**Date: August 26nd, 2024**

**Project: NCDOT RP 2023-20 (Three-phase Intersections)**

**Title: 20 Flag Assessment for Three-phase Alternative Intersections**

**(Part A: Hypothetical Scenarios)**

**(Part B: Case Study Sites)**

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Figure 1. Pedestrian paths of (a) Conventional; (b) MUT 1; (c) MUT 2; (d) Seven-phase (Type I); (e) Seven Phase (Type II); (f) Reverse RCI; (g) Partial CFI; (h) Redirect L&T (Type I); (i) Redirect L&T (Type II); (j) Thru-cut (Standard crosswalk); (k) Thru-cut (Barnes dance Type I); (l)Thru-cut (Barnes Dance Type II); (m) Single Quadrant; (n) RCI; (o) CFI/MUT Combo; (p) Redirect 2L&T; (q) Offset Thru-cut (Type I); (r) Offset Thru-cut (Type II); (s) Offset T; (t) Two-phase MUT

**Part A: Hypothetical Scenarios**

The following paragraphs summarize the pedestrian performance of fourteen alternative (14) alternative intersections and a conventional intersection. Based on the different variations in the configurations of the pedestrian paths, a total of twenty (20) intersections were assessed. The first part of this pedestrian performance analysis involved the assessment of pedestrian safety using the NCHRP Report 948’s 20-design flag assessment method. As the last part of this evaluation, pedestrian simulation modeling was done to determine the pedestrian travel times at intersections. Figure 1 presents the pedestrian paths of all the intersections with their different variations analyzed in this evaluation.

**NCHRP report 948’s 20-flag** **assessment for pedestrians and bicyclists**

The NCHRP developed the evaluation technique known as the "20 design flags" to analyze intersection design elements, prioritizing pedestrian and bicyclist safety [1]. Through this approach, designers can optimize intersection safety during project development. This method enables comparison between different intersection designs by utilizing yellow and red flag thresholds, which consider various factors and evaluate the percentage of flags. Note that red flags include variables impacting safety, while yellow flags include variables that may not pose an immediate risk.

This section presents the results of the evaluation of twenty (20) intersection models utilizing the 20-flag method. Among the twenty (20) models, four intersections have different crosswalk variations. These include the thru-cut standard crosswalk, which has a similar crosswalk orientation to the conventional intersection; the thru-cut barnes dance crosswalk Type I, which does not include a middle island on the minor road approach; and the thru-cut barnes dance crosswalk Type II, which includes middle islands on the minor approach. There are also the redirect L&T Type II and seven-phase Type II, which do not have crosswalks on the east leg of the intersection. The redirect L&T Type I and seven-phase Type I have crosswalks similar to those in a conventional intersection. Finally, there is the offset thru-cut Type I and offset thru-cut Type II with the main difference being the presence of middle islands on the offset thru-cut Type II minor road approaches. All the pedestrian path configurations of the analyzed intersections have been presented in Figure 1.

Thirteen design flags out of the 20 flags outlined in the NCHRP 948 report were used for the pedestrian safety assessment whereas sixteen design flags out of the twenty flags were utilized for the bicyclists’ safety assessment. This resulted in fifty-two (52) and sixty-eight (68) possible design flags, respectively, taking into consideration all four pedestrian and bicyclist movements for each of the design flags. Some assumptions were made during the completion of the 20 flags method as the assessed intersections were hypothetical models.

Flag #2 Uncomfortable/Tight Walking Environment

An effective walkway width of 5ft was assumed for traffic present on one side and 10ft for traffic present on both sides.

Flag #9 Undefined Crossing at Intersections

All crossings are marked.

Flag #11 Intersecting Driveways and Side Streets

This is not available because the model is not superimposed on a real-world site to determine the number of intersecting driveways and side streets. This can be updated when the model is superimposed on real-world sites.

Flag #12 Sight Distance for Gap Acceptance

The required sight distance for gap acceptance was implemented as part of the assumptions.

Flag #13 Grade Change

The percentage grade change is assumed to be less than 3%.

In the safety assessment of the bicyclists, it was assumed that the bicyclists had a shared path with pedestrians at crossings and a separate bike lane on the network.

Table 1 presents the results of the pedestrian and bicyclist assessment of the alternative intersections and the conventional intersection assessed based on the NCHRP report 948’s 20-flag analysis.

**Table 1. Pedestrian and bicyclist flag assessment of alternative intersections using 20-flag analysis.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Intersection Type** | **Pedestrian Flag Assessment** | | | **Bicyclist Flag Assessment** | | |
| **Yellow Flags** | **Red Flags** | **Flagged** | **Yellow Flags** | **Red Flags** | **Flagged** |
|
| Conventional | 4% | 15% | 19% | 21% | 24% | 44% |
| Partial CFI | 4% | 23% | 27% | 15% | 32% | 47% |
| CFI/MUT Combo | 4% | 15% | 19% | 19% | 21% | 40% |
| Redirect 2L&T | 4% | 15% | 19% | 21% | 19% | 40% |
| RCI | 15% | 8% | 23% | 21% | 18% | 38% |
| Reverse RCI | 15% | 15% | 31% | 18% | 24% | 41% |
| Offset T | 8% | 27% | 35% | 24% | 50% | 74% |
| Quadrant | 8% | 8% | 15% | 8% | 8% | 35% |
| MUT 1 | 8% | 8% | 15% | 24% | 18% | 41% |
| MUT 2 | 4% | 12% | 15% | 18% | 18% | 35% |
| Two-phase MUT | 8% | 8% | 15% | 24% | 18% | 41% |
| Redirect L&T (Type I) | 2% | 13% | 15% | 22% | 18% | 40% |
| Redirect L&T(Type II) | 2% | 12% | 13% | 16% | 15% | 31% |
| Thru-cut (standard crosswalk) | 4% | 12% | 15% | 21% | 18% | 38% |
| Thru-cut (Barnes dance Type I) | 8% | 12% | 19% | 24% | 18% | 41% |
| Thru-cut (Barnes dance Type II) | 8% | 19% | 19% | 21% | 18% | 38% |
| Seven-phase (Type I) | 4% | 19% | 23% | 26% | 21% | 47% |
| Seven-phase (Type 2) | 4% | 15% | 19% | 21% | 16% | 37% |
| Offset thru-cut (Type I) | 4% | 12% | 15% | 15% | 24% | 38% |
| Offset thru-cut (Type ii) | 4% | 12% | 15% | 15% | 24% | 38% |

Overall, the offset T exhibited the highest percentage of flags at 35% with 27% being red flags in the pedestrian assessment. This increase may be attributed to the two separate legs of the offset T, with each leg having a crosswalk in each direction of the intersection. This was followed closely by the reverse RCI with overall percentage flags of 31%. However, it had a relatively lower number of red flags of 15% compared to the offset T and the partial CFI. The partial CFI had the second-highest red flags at 23%. This may be attributed to the two free-flow northbound and southbound right turns which resulted in the non-intuitive motor vehicle movement (flag #3) and crossing yield or uncontrolled vehicle paths (flag #4). The MUT 1, two-phase MUT, thru-cut barnes dance Type 2, and the RCI all recorded a lower percentage of red flags at 8% with the quadrant recording the lowest overall percentage flagged at 15%.

The offset T in the assessment of the bicyclists showed the highest percentage flagged, with 50% being red flags, the highest among all the intersections assessed. This increase may be attributed to the two separate legs of the offset T, with each leg having a crosswalk in each direction of the intersection. Following closely is the partial CFI having 47% flagged with 32% red flags. Similar to the pedestrian assessment, this may be attributed to the two free-flow northbound and southbound right turns, resulting in the crossing yield or uncontrolled vehicle paths flag (flag #4). The redirect L&T (Type II) recorded the lowest number of flags at 31% with one of the lowest percentage of red flags at 15%. The lower number of yellow and red flags of the redirect L&T Type II may be attributed to the absence of a crosswalk at the east leg of the intersection. However, it must be noted that this is converted into a red flag for Flag #9—Undefined Crossings at Intersections—where the redirect L&T Type II falls short.

Tables 1 to 4 in Appendix A present the thirteen design aspects in the NCHRP 948 report and results for calculating identified red and yellow flags for the alternative intersections for pedestrian assessment. Figures 1 to 4 in Appendix A also summarize the percentages of the red and yellow flags computed for each model.

Tables 5 to 8 in Appendix A show the seventeen design aspects outlined in the NCHRP 948 report along with the outcomes of calculating red and yellow flags for all the alternative intersections during the bicyclists’ assessment. Figures 5 to 8 in Appendix A offer a concise overview of each model's computed percentages of red and yellow flags.

**Pedestrian Simulation Analysis**

This section provides a detailed analysis of the pedestrian performance across twelve (12) three-phase alternative intersections and a conventional intersection. To assess the pedestrian performance of the proposed alternative intersection designs in comparison to a conventional design, an extensive series of simulation scenarios was conducted to obtain pedestrian travel times.

Given that many of these alternative intersections have not yet been implemented in practice, simulation modeling provided a robust method for thoroughly evaluating each concept. PTV VISSIM (version 2024) was used to conduct pedestrian analysis, focusing on travel times. This analysis was facilitated by importing signal data from Synchro. Table 2 presents the input traffic volume per movement for each scenario included in this part of the research study.

