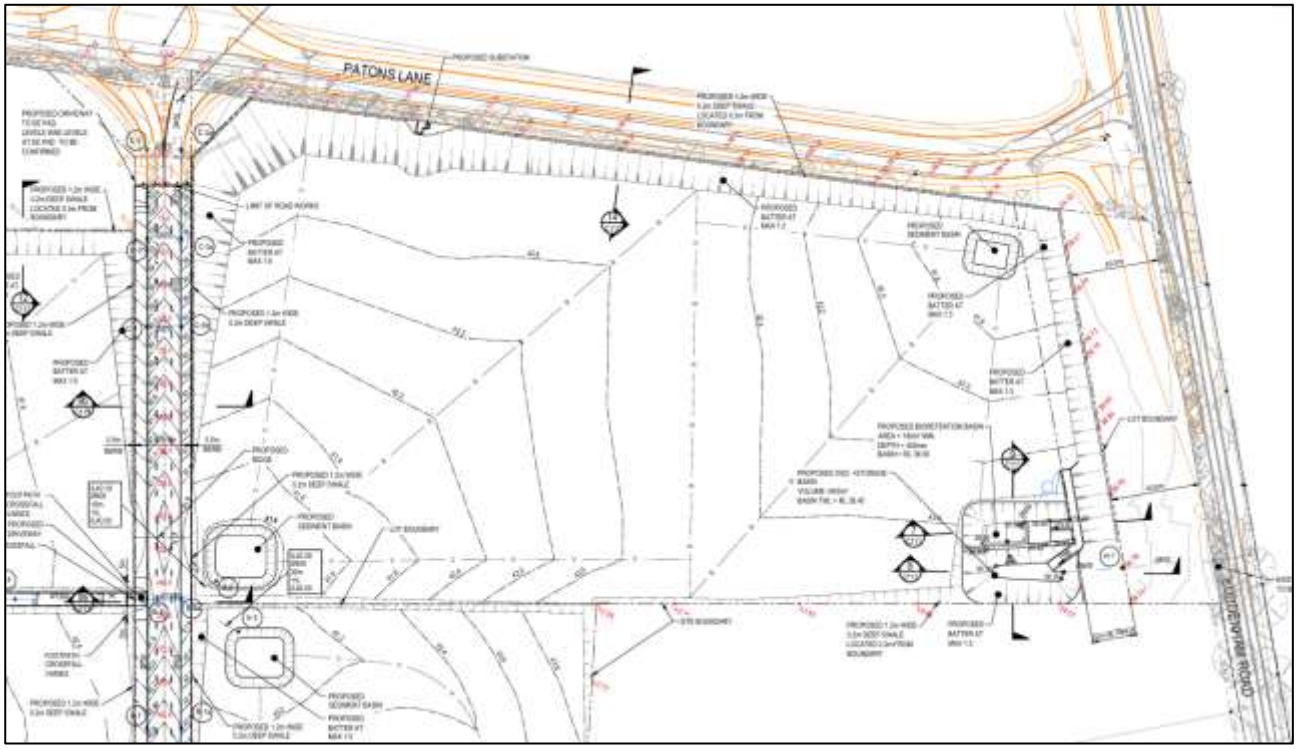
TRAFFIC ENGINEERING

# Arcadis

# Alspec Industrial Business Park, Orchard Hills

## Detailed design road safety audit



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# Arcadis

# Alspec Industrial Business Park, Orchard Hills

## Detailed design road safety audit

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**Report No** ARC-PROJ-0009-01 DD RSA ALSPEC INTERNAL REV 1

**Date** 20/8/2024

This report has been prepared for Arcadis.

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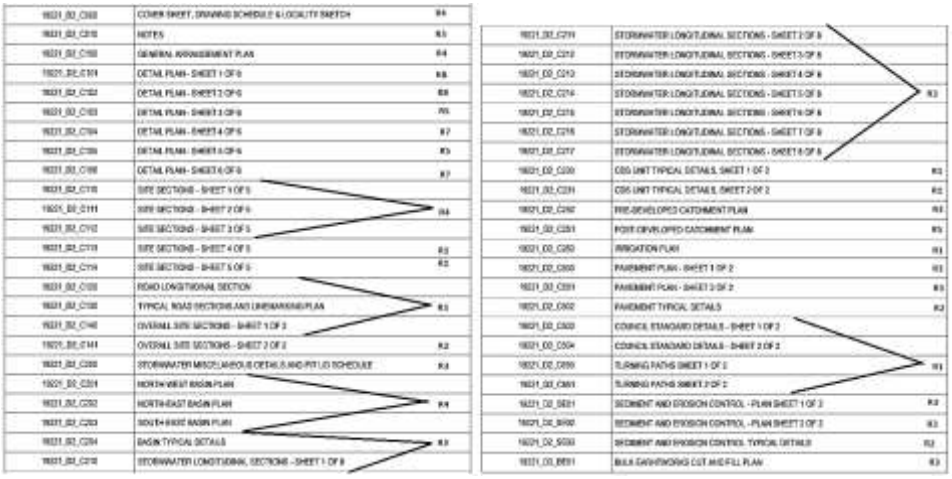
## Appendices

# 1 Introduction

## 1.1 Project and audit details

Details of the audit have been summarised in Table 1.

