

Figure 35: Normal reaction force versus stride number while approaching the catching pen by a greyhound for 297 m, 509 m, 588 m and 721 m starting distances at Northam track.

[9]When modelled with a greyhound mass of 32 kg.

[10]The slow down distance is the distance available to the greyhound for slowing down. For the Northam greyhound track this is approximately 22 m. It is different to the distance from the Finish Post to the gate which for Northam is approximately 115 m.