Among the twelve models analyzed, the thru-cut design had three variations based on crosswalk orientation: thru-cut with a standard crosswalk, thru-cut with barnes dance crosswalk Type I, and thru-cut with barnes dance crosswalk Type II. The thru-cut barnes dance crosswalk Type 1 has no middle island on the minor road approach whereas the thru-cut barnes dance Type II has the minor crosswalks connected through the middle islands on the minor approach. Figure 1 shows all the configurations of the assessed intersections with their pedestrian paths.

Pedestrians were given the right of way in all simulation models. Each intersection quadrant was allocated 90 pedestrians per hour, who were evenly distributed along pedestrian paths from their origin to their destination within the quadrant. For pedestrians needing to cross diagonally to reach their destination, their movement was evenly split between two routes, using the adjacent quadrant as a midway point to streamline routing decisions. The pedestrian walking speeds were based on a range between 3.5 ft/sec and 9 ft/sec, as reported in an NCDOT project in 2014 [2]. Five desired speed distributions from the NCDOT [2] report were selected and used in the analysis, in conjunction with the relative pedestrian flow composition. Specifically, for a selected percentage of pedestrian composition moving at a desired speed, the distribution was set at 20%, 20%, 30%, 20%, and 10% for walking speeds of 3.5 fps, 4 fps, 5 fps, 6 fps, and 9 fps, respectively.

**Table 2: Input Traffic volume per movement (vehicles per hour) in each scenario**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Turning/Volume Case** | **Test** | **EB** | | | **WB** | | | **NB** | | | **SB** | | | **Total** |
| **Left Turn** | **Thru** | **Right Turn** | **Left Turn** | **Thru** | **Right Turn** | **Left Turn** | **Thru** | **Right Turn** | **Left Turn** | **Thru** | **Right Turn** |
| **Low Turning Traffic** | 1 | 80 | 1520 | 80 | 80 | 1520 | 80 | 20 | 200 | 20 | 40 | 400 | 40 | 4080 |
| 2 | 40 | 800 | 40 | 80 | 1600 | 80 | 20 | 200 | 20 | 40 | 400 | 40 | 3360 |
| **Moderate Turning Traffic** | 3 | 165 | 1330 | 165 | 165 | 1330 | 165 | 50 | 190 | 50 | 95 | 375 | 95 | 4175 |
| 4 | 90 | 740 | 90 | 180 | 1500 | 180 | 50 | 190 | 50 | 95 | 375 | 95 | 3635 |
| **High Turning Traffic** | 5 | 280 | 1120 | 280 | 280 | 1120 | 280 | 85 | 170 | 85 | 170 | 335 | 85 | 4290 |
| 6 | 165 | 665 | 165 | 335 | 1340 | 335 | 85 | 170 | 85 | 170 | 335 | 85 | 3935 |

Table 3 presents the average pedestrian travel times. The two-phase MUT, MUT 1, conventional, RCI, and thru-cut (standard crosswalk) designs exhibited relatively shorter travel times compared to the other intersections, with the two-phase MUT performing the best. The outstanding performance of the two-phase MUT may be attributed to the reduced number of phases compared to other alternative intersections and the conventional intersection. This reduction decreases the number of red intervals that a pedestrian has to experience, as compared to the three-phase intersections and the four-phase conventional intersection.

Among the three variations analyzed for the thru-cut intersection, the standard crosswalk orientation within the thru-cut design emerged as the most effective in terms of pedestrian travel time. This superior performance may be because, in the other variations, pedestrians must traverse longer distances, particularly when using diagonal crosswalks. These diagonal crosswalks often span a greater length compared to the traditional crosswalks positioned along the east and west legs of the standard thru-cut intersection.

The results also reveal that the thru-cut barnes dance crosswalk Type I configuration performed better than the thru-cut barnes dance crosswalk Type II configuration. Reviewing simulation animations, it was found that pedestrians can access the diagonal crosswalk to cross the major road in the presence of middle islands on minor approaches. Also, it is worth noting that the offset thru-cut design resulted in shorter travel times for pedestrians than thru-cut designs with barnes dance crosswalks. As a possible reason for this finding, the offset thru-cut’s signal phasing diagram increases green interval for pedestrians crossing minor roads. Also, pedestrians crossing the major road will experience slightly a shorter travel distance at the offset thru-cut intersection than thru-cut designs with diagonal crosswalks.

The relatively poor performance of the seven-phase intersection may be attributed to the longer cycle lengths and increased travel distances for pedestrians on the eastern side of the intersection. In other words, at the seven-phase intersection, the absence of a crosswalk on the east leg results in longer travel distances for some pedestrians.

**Table 3. Ranking of assessed intersections based on average travel time**

|  |  |  |
| --- | --- | --- |
| **Rank** | **Intersection Type** | **Average Travel Time( sec)** |
| 1 | Two-phase MUT | 43 |
| 2 | MUT 1 | 56 |
| 3 | Conventional | 58 |
| 4 | RCI | 60 |
| 5 | Redirect L&T (Type I) | 62 |
| 6 | Thru-cut (standard crosswalk) | 66 |
| 7 | Redirect L&T (Type II) | 68 |
| 7 | Reverse RCI | 68 |
| 8 | CFI/MUT combo | 70 |
| 8 | MUT 2 | 70 |
| 8 | Offset Thru-cut | 70 |
| 9 | Redirect 2L&T | 73 |
| 10 | Partial CFI | 81 |
| 11 | Thru-cut (Barnes dance-Type I)a | 82 |
| 12 | Seven-phase (Type II) | 88 |
| 13 | Thru-cut (Barnes dance-Type II)b | 94 |

a This type of Barnes dance crosswalk has no middle islands on the minor road approach

b This type of Barnes dance crosswalk has middle islands on the minor approach.

Table 4 provides an overview of intersections that feature free-flow crossings and the associated conflicting traffic volumes at these crossings. Out of all the intersections examined, only four are distinguished by their inclusion of free-flow crossings: the reverse RCI, partial CFI, redirect 2L&T, and the CFI/MUT combo.

It is noteworthy that, despite both the reverse RCI and partial CFI incorporating two free-flow crossings, their impact on pedestrian comfort and safety varies. The reverse RCI, while offering free-flow crossings, presents challenges for pedestrians due to the high volume of conflicting traffic from major right turns. In contrast, in the partial CFI, the conflicting traffic primarily originates from minor right turns, which generally results in fewer disruptions and a more predictable crossing experience for pedestrians.

**Table 4. Free –Flow crossings for Pedestrians in each Intersection**

|  |  |  |  |
| --- | --- | --- | --- |
| **Intersection Type** | **Free-Flow Crossing** | | |
|
|
| **N\*** | **L\*** | **V\*** |
| Conventional | 0 | 0 | 0 |
| Partial CFI | 2 | 2 | 73 |
| CFI/MUT Combo | 1 | 1 | 73 |
| RCI | 0 | 0 | 0 |
| MUT 1 | 0 | 0 | 0 |
| MUT 2 | 0 | 0 | 0 |
| Seven-Phase | 0 | 0 | 0 |
| Redirect 2L&T | 1 | 1 | 73 |
| Redirect L&T | 0 | 0 | 0 |
| Two-phase MUT | 0 | 0 | 0 |
| Offset Thru-cut | 0 | 0 | 0 |
| Thru-cut (standard crosswalk) | 0 | 0 | 0 |
| Thru-cut (Barnes dance-Type I | 0 | 0 | 0 |
| Thru-cut (Barnes dance-Type II) | 0 | 0 | 0 |
| Reverse RCI | 2 | 2 | 693 |

\*N=Number of crossings, \*L=Number of lanes crossed, C=Conflicting traffic volume (veh/hr)

**Part B: Case Study Sites**

**20 DESIGN FLAGS ASSESSMENT FOR PEDESTRIANS AND BICYCLISTS OF THREE PHASE ALTERNATIVE INTERSECTIONS ON THE CASE STUDY SITES**

The National Cooperative Highway Research Program (NCHRP) developed the evaluation technique known as the "20 Design Flags" to analyze intersection design elements, prioritizing pedestrian and bicyclist safety in the NCHRP 948 report. This approach allows designers to improve intersection safety for pedestrians and bicyclists during project development. By utilizing yellow and red flag thresholds, which consider various factors, and evaluating the percentage of flags, this method enables comparison between different intersection designs. Yellow flags represent a concern related to users’ comfort, while red flags represent a safety concern for pedestrians and bicyclists.

This document presents the results of evaluating sixteen alternative intersection models using the 20 Design Flags. Out of the 20 flags outlined in the NCHRP 948 report, thirteen were used for the pedestrian safety assessment, while sixteen were utilized for the bicyclists’ safety assessment. This resulted in fifty-two (52) and sixty-eight (68) possible design flags, respectively, considering all four pedestrian and bicyclist movements for each design flag.

Several assumptions were made during the completion of this 20 Design Flags assessment:

1. **Vehicle Turning Speed:** For flag 1 (motor vehicle right turns) and flag 10 (motor vehicle left turns), the vehicle turning speed was assumed to be less than 20 mph for all the intersections assessed. Although a speed of more than 20 mph might be expected for free-flow right-turn movements with larger curb radii, most drivers should have speeds below 20 mph on right turns at the eight intersections selected.
2. **Assessment of Flag 9 (Undefined Crossing at Intersections):** The conditions of the existing crossings for the conventional intersections were maintained for all the proposed alternative intersections at each assessed site.
3. **Bicyclist Safety Assessment:** It was assumed that bicyclists shared the use of paths with pedestrians at crossings and had a separate bike lane.