**Table 1 Details of the road safety audit.**

| | |
|---|---|
| **Audited project** | Internal road associated with the Alspec Industrial Business Park, off Patons Lane, Orchard Hills. |
| **Client/ contact** | Lynda Cahill<br>Senior Civil Engineer<br>Arcadis Australia Pacific<br>Level 16/ 580 George Street<br>Sydney NSW 2000<br>Ph: (02) 8907 9045<br>E: Lynda.Cahill@arcadis.com |
| **Audit type** | *Detailed design* road safety audit. |
| **Purpose** | A *detailed design* road safety audit was required to identify potential safety issues for consideration prior to the construction phase. This was also requested to fulfil a request from Penrith City Council. |
| **Background** | The proposed Alspec Industrial Business Park is situated on the lands at 221-227 and 289-317 Luddenham Road, Orchard Hills. This business park will be ultimately accessed via two connection points – (i) a northern connection via the Luddenham Road/ Patons Lane intersection and an internal road stemming off the southern side of Patons Lane and (ii) a southern connection via a *left-in-left-out* T intersection with Luddenham Road.<br>A *detailed design* road safety audit was requested of the internal road that will connect Patons Lane at the northern end of the business park, to the southern connection point at Luddenham Road. Due to the planned staging of the project, the internal road, as presented in the detailed design would initially consist of a cul-de-sac terminal at its southern end, with no connection to Luddenham Road. The cul-de-sac would be a temporary u-turn point so that vehicles can head north and egress via Patons Lane. As a subsequent stage, the internal road would be extended and the *left-in-left-out* T intersection constructed (as the southern connection point).<br>Penrith City Council requested a road safety audit of the proposed internal road. As such, this report details the processes and findings associated with this road safety audit. |
| **Scope of project/ audit** | The following designs were issued to the audit team and were regarded as the auditable materials:<br>  <br>The revision numbers for each plan are marked by the prefix “R”. |
| **Audit team details** | Damien Chee, DC Traffic Engineering (level 3 and lead auditor – RSA-02-0094).<br>Linda Chee, DC Traffic Engineering (level 2 road safety auditor - RSA-02-1069). |

| | |
|---|---|
| **Audit methodology** | The audit was undertaken using the following methodology:<br>▪ Formal review of plans on 18/8/2024.<br>▪ A site inspection was carried on 19/8/2024 out for familiarisation.<br>▪ The road safety audit findings have been documented in this report in accordance with the NSW Centre for Road Safety's *Guidelines for Road Safety Audit Practices* (2011).<br>▪ This report includes completed *checklist 3 –detailed design stage audit* as sourced from the Austroads *Guide to Road Safety Part 6A: Implementing Road Safety Audits*. |
| **Material supplied** | See *scope of project/ audit*. |

## 1.2 Responding to the audit report

Road safety audits provide the opportunity to highlight potential road safety problems and have them formally considered by the project manager in conjunction with all other project considerations.

The responsibility for the project rests with the project manager, not with the auditor. The project manager is under no obligation to accept the audit findings. Also, it is not the role of the auditor to agree to, or approve the project manager's responses to the audit.

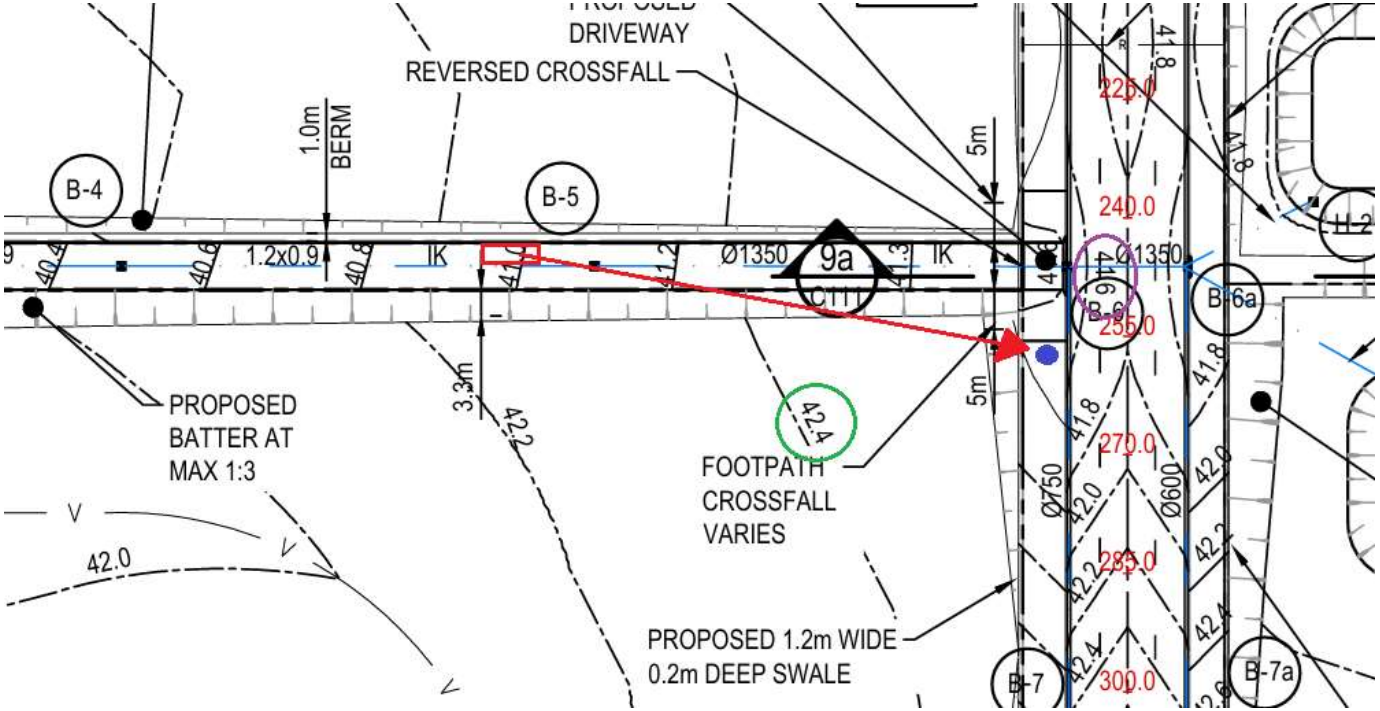
## 1.3 Previous audits

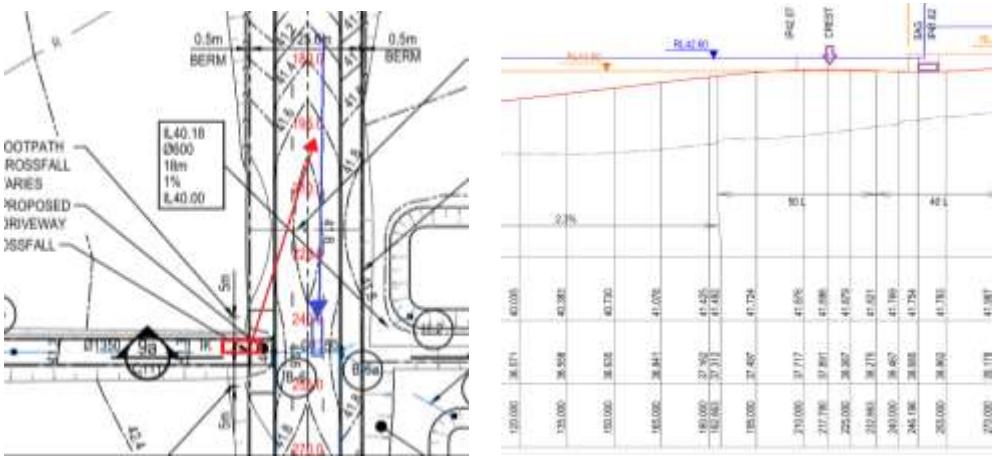
There were no previous audits of direct relevance to the design that were issued to the audit team.

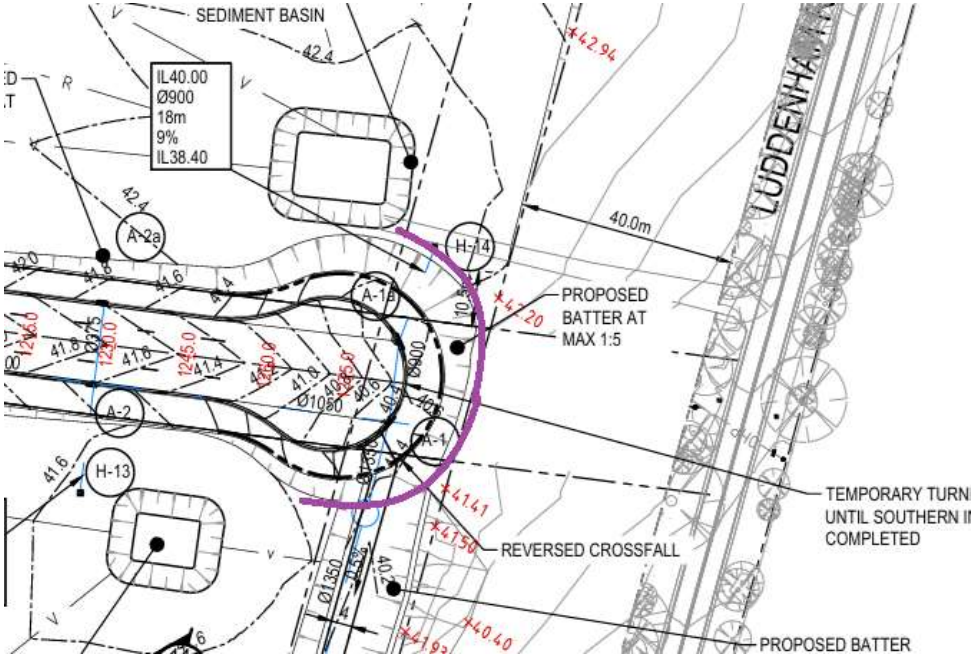
# 2 Safety audit findings

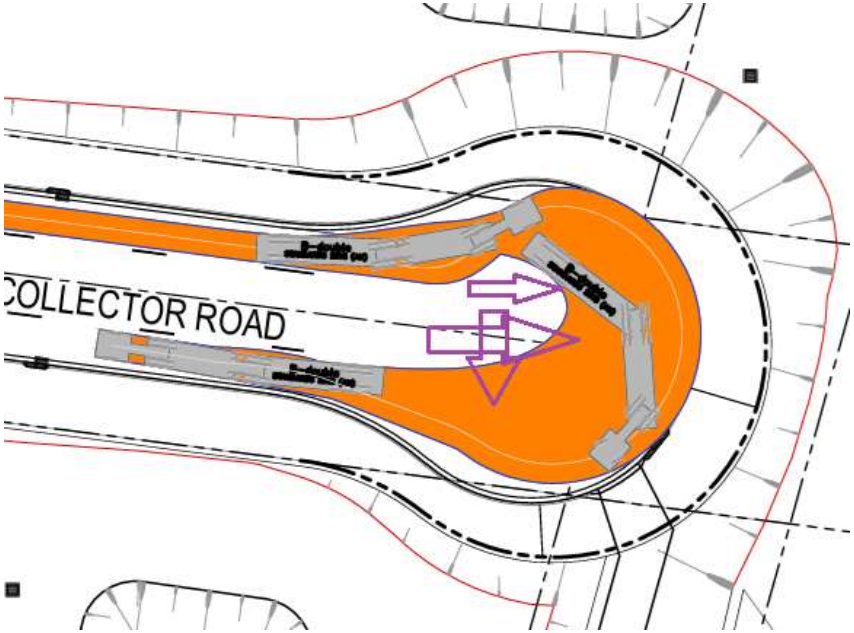
The road safety audit findings are presented in Table 2.

**Table 2 Road safety audit findings.**

| Ref | Location | Road safety audit finding | Priority |
|---|---|---|---|
| 1 | Outbound vehicle movements from the driveway at chainage 245, and visibility to persons on the footpath. | The design indicates that the southern side of this driveway will have a batter with slopes up to 1V:3H. Furthermore, since the width of the batter will be 3.3m, this implies that its height could be up to 1.1m. As such, eastbound drivers on this driveway could have restricted view to the portion of the footpath to the south of the intersection with Collector Road. Any pedestrians/ cyclists using this footpath and approaching from the blue dot could be hidden from the view of the outbound driver. This could increase the risk of *vehicle-pedestrian* or *vehicle-bicycle* crashes.<br>The sight line is further constrained since the driveway approaches from a lower grade and goes uphill towards Collector Road.<br>  <br><br>***Above:*** *The sight line from the driveway to the southern side of the Collector Road intersection (as marked by the red arrow) is likely to be obscured by the batter on the southern side.* | Medium |