For this assessment, the case study sites were evaluated separately for pedestrian and bicyclist flags. Proposed three-phase alternative intersections were also evaluated for each site. Tables 1 to 16 show the pedestrian and bicycle flag assessments for Sites 1 to 8. Similarly, Figures 1 to 16 present summaries of the percentages of red and yellow flags computed for the conventional and each proposed alternative intersection model for Sites 1 to 8, respectively. Thirteen of the twenty flags were assessed for pedestrians only, and seventeen of the twenty flags were assessed for bicycle movements only.

Tables 1 provides a summary of how different intersection designs were evaluated across various sites for both pedestrians and bicyclists, focusing on the number and percentage of identified red flags. Conventional designs appeared frequently but did not consistently achieve top rankings, suggesting varying pedestrian safety concerns depending on specific intersection layouts.

MUT 1 and two-phase MUT consistently performed well across multiple sites, indicating fewer concerns related to pedestrian safety than other alternatives in many of the intersection sites. MUT 2 also demonstrated strong performance, often ranking second across different sites. It effectively manages pedestrian movements and potential conflicts compared to other designs assessed. For instance, in the analysis of pedestrian safety at sites 5 and 6, MUT 2 and MUT 1 intersections showed the lowest occurrence of red flags at 15% and 19%, respectively, in contrast to 27% at the conventional intersection. Assessing bicyclist safety, MUT 1 demonstrated a relatively superior performance with a 10% decrease in red flags compared to the conventional design. MUT 2 also showed improvement, with a 7% reduction compared to the conventional intersection.

Thru-cut designs with the Barnes Dance crosswalk generally showed higher rankings especially when compared with the conventional intersection and the thru-cut with the standard crosswalk design. For example, among the two types of thru-cut pedestrian walkways assessed for site 1, the Barnes Dance thru-cut performed better than the standard thru-cut, resulting in a 4% reduction in the percentage of red flags. The relatively shorter red times experienced by pedestrians using the Barnes Dance crosswalk thru-cut may be one reason for its better performance.

The other intersections designs including redirect L&T, seven-phase, redirect 2L&T, CFI/MUT Combo, partial CFI, and reverse RCI showed mixed results across sites.

These rankings emphasize the critical importance of prioritizing pedestrian and bicycle safety in intersection design. The MUT designs (two-phase MUT, MUT 1, and MUT 2) emerge as potentially safer options based on the Pedestrian Flag Assessment criteria. However, adjustments or enhancements may be necessary for other designs to enhance safety outcomes while ensuring efficient traffic flow and pedestrian protection. A comprehensive analysis has been provided as an attached appendix (Appendix B) to this document.

**Table 1. Ranking of Pedestrian Flag Assessment of Proposed Alternative Intersections for Each Site**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Rank** | **Site1** | **Site 2** | **Site 4** | **Site 5 and 6** | **Site 7** | **Site 8** |
| 1 | Two-Phase MUT | Conventional | MUT 1 | MUT 2 | Thru-cut | Conventional |
| 2 | MUT 1 | Redirect L&T | MUT 2 | MUT 1 | Conventional | CFI/MUT Combo |
| 3 | MUT 2 | Seven Phase | Two Phase MUT | Conventional |  | CFI |
| 4 | Seven Phase |  | Redirect 2L&T |  |  |  |
| 5 | Thru-Cut (Barnes Dance) |  | Conventional |  |  |  |
| 6 | Conventional |  | CFI/MUT Combo |  |  |  |
| 7 | Thru-cut (Standard) |  | Partial CFI |  |  |  |
| 8 | Redirect L&T |  |  |  |  |  |
| 9 | Reverse RCI |  |  |  |  |  |
| **Ranking of Bicyclists Flag Assessment of Proposed Alternative Intersection for Each Site** | | | | | | |
| **Rank** | **Site1** | **Site 2** | **Site 4** | **Site 5 and 6** | **Site 7** | **Site 8** |
|  | Two-Phase MUT | Conventional | MUT 1 | MUT 1 | Thru-cut | Conventional |
| 1 | MUT 1 | Redirect L&T | MUT 2 | MUT 2 | Conventional | CFI/MUT Combo |
| 2 | MUT 2 | Seven Phase | Two Phase MUT | Conventional |  | CFI |
| 3 | Seven Phase |  | Redirect 2L&T |  |  |  |
| 4 | Thru-cut (Barnes Dance) |  | Conventional |  |  |  |
| 5 | Conventional |  | CFI/MUT Combo |  |  |  |
| 6 | Reverse RCI |  | Partial CFI |  |  |  |
| 7 | Redirect L&T |  |  |  |  |  |
| 8 | Thru-cut (Standard) |  |  |  |  |  |

**Reference**

[1] National Cooperative Highway Research Program (NCHRP). Guide for pedestrian and bicyclist safety at alternative and other intersections and interchanges, 2021. National Acadmies Press.

[2] J. E. Hummer *et al.*, “Pedestrian and bicycle accommodations on superstreets.,” FHWA/NC/2012-13, Jan. 2014. Accessed: Aug. 20, 2024. [Online]. Available: https://rosap.ntl.bts.gov/view/dot/26967

**APPENDIX A (Part A: Hypothetical Scenarios)**

**Table 1. Pedestrian Flag Assessment for Conventional, Partial CFI, CFI/MUT Combo and Redirect 2L&T**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **Conventional** | | | | **Partial CFI** | | | | **CFI/MUT Combo** | | | | **Redirect 2L&T** | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 1 | Motor vehicle right turn | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |
| 2 | Uncomfortable/tight walking environment |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 | Non-intuitive motor vehicle movement |  |  |  |  |  |  | R | R |  |  | R |  |  |  | R |  |
| 4 | Crossing yield or uncontrolled vehicle paths |  |  |  |  |  |  | R | R |  |  | R |  |  |  | R |  |
| 5 | Indirect paths |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 | Executing unusual movements |  |  |  |  |  |  | Y | Y |  |  |  |  |  |  |  |  |
| 7 | Multilane crossing | R | R | R | R | R | R | R | R | Y | Y | R | R | R | Y | R | Y |
| 8 | Long red times | Y | Y |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 9 | Undefined crossing at intersections |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 | The motor vehicle left turn |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 11 | Intersecting driveways and side streets |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 12 | Sight distance for gap acceptance |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 13 | Grade change |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Total Possible Flags** | | 52 | | | | 52 | | | | 52 | | | | 52 | | | |
| **Total Yellow Flags** | | 2 | | | | 2 | | | | 2 | | | | 2 | | | |
| **Total Red Flags** | | 8 | | | | 12 | | | | 8 | | | | 8 | | | |
| **Percentage of Yellow Flags** | | 4% | | | | 4% | | | | 4% | | | | 4% | | | |
| **Percentage of Red Flags** | | 15% | | | | 23% | | | | 15% | | | | 15% | | | |
| **Percentage Flagged** | | 19% | | | | 27% | | | | 19% | | | | 19% | | | |

*Note:* E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag and “-” = No Flag

**Table 2. Pedestrian Flag Assessment for MUT 1, MUT 2, Two-phase MUT, and Redirect L&T (Type I and Type II) intersections**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **MUT 1** | | | | **MUT 2** | | | | **Two-phase MUT** | | | | **Redirect L&T**  **(Type I)** | | | | **Redirect L&T**  **(Type II)** | | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 1 | Motor vehicle right turn | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |  | R | R | R |
| 2 | Uncomfortable/tight walking environment |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 | Non-intuitive motor vehicle movement |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 | Crossing yield or uncontrolled vehicle paths |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 | Indirect paths |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 | Executing unusual movements |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7 | Multilane crossing | Y | Y | Y | Y | R | R | Y | Y | Y | Y | Y | Y | R | R | R | Y |  | R | R | Y |
| 8 | Long red times |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 9 | Undefined crossing at intersections |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | R |  |  |  |
| 10 | The motor vehicle left turn |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 11 | Intersecting driveways and side streets |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 12 | Sight distance for gap acceptance |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 13 | Grade change |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Total Possible Flags** | | 52 | | | | 52 | | | | 52 | | | | 52 | | | | 52 | | | | |
| **Total Yellow Flags** | | 4 | | | | 2 | | | | 4 | | | | 1 | | | | 1 | | | | |
| **Total Red Flags** | | 4 | | | | 6 | | | | 4 | | | | 7 | | | | 6 | | | | |
| **Percentage of Yellow Flags** | | 8% | | | | 4% | | | | 8% | | | | 2% | | | | 2% | | | | |
| **Percentage of Red Flags** | | 8% | | | | 12% | | | | 8% | | | | 13% | | | | 12% | | | | |
| **Percentage Flagged** | | 15% | | | | 15% | | | | 15% | | | | 15% | | | | 13% | | | | |