| Ref | Location | Road safety audit finding | Priority |
|---|---|---|---|
| 2 | Impact of crest vertical curve on sight distances associated with the Collector Road intersection with driveway (chainage 245). | The design indicates that there will be a crest vertical curve (VC) on the Collector Road, with its apex at chainage 217. Using the long section profile and the change in grade, this vertical curve will have a K value of approximately 15.2 (ie. 2.3% grade change over 35m arc length between northern tangent point and crest (0% gradient point). In these respects, the following sight distances would be affected:<br>▪ The approximated K value of 15.2 (VC radius ~ 1520m) corresponds with a sight line of 82.5m from a 1.1m driver eye height to an object 0.2m high. This sight line corresponds to an operating speed of 65km/h (using formula in Section 5.3 of AGRD03). This is the threshold speed for *stopping sight distance* (SSD). Drivers that exceed the threshold speed are unlikely to have enough SSD to see, react, decelerate and come to a complete stop in response to a hazard. The most critical source or need to stop would be southbound drivers reacting to either (i) a stopped southbound right-turning vehicle in the road ahead that is waiting for a gap to turn right into the driveway or (ii) a vehicle that has emerged from the driveway and failed to observe a safe gap for entering the Collector Road. Measures may be needed for regulatory and physical control of speeds along this road, to ensure that the 65km/h threshold speed is not exceeded. NB. The SSD discussed above is based on a driver reaction of 2 seconds and a deceleration coefficient of 0.36.<br>▪ With the approximated VC radius of 1520m, this corresponds to a sight line of 102.3m from a driver eye height of 1.1m to an indicator light 0.65m above the ground. As such, the *minimum gap sight distance* (MGSD) from the driveway to the north would be 102.3m. For a critical gap of 5 seconds, this means the southbound vehicle cannot approach at speeds higher than 20.5m/s (74km/h). That is, if the southbound vehicle exceeds this speed, the outbound right-turning driver from the driveway will not have a sufficient sight line to achieve a 5-second critical gap. This could increase the risk of *cross traffic* crashes due to poor gap acceptance. Although there is a low probability of southbound vehicles exceeding this speed, the location of the driveway, immediately beyond the sight limited crest VC is still undesirable. An alternative location should be considered, or the crest VC should be flattened.<br>  <br>***Left:*** *The driveway at chainage 245 is positioned immediately south of a sight-limited crest vertical curve. This will create limitations on MGSD (red car and red sight line arrow to the north) as well as SSD (blue sight line arrow to stopped right-turning blue vehicle).* ***Right:*** *The long section profile showing the crest apex at chainage 117 and the location of the driveway at the purple rectangle.* | Medium |

| Ref | Location | Road safety audit finding | Priority |
|---|---|---|---|
| 3 | Unauthorised vehicle, bicycle, motorcycle and pedestrian movements between the cul-de-sac terminal and Luddenham Road. | Under the initial opening plan of the site and prior to the southern intersection/ connection being constructed, the southern end of Collector Road will terminate as a cul-de-sac and turning bell. All inbound vehicles would need to perform a u-turn and head back north to the Patons Lane exit. Whilst this temporary road terminus and cul-de-sac is in place, there would be a temptation for road users to cross the unformed land as a short cut to and from Luddenham Road. This is particularly if the outbound vehicle is heading to the south, as well as during peak periods when there is queuing/delays at the Luddenham Road/ Patons Lane intersection.<br>Furthermore, the ground conditions as presented in the design (ie. 1V:5H batter slopes) as well as when observed during the site inspection indicate that this ground is traversable.<br>Due to the temptation for such short cuts, consideration should be given to temporary measures to restrict such illegal movements. This could include temporary barriers or chainwire mesh fencing lining the outside of the cul-de-sac. The purple line is an indicative extent of such temporary barriers to movement.<br>  <br><br>***Above:*** *Consideration should be given to a temporary barrier or fence, to prevent illegal (short-cut) movements between the cul-de-sac terminal and Luddenham Road, during the interim period until the southern connection is completed.* | Low |

| Ref | Location | Road safety audit finding | Priority |
|---|---|---|---|
| 4 | U-turn movements by trucks at cul-de-sac terminal. | The swept path model below demonstrates that the temporary cul-de-sac and terminal at the southern end of the project will be able to cater for single-point u-turns by B-doubles. However, the rear right-hand wheels are likely to pivot and scrub, rather than perform a smooth, rolling and turning action. This is particularly since the rear axles tend to be closely spaced and the trailer is not capable of being rotated/ turned on such a sharp angle. The high pivot/ scrubbing action would generate the following issues:<br>▪ High shear forces on the pavement with risks of pavement shoving, stretching and cracking.<br>▪ Polishing of the pavement with a loss of micro-texture (essential for skid resistance/ traction).<br>▪ High shear forces on the pavement with accelerated wear of tyres, including residual rubber and debris on the pavement.<br>▪ Tyre-to-pavement noise.<br>As a side note, the design shows that there will be two traffic lanes in each direction. Whilst this may be necessary under the ultimate configuration when this road connects with Luddenham Road, under the interim arrangement, there should only be one lane feeding into the cul-de-sac turning head, and one lane departing from it. The linemarking layout should not allow for two lanes to concurrently feed traffic into the turning head as this would create *side-swipe* conflicts. A 2-1 lane merge should be implemented in the eastbound direction under the interim layout.<br>  <br><br>***Above:*** *The u-turning truck is likely to impart high shear stresses on the pavement (particularly the pivoting action of its rear right-tyres). This is likely to damage the pavement and the vehicle tyres.* | Low |

# 3 Concluding statement

*DC Traffic Engineering* has undertaken a *detailed design* road safety audit of this project in accordance with the methodology outlined in Section 1 of this report.

Issues identified have been noted in this report for the Project Manager to review, assess, and where appropriate, make the necessary recommendations to improve safety.

Damien Chee
Audit Team Leader
DC Traffic Engineering Pty Ltd

# Appendix A

# Road Safety Audit Checklist

| Checklist questions | Comments |
|---|---|
| **3.1 General topics** | |
| **3.1.1 Changes since previous audit**<br>▪ Do the conditions for which the scheme was originally designed still apply? (i.e. no significant changes to the surrounding network or area to be served, or traffic mix).<br>▪ Has the design of the project remained unchanged since previous audit (if any)? | There were no previous audit reports of direct relevance to this design that were issued to the audit team. |
| **3.1.2 Drainage**<br>▪ Will the new road drain adequately?<br>▪ Are the road grades and crossfalls adequate for satisfactory drainage?<br>▪ Are flat spots avoided or adequately dealt with at start/end of superelevation?<br>▪ Has the possibility of surface flooding been adequately addressed, including overflow from surrounding or intersecting drains and water courses?<br>▪ Is gully pit spacing adequate to limit flooding?<br>▪ Is pit grate design safe for pedal cycles? (i.e. gaps not parallel with wheel tracks)<br>▪ Will footpaths drain adequately? | Yes. |
| **3.1.3 Climatic conditions**<br>▪ Has the design taken into account weather records or local experience which may indicate a particular problem? (for example, snow, ice, wind, fog) | Yes. |
| **3.1.4 Landscaping**<br>▪ Will drivers be able to see pedestrians (and vice versa) past or over the landscaping?<br>▪ Will intersection sight lines be maintained past or over the landscaping?<br>▪ Will safety be adequate with seasonal growth? (for example, no obscuring of signs, shading or light effects, slippery surface, etc.)<br>▪ Will roadside safety be adequate when trees or plantings mature (no roadside hazard)?<br>▪ Has 'frangible' vegetation been used in possible run-off road areas? | Landscaping plans not provided. |
| **3.1.5 Services**<br>▪ Does the design adequately deal with buried and overhead services? (especially in regard to overhead clearances, etc.)<br>▪ Has the location of fixed objects/furniture associated with services been checked? (including any loss of visibility, position of poles, and clearance to overhead wires) | Services plans not issued. |

| Checklist questions | Comments |
|---|---|
| **3.1.6 Access to property and developments**<br>▪ Can all accesses be used safely?<br>▪ Is the design free of any downstream or upstream effects from accesses, particularly near intersections?<br>▪ Do rest areas and truck parking area have adequate sight distance at access points? | Issue raised with driveway at chainage 245. |
| **3.1.7 Emergencies, breakdowns, emergency and service vehicle access**<br>▪ Has provision been made for safe access and movements by emergency vehicles?<br>▪ Does the design and positioning of medians and vehicle barriers allow emergency vehicles to stop and turn without unnecessarily disrupting traffic?<br>▪ Have broken-down vehicles or stopped emergency vehicles been adequately considered?<br>▪ Is provision for emergency telephones satisfactory?<br>▪ Are median breaks on divided carriageways safely located? (i.e. frequency, visibility) | Yes. |
| **3.1.8 Future widening and/or realignments**<br>▪ If the scheme is only a stage towards a wider or dual carriageway is the design adequate to impart this message to drivers? (is the reliance on signs minimal/appropriate, rather than excessive?)<br>▪ Is the transition between single and dual carriageway (either way) handled safely? | Unknown. |
| **3.1.9 Staging of the scheme**<br>▪ If the scheme is to be staged or constructed at different times:<br>  ▪ are the construction plans and program arranged to ensure maximum safety?<br>  ▪ do the construction plans and program include specific safety measures, signing; adequate transitional geometry; etc. for any temporary arrangements? | Unknown. |
| **3.1.10 Staging of the work**<br>▪ If the construction is to be split into several subprojects, is the order safe? (i.e. the stages are not constructed in an order that creates unsafe conditions) | Unknown. |
| **3.1.11 Adjacent developments**<br>▪ Does the design handle accesses to major adjacent generators of traffic and developments safely?<br>▪ Is drivers' perception of the road ahead free of misleading effects of any lighting or traffic signals on an adjacent road?<br>▪ Has the need for screening against glare from lighting of adjacent property been adequately considered? | Sight limiting crest vertical curve identified and discussed. |

| Checklist questions | Comments |
|---|---|
| **3.1.12 Stability of cut and fill**<br>▪ Is the stability of batters satisfactory? (for example, no potential for loose material to affect road users) | Yes. |
| **3.1.13 Skid resistance**<br>▪ Has the need for anti-skid surfacing been considered where braking or good road adhesion is most essential? (for example, on gradients, curves, approaches to intersections and signals) | Potential pavement damage noted at cul-de-sac turning bell. |
| **3.2 Design issues (general*)*** | |
| **3.2.1 Geometry of horizontal and vertical alignment**<br>▪ Does the horizontal and vertical design fit together correctly?<br>▪ Is the vertical alignment consistent and appropriate throughout?<br>▪ Is the horizontal alignment consistent throughout?<br>▪ Is the alignment consistent with the function of the road?<br>▪ Is the design free of misleading visual cues? (for example, visual illusions, subliminal delineation like lines of poles) | Issues with one crest vertical curve noted, as well as the presence of a driveway on the downstream side of it. |
| **3.2.2 Typical cross-sections**<br>▪ Are lane widths, shoulders, medians and other cross section features adequate for the function of the road?<br>▪ Are the shoulder widths adequate for stationary vehicles and errant vehicles?<br>▪ Are median widths adequate for road furniture?<br>▪ Is superelevation consistent with the road environment?<br>▪ Is the width of traffic lanes and carriageways suitable in relation to:<br>  ▪ alignment?<br>  ▪ traffic volume?<br>  ▪ vehicle dimensions?<br>  ▪ the speed environment?<br>  ▪ combinations of speed and traffic volume?<br>▪ Are the shoulder crossfalls safe for vehicles to traverse?<br>▪ Are batter slopes drivable for cars, trucks?<br>▪ Are side slopes under structures appropriate?<br>▪ Have adequate facilities been provided for pedestrians and cyclists? | Yes. |
| **3.2.3 Effect of cross-sectional variation**<br>▪ Is the design free of undesirable variations in cross section design?<br>▪ Are crossfalls safe? (particularly where sections of existing highway have been used, there have been compromises to accommodate accesses, at narrowings at bridges, etc.)<br>▪ Are any curves with adverse crossfall within appropriate limits?<br>▪ Is superelevation provided and sufficient at all locations where required? | Yes. |