**Note:**E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag

**Table 3. Pedestrian Flag Assessment for Thru-cut (Barnes Dance-Types I and II), Thru-cut (standard crosswalk), Seven Phase (Types I and II), and Offset Thru-cut**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **THRU-CUT (STANDARD CROSSWALK)** | | | | **THRU-CUT (BARNES DANCE-TYPE I)** | | | | **THRU-CUT (BARNES DANCE TYPE II)** | | | | **SEVEN PHASE (TYPE I)** | | | | **SEVEN PHASE (TYPE II)** | | | | **OFFSET THRU-CUT (TYPE 1)** | | | | **OFFSET THRU-CUT (TYPE II)** | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 1 | Motor vehicle right turn | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |  | R | R | R | R | R | R | R | R | R | R | R |
| 2 | Uncomfortable/tight walking environment |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 | Non-intuitive motor vehicle movement |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 | Crossing yield or uncontrolled vehicle paths |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 | Indirect paths |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 | Executing unusual movements |  |  |  |  | Y | Y |  |  | Y | Y |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7 | Multilane crossing | Y | Y | R | R | Y | Y | R | R | Y | Y | Y | Y | R | R | R | R |  | R | R | R | Y | Y | R | R | R | R | Y | Y |
| 8 | Long red times |  |  |  |  |  |  |  |  |  |  |  |  | R | R | Y | Y |  | R | Y | Y |  |  |  |  |  |  |  |  |
| 9 | Undefined crossing at intersections |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | R |  |  |  |  |  |  |  |  |  |  |  |
| 10 | The motor vehicle left turn |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 11 | Intersecting driveways and side streets |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 12 | Sight distance for gap acceptance |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 13 | Grade change |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Total Possible Flags** | | 52 | | | | 52 | | | | 52 | | | | 52 | | | | 52 | | | | 52 | | | | 52 | | | |
| **Total Yellow Flags** | | 2 | | | | 4 | | | | 6 | | | | 2 | | | | 2 | | | | 2 | | | | 2 | | | |
| **Total Red Flags** | | 6 | | | | 6 | | | | 4 | | | | 10 | | | | 8 | | | | 6 | | | | 6 | | | |
| **Percentage of Yellow Flags** | | 4% | | | | 8% | | | | 12% | | | | 4% | | | | 4% | | | | 4% | | | | 4% | | | |
| **Percentage of Red Flags** | | 12% | | | | 12% | | | | 8% | | | | 19% | | | | 15% | | | | 12% | | | | 12% | | | |
| **Percentage Flagged** | | 15% | | | | 19% | | | | 19% | | | | 23% | | | | 19% | | | | 15% | | | | 15% | | | |

**Note:**E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag

**Table 4. Pedestrian Flag Assessment for RCI, Reverse RCI, Offset T and Quadrant**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **RCI** | | | | **Reverse RCI** | | | | **Offset T** | | | | | | | | | **Quadrant** | | | | |
| **Left Leg** | | | | **Right Leg** | | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | | **W** | **N** | **S** |
| 1 | Motor vehicle right turn | R | R | R | R | R | R | R | R | R |  |  | R |  | R | R |  | R | | R | R | R |
| 2 | Uncomfortable/tight walking environment |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |
| 3 | Non-intuitive motor vehicle movement |  |  |  |  | R | R |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |
| 4 | Crossing yield or uncontrolled vehicle paths |  |  |  |  | R | R |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |
| 5 | Indirect paths | Y | Y |  |  | Y | Y |  |  |  | Y |  |  | Y |  |  |  |  | |  |  |  |
| 6 | Executing unusual movements | Y | Y |  |  | Y | Y |  |  |  | Y |  |  | Y |  |  |  |  | |  |  |  |
| 7 | Multilane crossing | Y | Y | Y | Y | Y | Y | Y | Y | R |  |  | R |  | R | R |  | Y | | Y | Y | Y |
| 8 | Long red times |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |
| 9 | Undefined crossing at intersections |  |  |  |  |  |  |  |  |  | R |  |  | R |  |  |  |  | |  |  |  |
| 10 | The motor vehicle left turn |  |  |  |  |  |  |  |  | R |  |  | R |  | R | R |  |  | |  |  |  |
| 11 | Intersecting driveways and side streets |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |
| 12 | Sight distance for gap acceptance |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |
| 13 | Grade change |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |
| **Total Possible Flags** | | 52 | | | | 52 | | | | 52 | | | | | | | | | 52 | | | | |
| **Total Yellow Flags** | | 8 | | | | 8 | | | | 4 | | | | | | | | | 4 | | | | |
| **Total Red Flags** | | 4 | | | | 8 | | | | 14 | | | | | | | | | 4 | | | | |
| **Percentage of Yellow Flags** | | 15% | | | | 15% | | | | 8% | | | | | | | | | 8% | | | | |
| **Percentage of Red Flags** | | 8% | | | | 15% | | | | 27% | | | | | | | | | 8% | | | | |
| **Percentage Flagged** | | 23% | | | | 31% | | | | 35% | | | | | | | | | 15% | | | | |

**Note:**E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag

**Figure 1** Summary of pedestrian design flag assessment

**Figure 2** Summary of pedestrian design flag assessment

**Figure 3** Summary of pedestrian design flag assessment

**Figure 4** Summary of pedestrian design flag assessment

**Table 5. Bicycle Flag Assessment for Conventional, Partial CFI, CFI/MUT Combo and Redirect 2L&T**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **Conventional** | | | | **Partial CFI** | | | | **CFI/MUT Combo** | | | | **Redirect 2L&T** | | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 4 | Crossing yield or uncontrolled vehicle paths |  |  |  |  |  |  | R | R |  |  | R |  |  |  | R |  |
| 5 | Indirect paths |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 | Executing unusual movements |  |  |  |  |  |  | Y | Y |  |  |  |  |  |  |  |  |
| 7 | Multilane crossing | R | R | R | R | R | R | R | R |  |  | Y | Y |  | Y |  | Y |
| 8 | Long red times | Y | Y |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 9 | Undefined crossing at intersections |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 | The motor vehicle left turn |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 11 | Intersecting driveways and side streets |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 12 | Sight distance for gap acceptance |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 13 | Grade change |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 14 | Riding in mixed traffic | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |
| 15 | Bicycle Clearance Times | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |
| 16 | Lane Change across motor vehicle travel lanes | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |
| 17 | Bicyclist Crossing motor vehicle travel lane | Y | Y | Y | Y | R | R | R | R | Y | Y | R | Y | Y | Y | Y | Y |
| 18 | Turning motor vehicles crossing bike path | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 19 | Riding between lanes | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 20 | Off-tracking trucks in multi-lane curves |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Total Possible Flags** | | 68 | | | | 68 | | | | 68 | | | | 68 | | | | |
| **Total Yellow Flags** | | 14 | | | | 10 | | | | 13 | | | | 14 | | | | |
| **Total Red Flags** | | 16 | | | | 22 | | | | 14 | | | | 13 | | | | |
| **Percentage of Yellow Flags** | | 21% | | | | 15% | | | | 19% | | | | 21% | | | | |
| **Percentage of Red Flags** | | 24% | | | | 32% | | | | 21% | | | | 19% | | | | |
| **Percentage Flagged** | | 44% | | | | 47% | | | | 40% | | | | 40% | | | | |

**Note:**E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag

**Table 6. Bicycle Flag Assessment for Intersections MUT 1, MUT 2, Two-phase MUT, and Redirect L&T (Types I and II) intersections**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **MUT 1** | | | | **MUT 2** | | | | **Two-phase MUT** | | | | **Redirect L&T**  **(Type I)** | | | | **Redirect L&T**  **(Type II)** | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 4 | Crossing yield or uncontrolled vehicle paths |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 | Indirect paths |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 | Executing unusual movements |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7 | Multilane crossing | Y | Y | Y | Y |  |  |  |  | Y | Y | Y | Y | Y | Y |  | Y |  | Y |  | Y |
| 8 | Long red times |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | R |  |  |  |
| 9 | Undefined crossing at intersections |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 | The motor vehicle left turn |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 11 | Intersecting driveways and side streets |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 12 | Sight distance for gap acceptance |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 13 | Grade change |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 14 | Riding in mixed traffic | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |  | R | R | R |
| 15 | Bicycle Clearance Times | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |  | R | R | R |
| 16 | Lane Change across motor vehicle travel lanes | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |  | R | R | R |
| 17 | Bicyclist Crossing motor vehicle travel lane | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |  | Y | Y | Y |
| 18 | Turning motor vehicles crossing bike path | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |  | Y | Y | Y |
| 19 | Riding between lanes | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |  | Y | Y | Y |
| 20 | Off-tracking trucks in multi-lane curves |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Total Possible Flags** | | 68 | | | | 68 | | | | 68 | | | | 68 | | | | 68 | | | |
| **Total Yellow Flags** | | 16 | | | | 12 | | | | 16 | | | | 15 | | | | 11 | | | |
| **Total Red Flags** | | 12 | | | | 12 | | | | 12 | | | | 12 | | | | 10 | | | |
| **Percentage of Yellow Flags** | | 24% | | | | 18% | | | | 24% | | | | 22% | | | | 16% | | | |
| **Percentage of Red Flags** | | 18% | | | | 18% | | | | 18% | | | | 18% | | | | 15% | | | |
| **Percentage Flagged** | | 41% | | | | 35% | | | | 41% | | | | 40% | | | | 31% | | | |