| Checklist questions | Comments |
|---|---|
| **3.2.4 Roadway layout**<br>▪ Are all traffic management features designed so as to avoid creating unsafe conditions?<br>▪ Is the layout of road markings and reflective materials able to deal satisfactorily with changes in alignment? (particularly where the alignment may be substandard)<br>▪ Is there adequate provision for overtaking?<br>▪ Are overtaking lanes provided where required and safely commenced and ended?<br>▪ Are overtaking requirements satisfactory?<br>▪ Is the design free of sunrise/sunset problems?<br>▪ Have public transport requirements been adequately catered for? | Issues raised. |
| **3.2.5 Shoulders and edge treatment**<br>▪ Are the shoulders likely to be safe if used by slow moving vehicles or cyclists?<br>▪ Are the following safety aspects of shoulder provision satisfactory?<br>  ▪ provision of sealed or unsealed shoulders<br>  ▪ width and treatment on embankments<br>  ▪ crossfall of shoulders | Yes. |
| **3.2.6 Effect of departures from standards or guidelines**<br>▪ Any approved departures from standards or guidelines:is safety maintained?<br>▪ Any hitherto undetected departures from standards: is safety maintained? | Yes. |
| **3.2.7 Visibility and sight distance**<br>▪ Are horizontal and vertical alignments consistent with visibility requirements?<br>▪ Has an appropriate design speed been selected for visibility requirements? | Restricted sight distances at the Collector Road intersection with a driveway at chainage 425. |
| **3.2.8 Environmental treatments**<br>▪ Has safety been considered in the location of environmental features? (for example, noise fences) | Yes. |
| **3.3 Alignment details** | |

| Checklist questions | Comments |
|---|---|
| **3.3.1 Visibility; sight distance**<br>▪ Are horizontal and vertical alignments consistent with the visibility requirements?<br>▪ Is the design free of sight line obstructions due to safety fences or barriers?<br>  ▪ boundary fences?<br>  ▪ street furniture?<br>  ▪ parking facilities?<br>  ▪ signs?<br>  ▪ landscaping?<br>  ▪ bridge abutments?<br>  ▪ parked vehicles in laybys or at the kerb?<br>  ▪ queued traffic?<br>▪ Are railway crossings, bridges and other hazards all conspicuous?<br>▪ Is the design free of any other local features which may affect visibility?<br>▪ Is the design free of overhead obstructions (for example, road or rail overpasses, sign gantries, overhanging trees) which may limit sight distance at sag curves?<br>▪ Has a clear headroom or a high vehicle detour been provided where necessary?<br>▪ Is visibility adequate at:<br>  ▪ any pedestrian, bicycle or cattle crossings?<br>  ▪ access roads, driveways, on and off ramps, etc.?<br>▪ Has the minimum sight triangle been provided at:<br>  ▪ entry and exit ramps?<br>  ▪ gore areas?<br>  ▪ intersections?<br>  ▪ roundabouts?<br>  ▪ other conflict points? | Issues raised at driveway intersection at chainage 425. |

| Checklist questions | Comments |
|---|---|
| **3.3.2 New/existing road interface**<br>▪ Have implications for safety at the interface been considered?<br>▪ Is the transition from old road to the new scheme satisfactory?<br>▪ If the existing road is of a lower standard than the new scheme, is there clear and unambiguous warning of the reduction in standard?<br>▪ Have the appropriate provisions for safety been made where sudden changes in speed are required?<br>▪ Is access or side friction handled safely?<br>▪ Does the interface occur well away from any hazard? (for example, a crest, a bend, a roadside hazard or where poor visibility/distractions may occur)<br>▪ If carriageway standards differ, is the change effected safely?<br>▪ Is the transition where the road environment changes (for example, urban to rural; restricted to unrestricted; lit to unlit) done safely?<br>▪ Has the need for advance warning been considered? | Temptation for illegal short-cut movements from cul-de-sac terminal to Luddenham Road during stage 1 layout. |
| **3.3.3 Readability of the alignment by drivers**<br>▪ Will the general layout, function and broad features be recognised by drivers in sufficient time?<br>▪ Will approach speeds be suitable and will drivers correctly track through the scheme? | Yes. |
| **3.3.4 Detail of geometric design**<br>▪ Are the design standards appropriate for all the requirements of the scheme?<br>▪ Is consistency of general standards and guidelines, such as lane widths and crossfalls, maintained? | Yes. |
| **3.3.5 Treatment at bridges and culverts**<br>▪ Is the geometric transition from the standard cross-section to that on the bridge handled safely? | NA. |
| **3.4 Intersections** | |

| Checklist questions | Comments |
|---|---|
| **3.4.1 Visibility to and at intersections**<br>▪ Are horizontal and vertical alignments at the intersection or on the approaches to the intersection consistent with the visibility requirements?<br>▪ Is the standard adopted for provision of visibility appropriate for the speed of traffic and for any unusual traffic mix?<br>▪ Will the design be free of sight line obstructions due to safety fences or barriers<br>  ▪ boundary fences?<br>  ▪ street furniture?<br>  ▪ parking facilities?<br>  ▪ signs?<br>  ▪ landscaping?<br>  ▪ bridge abutments?<br>  ▪ parked vehicles in laybys and at the kerb?<br>  ▪ queued traffic?<br>▪ Are railway crossings, bridges and other hazards all conspicuous?<br>▪ Is the design free of any other local features which may affect visibility? | Sight distance issues raised with driveway intersection at chainage 425. |
| **3.4.2 Layout**<br>▪ Are intersections and accesses adequate for all vehicular movements?<br>▪ Have the appropriate design vehicle and check vehicle been used for turning dimensions?<br>▪ Are swept paths accommodated for all likely vehicle types? (has the appropriate design vehicle been used?)<br>▪ Are intersections free of any unusual features which could affect road safety?<br>▪ Are pedestrian fences provided where needed? (for example, to guide pedestrians or discourage parking)<br>▪ Has pavement anti-skid treatment been provided where needed?<br>▪ Have islands and signs been provided where required?<br>▪ Vehicles which may park at or close to the intersection: can they do this safely or does this activity need to be relocated?<br>▪ Are safety hazards due to parked vehicles avoided? | Only one access was proposed in the design. All others will be created with development of individual lots.<br>Sight distance issues raised with the access at chainage 425.<br>Barrier needed in interim period to prevent unauthorised movements between cul-de-sac terminal and Luddenham Road. |

| Checklist questions | Comments |
|---|---|
| **3.4.3 Readability by drivers**<br>▪ Will the existence of the intersection and its general layout, function and broad features be perceived correctly and in adequate time?<br>▪ Are the approach speeds and likely positions of vehicles tracking through the intersection safe?<br>▪ Is the design free of misleading elements?<br>▪ Is the design free of sunrise or sunset problems which may create a hazard for motorists? | Sight distance issues raised at driveway at chainage 425. |
| **3.4.4 Detailed geometric design**<br>▪ Can the layout safely handle unusual traffic mixes or circumstances?<br>▪ Does any median or any island safely account for:<br>  ▪ vehicle alignments and paths?<br>  ▪ future traffic signals?<br>  ▪ pedestrian storage space and surface?<br>  ▪ turning path clearance?<br>  ▪ stopping sight distance to the nose?<br>  ▪ mountability by errant vehicles?<br>▪ Is adequate vertical clearance to structures provided? (for example, powerlines, shop awnings) | Yes. |
| **3.4.5 Traffic signals**<br>▪ Is the signal phasing/sequence safe?<br>▪ Is adequate time provided for traffic movements and pedestrian movements?<br>▪ Will the signal lanterns be visible? (for example, not obstructed by trees, poles, signs or large vehicles)<br>▪ Are lanterns for other approach directions adequately shielded from view?<br>▪ Are high-intensity signals and/or target boards provided if likely to be affected by sunrise/sunset?<br>▪ Does the alignment (vertical and horizontal) provide satisfactory stopping sight distance to the intersection or back of queue?<br>▪ Are pedestrian facilities provided where they are required?<br>▪ Will approaching drivers be able to see pedestrians?<br>▪ Are partially or fully controlled turning phases provided where required?<br>▪ Are signal posts located where they are not an undue hazard?<br>▪ Are road markings for turning traffic satisfactory?<br>▪ Have adequate pedestrian phases been provided? | NA. |

| Checklist questions | Comments |
|---|---|
| **3.4.6 Roundabouts**<br>▪ Is adequate deflection provided to reduce approach speeds?<br>▪ If splitter islands are needed, are they adequate for sight distance, length, pedestrian storage, etc.?<br>▪ Is the central island prominent?<br>▪ Can the appropriate design vehicle and check vehicle be accommodated?<br>▪ Are the central island details satisfactory? (delineation, mountability, conspicuousness)<br>▪ Can pedestrians be seen by drivers in sufficient time?<br>▪ Can pedestrians determine whether vehicles are turning? (no obstructions to sight lines)<br>▪ Are direction markings in approach lanes provided where required?<br>▪ Is the lighting adequate? | NA. Outside scope of this design package and audit. |
| **3.4.7 Other intersections**<br>▪ Has the need for kerbed or painted islands and refuges been considered?<br>▪ Do intersections have adequate queue length/storage for turning movements (including in the centre of a staggered intersection)? | Yes. |
| **3.5 Special road users** | |
| **3.5.1 Adjacent land**<br>▪ Are all accesses to and from adjacent land/properties safe?<br>▪ Have the special needs of agriculture and stock movements been considered? | Only one access was presented in the design. All others will be proposed with individual lot development. |

| Checklist questions | Comments |
|---|---|
| **3.5.2 Pedestrians**<br>▪ Can pedestrians cross safely at:<br>  ▪ intersections?<br>  ▪ signalised and pedestrian crossings?<br>  ▪ refuges?<br>  ▪ kerb extensions?<br>  ▪ bridges and culverts?<br>  ▪ other locations?<br>▪ Is each crossing point satisfactory for:<br>  ▪ visibility, for each direction?<br>  ▪ use by the disabled?<br>  ▪ use by the elderly?<br>  ▪ use by children/schools?<br>▪ Is pedestrian fencing on reservations and medians provided where required for each crossing?<br>▪ Is fencing adequate on freeways?<br>▪ Are pedestrians deterred from crossing roads at unsafe locations?<br>▪ Are pedestrian related signs appropriate and adequate?<br>▪ Is width and gradient of pedestrian paths, crossings, etc. satisfactory?<br>▪ Is surfacing of pedestrian paths, crossings, etc.satisfactory?<br>▪ Have dropped kerbs been provided for each crossing?<br>▪ Have channels and gullies been avoided at each crossing?<br>▪ Is lighting satisfactory for each crossing?<br>▪ Are crossings sited to provide maximum use?<br>▪ Is avoidance of a crossing unlikely? (for example, by more direct but less safe alternative) | Visibility to pedestrians on southern side of driveway at chainage 425 could be compromised by batter. |
| **3.5.3 Cyclists**<br>▪ Have the needs of cyclists been considered:<br>  ▪ at intersections (particularly roundabouts)?<br>  ▪ especially on higher speed roads?<br>  ▪ on cycle routes and crossings?<br>  ▪ at freeway entry and exit ramps?<br>▪ Are shared cycleway/footway facilities (including subways and bridges) safe and adequately signed? | Temptation to make short cuts from cul-de-sac terminal to Luddenham Road and vice versa. |

| Checklist questions | Comments |
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| **3.5.4 Motorcyclists**<br>▪ Has the location of devices or objects that might destabilise a motorcycle been avoided on the road surface?<br>▪ Is the roadside clear of obstructions where motorcyclists may lean into curves?<br>▪ Will warning or delineation be adequate for motorcyclists?<br>▪ Has barrier kerb been avoided in high-speed areas?<br>▪ In areas more likely to have motorcycles run off the road is the roadside forgiving or safely yielded?<br>▪ Are all unnecessary poles, posts and devices removed or appropriately shielded?<br>▪ Are drainage pits and culverts traversable by motorcycle? | Temptation to make short cuts from cul-de-sac terminal to Luddenham Road and vice versa. |
| **3.5.5 Equestrians and stock**<br>▪ Have the needs of equestrians been considered, including the use of verges or shoulders and rules regarding the useof the carriageway?<br>▪ Can underpass facilities be used by equestrians/stock? | NA. |
| **3.5.6 Freight**<br>▪ Have the needs of truck drivers been considered, including turning radii and lane widths?<br>▪ Have the needs of freight transport been considered, adequately signed and catered for? | Pivoting and scrubbing of pavement by high angled turning truck at cul-de-sac turning bell. |
| **3.5.7 Public transport**<br>▪ Have the needs for public transport been considered, adequately signed and catered for?<br>▪ Have the needs of public transport users been considered?<br>▪ Have the manoeuvring needs of public transport vehicles been considered?<br>▪ Are bus stops well positioned for safety? | NA. |
| **3.5.8 Road maintenance vehicles**<br>▪ Have the needs of road maintenance vehicles been considered, adequately signed and catered for?<br>▪ Can maintenance vehicles be safely located? | Yes. |
| **3.6 Lighting, signs and delineation** | |