**Note:**E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag

**Table 7. Bicycle Flag Assessment for Intersections for Thru-cut (standard crosswalk), Thru-cut (Barnes dance-Type I and Type 2), Seven Phase (Type I and Type II) and Offset Thru-cut**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **THRU-CUT (STANDARD CROSSWALK)** | | | | **THRU-CUT (BARNES DANCE- TYPE I)** | | | | **THRU-CUT (BARNES DANCE- TYPE II)** | | | | **SEVEN PHASE (TYPE I)** | | | | **SEVEN PHASE (TYPE II)** | | | | **OFFSET THRU-CUT (TYPE I)** | | | | **OFFSET THRU-CUT (TYPE II)** | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 4 | Crossing yield or uncontrolled vehicle paths |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 | Indirect paths |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 | Executing unusual movements |  |  |  |  | Y | Y |  |  | Y | Y |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7 | Multilane crossing |  |  | Y | Y |  |  | Y | Y |  |  |  |  | Y | Y | Y | Y |  | Y | Y | Y |  |  | Y | Y | Y | Y |  |  |
| 8 | Long red times |  |  |  |  |  |  |  |  |  |  |  |  | R | R | Y | Y |  | R | Y | Y |  |  |  |  |  |  |  |  |
| 9 | Undefined crossing at intersections |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | R |  |  |  |  |  |  |  |  |  |  |  |
| 10 | The motor vehicle left turn |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 11 | Intersecting driveways and side streets |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 12 | Sight distance for gap acceptance |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 13 | Grade change |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 14 | Riding in mixed traffic | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |  | R | R | R | R | R | R | R | R | R | R | R |
| 15 | Bicycle Clearance Times | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |  | R | R | R | R | R | R | R | R | R | R | R |
| 16 | Lane Change across motor vehicle travel lanes | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |  | R | R | R | R | R | R | R | R | R | R | R |
| 17 | Bicyclist Crossing motor vehicle travel lane | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |  | Y | Y | Y | R | R | R | R | R | R | R | R |
| 18 | Turning motor vehicles crossing bike path | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |  | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 19 | Riding between lanes | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |  | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 20 | Off-tracking trucks in multi-lane curves |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Total Possible Flags** | | 68 | | | | 68 | | | | 68 | | | | 68 | | | | 68 | | | | 68 | | | | 68 | | | |
| **Total Yellow Flags** | | 14 | | | | 16 | | | | 14 | | | | 18 | | | | 14 | | | | 10 | | | | 10 | | | |
| **Total Red Flags** | | 12 | | | | 12 | | | | 12 | | | | 14 | | | | 11 | | | | 16 | | | | 16 | | | |
| **Percentage of Yellow Flags** | | 21% | | | | 24% | | | | 21% | | | | 26% | | | | 21% | | | | 15% | | | | 15% | | | |
| **Percentage of Red Flags** | | 18% | | | | 18% | | | | 18% | | | | 21% | | | | 16% | | | | 24% | | | | 24% | | | |
| **Percentage Flagged** | | 38% | | | | 41% | | | | 35% | | | | 47% | | | | 37% | | | | 38% | | | | 38% | | | |

**Note:**E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag

**Table 8. Bicycle Flag Assessment for Intersections for RCI, Reverse RCI, Offset T and Quadrant**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **RCI** | | | | **Reverse RCI** | | | | **Offset T** | | | | | | | | **Quadrant** | | | |
| **(Left Leg)** | | | | **(Right Leg)** | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 4 | Crossing yield or uncontrolled vehicle paths |  |  |  |  | R | R |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 | Indirect paths |  |  |  |  |  |  |  |  |  | Y |  |  | Y |  |  |  |  |  |  |  |
| 6 | Executing unusual movements | Y | Y |  |  | Y | Y |  |  |  | Y |  |  | Y |  |  |  |  |  |  |  |
| 7 | Multilane crossing |  |  |  |  |  |  |  |  | R |  |  | R |  | R | R |  | Y | Y | Y | Y |
| 8 | Long red times |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 9 | Undefined crossing at intersections |  |  |  |  |  |  |  |  |  | R |  |  | R |  |  |  |  |  |  |  |
| 10 | The motor vehicle left turn |  |  |  |  |  |  |  |  | R |  |  | R |  | R | R |  |  |  |  |  |
| 11 | Intersecting driveways and side streets |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 12 | Sight distance for gap acceptance |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 13 | Grade change |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 14 | Riding in mixed traffic | R | R | R | R | R | R | R | R | R | R |  | R | R | R | R |  | R | R | R | R |
| 15 | Bicycle Clearance Times | R | R | R | R | R | R | R | R | R | R |  | R | R | R | R |  | R | R | R | R |
| 16 | Lane Change across motor vehicle travel lanes | R | R | R | R | R | R | R | R | R | R |  | R | R | R | R |  | R | R | R | R |
| 17 | Bicyclist Crossing motor vehicle travel lane | Y | Y | Y | Y | R | R | Y | Y | R | R |  | R | R | R | R |  |  |  |  |  |
| 18 | Turning motor vehicles crossing bike path | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |  | Y | Y | Y | Y |  | Y | Y | Y | Y |
| 19 | Riding between lanes | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |  | Y | Y | Y | Y |  | Y | Y | Y | Y |
| 20 | Off-tracking trucks in multi-lane curves |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |
| **Total Possible Flags** | | 68 | | | | 68 | | | | 68 | | | | | | | | 68 | | | |
| **Total Yellow Flags** | | 14 | | | | 12 | | | | 16 | | | | | | | | 12 | | | |
| **Total Red Flags** | | 12 | | | | 16 | | | | 34 | | | | | | | | 12 | | | |
| **Percentage of Yellow Flags** | | 21% | | | | 18% | | | | 24% | | | | | | | | 18% | | | |
| **Percentage of Red Flags** | | 18% | | | | 24% | | | | 50% | | | | | | | | 18% | | | |
| **Percentage Flagged** | | 38% | | | | 41% | | | | 74% | | | | | | | | 35% | | | |

**Note:**E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag

**Figure 5** Summary of bicyclists’ design flag assessment

**Figure 6** Summary of bicyclists' design flag assessment

**Figure 7** Summary of bicyclists' design flag assessment

**Figure 8** Summary of bicyclists’ design flag assessment

**APPENDIX B (Case Study Sites)**

Nine intersection designs, including the existing conventional intersection and eight proposed alternatives, were assessed for both pedestrians and bicyclists at site 1. Tables 2 and 3 present the pedestrian assessment for the proposed two-phase MUT, MUT 1, MUT 2, reverse RCI, seven-phase, redirect L&T, standard thru-cut, barnes dance thru-cut, and the existing conventional intersection. Figures 1 and 2 present a summary of the results of the pedestrian flag assessment for site 1.

The two-phase MUT resulted in the lowest total number of flags, largely due to a relatively lower percentage of yellow flags (40%), even though it recorded 4% red flags, similar to the MUT 1, MUT 2 and seven-phase intersections. The reverse RCI had the highest percentage of red flags at 12%, while the conventional intersection recorded the highest percentage of yellow flags. Between the two types of pedestrian walkways assessed for the thru-cut, the barnes dance thru-cut performed better than the standard thru-cut, resulting in a 4% reduction in the percentage of red flags.

The results of the bicyclist assessment are presented in Tables 4 and 5, with a summary shown in Figures 3 and 4. Similar to the pedestrian analysis, MUT 1 and MUT 2 outperformed all other intersections, resulting in a 3% reduction in the total number of flags compared to the conventional intersection. As observed in the pedestrian analysis, the Barnes Dance thru-cut outperformed the standard thru-cut in the bicyclist assessment.

**Table 2. Pedestrian Flag Assessment for Five of the Intersections Designs at Site 1**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **Conventional** | | | | **Reverse RCI** | | | | **Two-Phase MUT** | | | | **MUT 1** | | | | **MUT 2** | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 1 | Motor vehicle right turn | Y | R | R | Y | Y | R | R | Y | Y | R | R | Y | Y | R | R | Y | Y | R | R | Y |
| 2 | Uncomfortable/tight walking environment | Y | Y |  | Y | Y | Y |  | Y | Y | Y |  | Y | Y | Y |  | Y | Y | Y |  | Y |
| 3 | Non-intuitive motor vehicle movement | Y | Y | Y | Y | R | R | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 4 | Crossing yield or uncontrolled vehicle paths | - | - | - | - | R | R | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | Indirect paths | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 6 | Executing unusual movements | - | - | - | - | Y | Y | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 7 | Multilane crossing | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 8 | Long red times | Y | Y | - | - | - | - | - | - |  |  |  |  | Y | Y | - | - | Y | Y | - | - |
| 9 | Undefined crossing at intersections | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 10 | The motor vehicle left turn | R | Y | Y | Y | - | - | Y | Y | - | - | - | - | - | - | Y | Y | Y | Y | - | - |
| 11 | Intersecting driveways and side streets | - | - | Y | Y | - | - | Y | Y | - | - | Y | Y | - | - | Y | Y | - | - | Y | Y |
| 12 | Sight distance for gap acceptance | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 13 | Grade change | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Total Possible Flags** | | 52 | | | | 52 | | | | 52 | | | | 52 | | | | 52 | | | |
| **Total Yellow Flags** | | 24 | | | | 21 | | | | 19 | | | | 23 | | | | 23 | | | |
| **Total Red Flags** | | 3 | | | | 6 | | | | 2 | | | | 2 | | | | 2 | | | |
| **Percentage of Yellow Flags** | | 46 | | | | 40 | | | | 40 | | | | 44 | | | | 44 | | | |
| **Percentage of Red Flags** | | 6 | | | | 12 | | | | 4 | | | | 4 | | | | 4 | | | |
| **Percentage Flagged** | | 56 | | | | 52 | | | | 44 | | | | 48 | | | | 48 | | | |

*Note:* E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag and “-” = No Flag