| Checklist questions | Comments |
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| **3.6.1 Lighting**<br>▪ Has lighting been adequately provided where required?<br>▪ Is the design free of features which interrupt illumination? (for example, trees or overbridges)<br>▪ Is the design free of lighting poles that would present a fixed roadside hazard?<br>▪ Are frangible or slip-base poles to be provided?<br>▪ Ambient lighting: if it creates special lighting needs, have these been satisfied?<br>▪ Is the lighting scheme free of confusing or misleading effects on signals or signs?<br>▪ Does the lighting adequately illuminate crossings, nearby paths, refuges, etc.?<br>▪ Are all gore areas adequately illuminated?<br>▪ Are all merge areas adequately illuminated?<br>▪ Is the scheme free of any lighting black patches?<br>▪ If there are locations with accident problems that are<br>▪ known to be amenable to treatment with improved lighting, has this lighting been provided? | Lighting plans not issued. |
| **3.6.2 Signs**<br>▪ Are signs appropriate for their location?<br>▪ Are signs located where they can be seen and read in adequate time?<br>▪ Will signs be readily understood?<br>▪ Are signs appropriate to the driver's needs? (for example, direction signs, advisory speed signs, etc.)<br>▪ Are signs located so that drivers' sight distance is maintained?<br>▪ Are signs located so that visibility is maintained:<br>  ▪ to/from accesses and intersecting roads?<br>  ▪ to/from pedestrians and important features on the road?<br>▪ Have the consequences of vehicles striking signposts been considered?<br>▪ Are sign supports out of the clear zone?<br>▪ If not, are they:<br>  ▪ frangible?<br>  ▪ shielded by barriers (e.g. guard fence, crash cushions)?<br>▪ Has an over-reliance on signs (in lieu of adequate geometric design) been avoided?<br>▪ Are signs on the new scheme consistent with those on the adjoining section of road (or will the previous signs need to be upgraded)? | Signage plan was only preliminary, not detailed. |

| Checklist questions | Comments |
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| **3.6.3 Marking and delineation**<br>▪ Are markings (lines, arrows, etc.) consistent with standard markings?<br>▪ Have any locations where standard markings might be confusing or misread been identified and treated in a way which considers road users' likely responses?<br>▪ Are barrier lines (no overtaking) provided where required?<br>▪ Are raised retroreflective pavement markers (RRPMs) provided where necessary?<br>▪ Are curve warning signs, advisory speed plates or chevron alignment markers provided where required?<br>▪ Are markings on the new scheme consistent with those on the adjoining section of road (or will the previous markings need to be upgraded)?<br>▪ Are diagonal markings or chevrons painted where required?<br>▪ Will markings and delineation be visible at night-time?<br>▪ Will markings and delineation be visible in wet weather?<br>▪ Has the need for profiled (audible) line marking been considered?<br>▪ Have both high and low-beam cases been considered?<br>▪ Are guide posts of the frangible type? | Linemarking plan was only preliminary, not detailed. |
| **3.7 Physical objects** | |
| **3.7.1 Median barriers**<br>▪ Have median barriers been considered and properly detailed?<br>▪ Have all design features that require special attention (for example, end treatments) been considered? | NA. |
| **3.7.2 Poles and other obstructions**<br>▪ Are all poles located well away from moving traffic?<br>▪ Have frangible or breakaway poles been included where required?<br>▪ Are median widths adequate to accommodate lighting poles or trees?<br>▪ Is the position of traffic signal controllers and other service apparatus satisfactory?<br>▪ Is the roadside clear of any other obstructions that may create a safety hazard?<br>▪ Have all necessary measures been taken to remove, relocate or shield all hazards?<br>▪ Can roadside drains and channels be safely traversed by any vehicle that runs off the road? | Services plan not issued. |

| Checklist questions | Comments |
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| **3.7.3 Crash barriers**<br>▪ Are crash barriers provided where necessary and properly detailed? (for example, at embankments, structures, trees,<br>▪ poles, drainage channels, bridge piers, gore areas) Is the crash barrier safe? (i.e. unlikely to create a danger for road users including pedestrians, cyclists, motorcyclists, etc.)<br>▪ Are the end conditions of the crash barrier safe and satisfactory?<br>▪ Is the guard fence designed according to standards for:<br>  ▪ end treatments?<br>  ▪ anchorages?<br>  ▪ post spacing?<br>  ▪ block outs?<br>  ▪ post depth?<br>  ▪ rail overlap?<br>  ▪ stiffening at rigid obstacles?<br>▪ Is all guard fence necessary? (i.e. what it shields is a greater hazard than the fence)<br>▪ Where pedestrians and cyclists travel behind guard fence, is the rear of the fence safe for them? | NA. |
| **3.7.4 Bridges, culverts and causeways/floodways**<br>▪ Are bridge barriers and culvert end walls safe regarding:<br>  ▪ visibility?<br>  ▪ ease of recognition?<br>  ▪ proximity to moving traffic?<br>  ▪ the possibility of causing injury or damage?<br>  ▪ collapsible or frangible ends?<br>  ▪ signs and markings?<br>  ▪ connection of crash barriers?<br>  ▪ roadside hazard protection?<br>▪ Is the bridge railing at the correct level and strong enough?<br>▪ Is the shoulder width on the bridge the same as on the adjacent road lengths?<br>▪ Is safe provision made for non-vehicular traffic over structures? (for example, pedestrians, pedal cycles, horses/stock, etc).<br>▪ Are all culvert end walls (including driveway culverts) drivable or outside the clear zone?<br>▪ Have causeways/floodways etc. been given correct signing and adequate sight distance? | Yes. |
| **3.8 Additional questions to be considered for development proposals** | Questions omitted as the works are external to the development. |
| **3.9 Any other matter** | |

| Checklist questions | Comments |
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| **Safety aspects not already covered**<br>▪ Is the road able to safely handle oversize vehicles, or large vehicles like trucks, buses, emergency vehicles, road maintenance vehicles?<br>▪ If required, can the road be closed for special events in a safe manner?<br>▪ If applicable, are special requirements of scenic or tourist routes satisfied?<br>▪ Have all unusual or hazardous conditions associated with special events been considered?<br>▪ Have all other matters which may have a bearing on safety been addressed? | No. |