**Figure 1. Summary of Pedestrian Flag Assessment for five of the intersections designs at Site 1**

**Table 3. Pedestrian Flag Assessment for Four of the Intersections Designs at Site 1**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **Thru-cut**  **(Barnes Dance)** | | | | **Thru-cut**  **(Standard)** | | | | **Redirect L&T** | | | | **Seven Phase** | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 1 | Motor vehicle right turn | Y | R | R | Y | Y | R | R | Y | Y | R | R | Y | Y | R | R | Y |
| 2 | Uncomfortable/tight walking environment | Y | Y |  | Y | Y | Y |  | Y | Y | Y |  | Y | Y | Y |  | Y |
| 3 | Non-intuitive motor vehicle movement | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 4 | Crossing yield or uncontrolled vehicle paths | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | Indirect paths | Y | Y | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 6 | Executing unusual movements | Y | Y | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 7 | Multilane crossing | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 8 | Long red times | Y | Y | - | - | Y | Y | - | - | Y | Y | - | - | Y | Y | - | - |
| 9 | Undefined crossing at intersections | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 10 | The motor vehicle left turn | - | - | Y | R | R | R | Y | R | R | R | R | - | Y | Y | Y | Y |
| 11 | Intersecting driveways and side streets | - | - | Y | Y | - | - | Y | Y | - | - | Y | Y | - | - | Y | Y |
| 12 | Sight distance for gap acceptance | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 13 | Grade change | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Total Possible Flags** | | 52 | | | | 52 | | | | 52 | | | | 52 | | | |
| **Total Yellow Flags** | | 22 | | | | 23 | | | | 24 | | | | 25 | | | |
| **Total Red Flags** | | 3 | | | | 5 | | | | 5 | | | | 2 | | | |
| **Percentage of Yellow Flags** | | 42 | | | | 44 | | | | 46 | | | | 48 | | | |
| **Percentage of Red Flags** | | 6 | | | | 10 | | | | 10 | | | | 4 | | | |
| **Percentage Flagged** | | 48 | | | | 54 | | | | 56 | | | | 52 | | | |

*Note:* E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag and “-” = No Flag

**Figure 2. Summary of Pedestrian Flag Assessment for Four of the Intersections Designs at Site 1**

**Table 4. Bicyclists Flag Assessment for Four of the Intersections Designs at Site 1**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **Conventional** | | | | **Reverse RCI** | | | | **Two-Phase MUT** | | | | **MUT 1** | | | | **MUT 2** | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 4 | Crossing yield or uncontrolled vehicle paths | - | - | - | - | R | R | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | Indirect paths | - | - | - | - |  |  | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 6 | Executing unusual movements | - | - | - | - | Y | Y | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 7 | Multilane crossing | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 8 | Long red times | Y | Y | - | - | - | - | - | - |  |  |  |  | Y | Y | - | - | Y | Y | - | - |
| 9 | Undefined crossing at intersections | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 10 | The motor vehicle left turn | R | Y | Y | Y | - | - | Y | Y | - | - | - | - | - | - | Y | Y | Y | Y | - | - |
| 11 | Intersecting driveways and side streets | - | - | Y | Y | - | - | Y | Y | - | - | Y | Y | - | - | Y | Y | - | - | Y | Y |
| 12 | Sight distance for gap acceptance | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 13 | Grade change | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 14 | Riding in mixed traffic | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |
| 15 | Bicycle Clearance Times | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |
| 16 | Lane Change across motor vehicle travel lanes | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |
| 17 | Channelized Lanes | - | - | - | - | R | R | - | - | - | - | - | - | R | R | - | - | - | - | - | - |
| 18 | Turning motor vehicles crossing bike path | R | R | R | R | Y | Y | R | R | R | R | R | R | Y | Y | R | R | R | R | R | R |
| 19 | Riding between lanes | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 20 | Off-tracking trucks in multi-lane curves | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Total Possible Flags** | | 68 | | | | 68 | | | |  | | | | 68 | | | | 68 | | | |
| **Total Yellow Flags** | | 19 | | | | 18 | | | |  | | | | 18 | | | | 18 | | | |
| **Total Red Flags** | | 17 | | | | 18 | | | |  | | | | 16 | | | | 16 | | | |
| **Percentage of Yellow Flags** | | 28 | | | | 26 | | | |  | | | | 26 | | | | 26 | | | |
| **Percentage of Red Flags** | | 25 | | | | 26 | | | |  | | | | 24 | | | | 24 | | | |
| **Percentage Flagged** | | 53 | | | | 52 | | | |  | | | | 50 | | | | 50 | | | |

*Note:* E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag and “-” = No Flag

**Figure 3. Summary of Bicyclists Flag Assessment for Four of the Intersections Designs at Site 1**

**Table 5. Bicyclists Flag Assessment for Four of the Intersections Designs at Site 1**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **Thru-Cut**  **(Barnes Dance)** | | | | **Thru-Cut**  **(Standard)** | | | | | **Redirect**  **L&T** | | | | **Seven Phase** | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 4 | Crossing yield or uncontrolled vehicle paths | - | - | - | - | - | - | - | | - | - | - | - | - | - | - | - | - |
| 5 | Indirect paths | Y | Y | - | - | - | - | - | | - | - | - | - | - | - | - | - | - |
| 6 | Executing unusual movements | Y | Y | - | - | - | - | - | | - | - | - | - | - | - | - | - | - |
| 7 | Multilane crossing | Y | Y | Y | Y | Y | Y | Y | | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 8 | Long red times | Y | Y | - | - | Y | Y | - | | - | Y | Y | - | - | Y | Y | - | - |
| 9 | Undefined crossing at intersections | Y | Y | Y | Y | Y | Y | Y | | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 10 | The motor vehicle left turn | - | - | Y | R | R | R | R | | R | R | R | R | - | Y | Y | Y | Y |
| 11 | Intersecting driveways and side streets | - | - | Y | Y | - | - | Y | | Y | - | - | Y | Y | - | - | Y | Y |
| 12 | Sight distance for gap acceptance | - | - | - | - | - | - | - | | - | - | - | - | - | - | - | - | - |
| 13 | Grade change | - | - | - | - | - | - | - | | - | - | - | - | - | - | - | - | - |
| 14 | Riding in mixed traffic | R | R | R | R | R | R | R | | R | R | R | R | R | R | R | R | R |
| 15 | Bicycle Clearance Times | R | R | R | R | R | R | R | | R | R | R | R | R | R | R | R | R |
| 16 | Lane Change across motor vehicle travel lanes | R | R | R | R | R | R | R | | R | R | R | R | R | R | R | R | R |
| 17 | Channelized Lanes | - | - | - | - | - | - | - | | - | - | - | - | - | - | - | - | - |
| 18 | Turning motor vehicles crossing bike path | R | R | R | R | R | R | R | | R | R | R | R | R | R | R | R | R |
| 19 | Riding between lanes | Y | Y | Y | Y | Y | Y | Y | | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 20 | Off-tracking trucks in multi-lane curves | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - | - | |
| **Total Possible Flags** | | 68 | | | | 68 | | | | | 68 | | | | 68 | | | |
| **Total Yellow Flags** | | 21 | | | | 16 | | | | | 16 | | | | 18 | | | |
| **Total Red Flags** | | 17 | | | | 20 | | | | | 19 | | | | 16 | | | |
| **Percentage of Yellow Flags** | | 31 | | | | 24 | | | | | 24 | | | | 26 | | | |
| **Percentage of Red Flags** | | 25 | | | | 29 | | | | | 28 | | | | 24 | | | |
| **Percentage Flagged** | | 56 | | | | 53 | | | | | 52 | | | | 50 | | | |

*Note:* E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag and “-” = No Flag

**Figure 4. Summary of Bicyclists Flag Assessment for Four of the Intersections Designs at Site 1**

The intersections assessed for site 2 included two proposed alternatives—redirect 2L&T and the seven-phase intersection—as well as the existing conventional intersection. The results of the pedestrian assessment are presented in Table 6 and Figure 5. All three intersections recorded an equal number of total flags. However, the conventional intersection performed better due to a lower number of red flags. The seven-phase intersection had the highest number of red flags, showing a 4% increase compared to the conventional intersection.

Table 7 and figure 6 present the results of the bicyclist assessment for the conventional, redirect 2L&T, and seven-phase intersections. Similar to the pedestrian assessment, the seven-phase intersection had the highest number of red flags, representing 38%, with an overall percentage flagged of 56%. Although the conventional intersection had the same overall percentage flagged of 56%, it showed a lower percentage of red flags at 35% compared to the seven-phase intersection

**Table 6. Pedestrian Flag Assessment for Site 2**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **Conventional** | | | | **Redirect 2L&T** | | | | **Seven Phase** | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 1 | Motor vehicle right turn | R | Y | R | R | R | Y | R | R | R | Y | R | R |
| 2 | Uncomfortable/tight walking environment | Y | Y |  | Y | Y | Y | Y | Y | Y | Y |  | Y |
| 3 | Non-intuitive motor vehicle movement | Y | Y | R | Y | Y | Y | R | Y | Y | Y | R | Y |
| 4 | Crossing yield or uncontrolled vehicle paths | - | - | R | - | - | - | R | - | - | - | R | - |
| 5 | Indirect paths | - | - | - | - | - | - | - | - | - | - | - | - |
| 6 | Executing unusual movements | - | - | - | - | - | - | - | - | - | - | - | - |
| 7 | Multilane crossing | R | R | R | R | R | R | R | R | R | R | R | R |
| 8 | Long red times | Y | Y | - | - | R | Y | - | - | R | R | - | - |
| 9 | Undefined crossing at intersections | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 10 | The motor vehicle left turn | R | R | R | Y | R | R | R | - | R | R | R | Y |
| 11 | Intersecting driveways and side streets | - | - | - | - | - | - | - | - | - | - | - | - |
| 12 | Sight distance for gap acceptance | - | R | - | - | - | R | - | - | - | R | - | - |
| 13 | Grade change | - | - | Y | Y | - | - | Y | Y | - | - | Y | Y |
| **Total Possible Flags** | | 52 | | | | 52 | | | | 52 | | | |
| **Total Yellow Flags** | | 16 | | | | 15 | | | | 14 | | | |
| **Total Red Flags** | | 13 | | | | 14 | | | | 15 | | | |
| **Percentage of Yellow Flags** | | 31 | | | | 29 | | | | 27 | | | |
| **Percentage of Red Flags** | | 25 | | | | 27 | | | | 29 | | | |
| **Percentage Flagged** | | 56 | | | | 56 | | | | 56 | | | |

*Note:* E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag and “-” = No Flag

**Figure 5. Summary of Pedestrian Flag Assessment for Site 2**

**Table 7. Bicyclists Flag Assessment for Site 2**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **Conventional** | | | | **Redirect L&T** | | | | **Seven Phase** | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 4 | Crossing yield or uncontrolled vehicle paths | - | - | R | - | - | - | R | - | - | - | R | - |
| 5 | Indirect paths | - | - | - | - | - | - | - | - | - | - | - | - |
| 6 | Executing unusual movements | - | - | - | - | - | - | - | - | - | - | - | - |
| 7 | Multilane crossing | R | R | R | R | R | R | R | R | R | R | R | R |
| 8 | Long red times | Y | Y | - | - | R | Y | - | - | R | R | - | - |
| 9 | Undefined crossing at intersections | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 10 | The motor vehicle left turn | R | R | R | Y | R | R | R | - | R | R | R | Y |
| 11 | Intersecting driveways and side streets | - | - | - | - | - | - | - | - | - | - | - | - |
| 12 | Sight distance for gap acceptance | - | R | - | - | - | R | - | - | - | R | - | - |
| 13 | Grade change | - | - | Y | Y | - | - | Y | Y | - | - | Y | Y |
| 14 | Riding in mixed traffic | R | R | R | R | R | R | R | R | R | R | R | R |
| 15 | Bicycle Clearance Times | R | R | R | R | R | R | R | R | R | R | R | R |
| 16 | Lane Change across motor vehicle travel lanes | R | R | R | R | R | R | R | R | R | R | R | R |
| 17 | Channelized Lanes | - | - | - | - | - | - | - | - | - | - | - | - |
| 18 | Turning motor vehicles crossing bike path | R | R | Y | R | R | R | Y | R | R | R | Y | R |
| 19 | Riding between lanes | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 20 | Off-tracking trucks in multi-lane curves | - | - | - | - | - | - | - | - | - | - | - | - |
| **Total Possible Flags** | | 68 | | | | 68 | | | | 68 | | | |
| **Total Yellow Flags** | | 14 | | | | 12 | | | | 12 | | | |
| **Total Red Flags** | | 24 | | | | 25 | | | | 26 | | | |
| **Percentage of Yellow Flags** | | 21 | | | | 18 | | | | 18 | | | |
| **Percentage of Red Flags** | | 35 | | | | 37 | | | | 38 | | | |
| **Percentage Flagged** | | 56 | | | | 55 | | | | 56 | | | |

*Note:* E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag and “-” = No Flag

**Figure 6. Summary of Bicyclists Flag Assessment for Site 2**

Seven intersection designs, including the existing conventional intersection and six proposed alternatives, were assessed for both pedestrians and bicyclists at site 4. Tables 8 and 9 present the pedestrian assessment of the proposed two phase MUT, MUT 1, MUT 2, partial CFI, CFI/MUT combo, redirect 2L&T, and the existing conventional intersection. Among all seven intersections assessed, MUT 1 and MUT 2 recorded the lowest percentage of red flags at 23%, followed closely by the two-phase MUT, as shown in Tables 8 and 9 and Figures 7 and 8. MUT 1 had the lowest total number of flags, largely due to a lower number of yellow flags. Notably, the CFI/MUT combo performed similarly to the conventional intersection in terms of the percentage flagged, while the partial CFI had the highest number of red flags among all six intersections.

In the assessment of bicyclists, MUT 1, MUT 2 and two-phase MUT performed relatively better than the existing conventional intersection, recording an 8% reduction in the number of red flags, as presented in Tables 10 and 11. The redirect 2L&T followed closely with a 5% reduction in red flags compared to the conventional intersection. Figures 9 and 10 summarize the bicyclist assessment for all six intersections.

**Table 8. Pedestrian Flag Assessment for Four of the Intersections Designs at Site 4**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **Conventional** | | | | **Two-Phase MUT** | | | | **MUT 1** | | | | **MUT 2** | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 1 | Motor vehicle right turn | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |
| 2 | Uncomfortable/tight walking environment | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 3 | Non-intuitive motor vehicle movement | - | R | R | - | - | R | R | - | - | R | R | Y | - | R | R | Y |
| 4 | Crossing yield or uncontrolled vehicle paths | - | R | R | - | - | R | R | - | - | R | R | - | - | R | R | - |
| 5 | Indirect paths | - | - | R | - | - | - | R | - | - | - | - | - | - | - | - | - |
| 6 | Executing unusual movements | - | - | Y | - | - | - | Y | - | - | - | - | - | - | - | - | - |
| 7 | Multilane crossing | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |
| 8 | Long red times | R | R | R | R | - | - | - | - | - | - | Y | Y | Y | Y | Y | Y |
| 9 | Undefined crossing at intersections | - | - | Y | - | - | - | Y | - | - | - | - | - | - | - | Y | - |
| 10 | The motor vehicle left turn | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 11 | Intersecting driveways and side streets | - | Y | - | - | - | Y | - | - | - | Y | - | - | - | Y | - | - |
| 12 | Sight distance for gap acceptance | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 13 | Grade change | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Total Possible Flags** | | 52 | | | | 52 | | | | 52 | | | | 52 | | | |
| **Total Yellow Flags** | | 3 | | | | 3 | | | | 3 | | | | 5 | | | |
| **Total Red Flags** | | 17 | | | | 13 | | | | 12 | | | | 12 | | | |
| **Percentage of Yellow Flags** | | 6 | | | | 6 | | | | 6 | | | | 10 | | | |
| **Percentage of Red Flags** | | 33 | | | | 25 | | | | 23 | | | | 23 | | | |
| **Percentage Flagged** | | 39 | | | | 31 | | | | 29 | | | | 33 | | | |

*Note:* E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag and “-” = No Flag

**Figure 7. Summary of Pedestrian Flag Assessment for Four of the Intersections Designs at Site 4**

**Table 9. Pedestrian Flag Assessment for Three of the Intersections Designs at Site 4**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **Partial CFI** | | | | **CFI/MUT COMBO** | | | | **REDIRECT 2L&T** | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 1 | Motor vehicle right turn | R | R | R | R | R | R | R | R | R | R | R | R |
| 2 | Uncomfortable/tight walking environment | - | - | - | - | - | - | - | - | - | - | - | - |
| 3 | Non-intuitive motor vehicle movement | R | R | R | - | R | R | R | - | - | R | R | - |
| 4 | Crossing yield or uncontrolled vehicle paths | R | R | R | - | R | R | R | - | - | R | R | - |
| 5 | Indirect paths | - | - | - | - | - | - | - | - | - | - | - | - |
| 6 | Executing unusual movements | Y | Y | - | - | Y | - | - | - | - | - | - | - |
| 7 | Multilane crossing | R | R | R | R | R | R | R | R | R | R | R | R |
| 8 | Long red times | R | R | R | R | R | R | R | R | R | R | - | - |
| 9 | Undefined crossing at intersections | - | - | - | - | - | - | - | - | - | - | - | - |
| 10 | The motor vehicle left turn | - | - | - | - | - | - | - | - | - | - | - | - |
| 11 | Intersecting driveways and side streets | - | Y | - | - | - | Y | - | - | - | Y | - | - |
| 12 | Sight distance for gap acceptance | - | - | - | - | - | - | - | - | - | - | - | - |
| 13 | Grade change | - | - | - | - | - | - | - | - | - | - | - | - |
| **Total Possible Flags** | | 52 | | | | 52 | | | | 52 | | | |
| **Total Yellow Flags** | | 3 | | | | 2 | | | | 1 | | | |
| **Total Red Flags** | | 18 | | | | 18 | | | | 14 | | | |
| **Percentage of Yellow Flags** | | 6 | | | | 4 | | | | 2 | | | |
| **Percentage of Red Flags** | | 35 | | | | 35 | | | | 27 | | | |
| **Percentage Flagged** | | 41 | | | | 39 | | | | 29 | | | |

*Note:* E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag and “-” = No Flag

**Figure 8. Summary of Pedestrian Flag Assessment for Three of the Intersections Designs at Site 4**

**Table 10. Bicyclists Flag Assessment for Four of the Intersections Designs at Site 4**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **Conventional** | | | | **Two-Phase MUT** | | | | **MUT 1** | | | | **MUT 2** | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 4 | Crossing yield or uncontrolled vehicle paths | - | R | R | - | - | R | R | - | - | R | R | - | - | R | R | - |
| 5 | Indirect paths | - | - | R | - | - | - | R | - | - | - | - | - | - | - | - | - |
| 6 | Executing unusual movements | - | - | Y | - | - | - | Y | - | - | - | - | - | - | - | - | - |
| 7 | Multilane crossing | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |
| 8 | Long red times | R | R | R | R | - | - | - | - | - | - | Y | Y | Y | Y | Y | Y |
| 9 | Undefined crossing at intersections | - | - | Y | - | - | - | Y | - | - | - | - | - | - | - | Y | - |
| 10 | The motor vehicle left turn | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 11 | Intersecting driveways and side streets | - | Y | - | - | - | Y | - | - | - | Y | - | - | - | Y | - | - |
| 12 | Sight distance for gap acceptance | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 13 | Grade change | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 14 | Riding in mixed traffic | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |
| 15 | Bicycle Clearance Times | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |
| 16 | Lane Change across motor vehicle travel lanes | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |
| 17 | Channelized Lanes | - | R | R | - | - | R | R | - | - | R | R | - | - | R | R | - |
| 18 | Turning motor vehicles crossing bike path | R | Y | Y | R | R | Y | Y | R | R | Y | Y | R | R | Y | Y | R |
| 19 | Riding between lanes | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 20 | Off-tracking trucks in multi-lane curves | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Total Possible Flags** | | 68 | | | | 68 | | | | 68 | | | | 68 | | | |
| **Total Yellow Flags** | | 11 | | | | 9 | | | | 9 | | | | 11 | | | |
| **Total Red Flags** | | 27 | | | | 23 | | | | 22 | | | | 22 | | | |
| **Percentage of Yellow Flags** | | 16 | | | | 13 | | | | 13 | | | | 16 | | | |
| **Percentage of Red Flags** | | 40 | | | | 34 | | | | 32 | | | | 32 | | | |
| **Percentage Flagged** | | 56 | | | | 47 | | | | 45 | | | | 48 | | | |

*Note:* E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag and “-” = No Flag

**Figure 9. Summary of Bicyclists Flag Assessment for Four of the Intersections Designs at Site 4**

**Table 11. Bicyclists Flag Assessment for Three of the Intersections Designs at Site 4**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **Partial CFI** | | | | **CFI/MUT Combo** | | | | **Redirect 2L&T** | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 4 | Crossing yield or uncontrolled vehicle paths | R | R | R | - | R | R | R | - | - | R | R | - |
| 5 | Indirect paths | - | - | - | - | - | - | - | - | - | - | - | - |
| 6 | Executing unusual movements | Y | Y | - | - | Y | - | - | - | - | - | - | - |
| 7 | Multilane crossing | R | R | R | R | R | R | R | R | R | R | R | R |
| 8 | Long red times | R | R | R | R | R | R | R | R | R | R | - | - |
| 9 | Undefined crossing at intersections | - | - | - | - | - | - | - | - | - | - | - | - |
| 10 | The motor vehicle left turn | - | - | - | - | - | - | - | - | - | - | - | - |
| 11 | Intersecting driveways and side streets | - | Y | - | - | - | Y | - | - | - | Y | - | - |
| 12 | Sight distance for gap acceptance | - | - | - | - | - | - | - | - | - | - | - | - |
| 13 | Grade change | - | - | - | - | - | - | - | - | - | - | - | - |
| 14 | Riding in mixed traffic | R | R | R | R | R | R | R | R | R | R | R | R |
| 15 | Bicycle Clearance Times | R | R | R | R | R | R | R | R | R | R | R | R |
| 16 | Lane Change across motor vehicle travel lanes | R | R | R | R | R | R | R | R | R | R | R | R |
| 17 | Channelized Lanes | R | R | R | - | R | R | R | - | R | R | - | - |
| 18 | Turning motor vehicles crossing bike path | Y | Y | Y | R | Y | Y | Y | R | Y | Y | R | R |
| 19 | Riding between lanes | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 20 | Off-tracking trucks in multi-lane curves | - | - | - | - | - | - | - | - | - | - | - | - |
| **Total Possible Flags** | | 68 | | | | 68 | | | | 68 | | | |
| **Total Yellow Flags** | | 10 | | | | 9 | | | | 7 | | | |
| **Total Red Flags** | | 30 | | | | 27 | | | | 24 | | | |
| **Percentage of Yellow Flags** | | 15 | | | | 13 | | | | 10 | | | |
| **Percentage of Red Flags** | | 44 | | | | 40 | | | | 35 | | | |
| **Percentage Flagged** | | 59 | | | | 53 | | | | 45 | | | |

*Note:* E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag and “-” = No Flag

**Figure 10. Summary of Bicyclists Flag Assessment for Three of the Intersections Designs at Site 4**

Tables 12 and 13 present the pedestrian and bicyclist assessments, respectively, for the existing conventional intersection and the proposed MUT 1 and MUT 2 intersections at sites 5 and 6. In the pedestrian analysis, as shown in Table 12, the MUT 2 and MUT 1 intersections recorded the lowest number of red flags at 15% and 19%, respectively, compared to the conventional intersection at 27%. In the assessment of bicyclists, MUT 1 performed relatively better, recording a 10% reduction in the number of red flags compared to the conventional design. MUT 2 followed closely with a reduction of 7% compared to the conventional intersection. Figures 5 and 6 summarize the pedestrian and bicyclist assessments, respectively.

**Table 12. Pedestrian Flag Assessment for Site 5 and 6**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **Conventional** | | | | **MUT 1** | | | | **MUT 2** | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 1 | Motor vehicle right turn | R | Y | R | Y | R | Y | R | Y | R | Y | R | Y |
| 2 | Uncomfortable/tight walking environment | - | - | - | - | - | - | - | - | - | - | - | - |
| 3 | Non-intuitive motor vehicle movement | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 4 | Crossing yield or uncontrolled vehicle paths | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | Indirect paths | - | - | - | - | - | - | - | - | - | - | - | - |
| 6 | Executing unusual movements | - | - | - | - | - | - | - | - | - | - | - | - |
| 7 | Multilane crossing | R | R | Y | R | R | R | Y | R | R | R | Y | R |
| 8 | Long red times | R | R | R | R | R | R | - | - | Y | Y | Y | Y |
| 9 | Undefined crossing at intersections | - | - | - | - | - | - | - | - | - | - | - | - |
| 10 | The motor vehicle left turn | R | R | Y | R | - | - | Y | R | - | - | Y | R |
| 11 | Intersecting driveways and side streets | R | Y | R | Y | R | Y | R | Y | R | Y | R | Y |
| 12 | Sight distance for gap acceptance | - | - | - | - | - | - | - | - | - | - | - | - |
| 13 | Grade change | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| **Total Possible Flags** | | 52 | | | | 52 | | | | 52 | | | |
| **Total Yellow Flags** | | 14 | | | | 12 | | | | 18 | | | |
| **Total Red Flags** | | 14 | | | | 10 | | | | 8 | | | |
| **Percentage of Yellow Flags** | | 27 | | | | 23 | | | | 35 | | | |
| **Percentage of Red Flags** | | 27 | | | | 19 | | | | 15 | | | |
| **Percentage Flagged** | | 54 | | | | 42 | | | | 50 | | | |

*Note:* E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag and “-” = No Flag

**Figure 11. Summary of Pedestrian Flag Assessment for Site 5 and 6**

**Table 13. Bicyclists Flag Assessment for Site 5 and 6**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **Conventional** | | | | **MUT 1** | | | | **MUT 2** | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 4 | Crossing yield or uncontrolled vehicle paths | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | Indirect paths | - | - | - | - | - | - | - | - | - | - | - | - |
| 6 | Executing unusual movements | - | - | - | - | - | - | - | - | - | - | - | - |
| 7 | Multilane crossing | R | R | Y | R | R | R | Y | R | R | R | Y | R |
| 8 | Long red times | R | R | R | R | R | R | - | - | Y | Y | Y | Y |
| 9 | Undefined crossing at intersections | - | - | - | - | - | - | - | - | - | - | - | - |
| 10 | The motor vehicle left turn | R | R | Y | R | - | - | Y | R | - | - | Y | R |
| 11 | Intersecting driveways and side streets | R | Y | R | Y | R | Y | R | Y | R | Y | R | Y |
| 12 | Sight distance for gap acceptance | - | - | - | - | - | - | - | - | - | - | - | - |
| 13 | Grade change | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 14 | Riding in mixed traffic | R | R | R | R | R | R | R | R | R | R | R | R |
| 15 | Bicycle Clearance Times | R | R | R | R | R | R | R | R | R | R | R | R |
| 16 | Lane Change across motor vehicle travel lanes | R | R | R | R | R | R | R | R | R | R | R | R |
| 17 | Channelized Lanes | - | - | - | - | - | - | - | - | - | - | - | - |
| 18 | Turning motor vehicles crossing bike path | R | R | R | R | R | R | R | R | R | R | R | R |
| 19 | Riding between lanes | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 20 | Off-tracking trucks in multi-lane curves | - | - | - | - | - | - | - | - | - | - | - | - |
| **Total Possible Flags** | | 68 | | | | 68 | | | | 68 | | | |
| **Total Yellow Flags** | | 12 | | | | 15 | | | | 19 | | | |
| **Total Red Flags** | | 28 | | | | 21 | | | | 23 | | | |
| **Percentage of Yellow Flags** | | 18 | | | | 22 | | | | 28 | | | |
| **Percentage of Red Flags** | | 41 | | | | 31 | | | | 34 | | | |
| **Percentage Flagged** | | 59 | | | | 53 | | | | 62 | | | |

*Note:* E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag and “-” = No Flag

**Figure 12. Summary of Bicyclists Flag Assessment for Site 5 and 6**

The thru-cut was the only proposed design for site 7. Compared to the existing conventional intersection, the thru-cut performed relatively better, as evidenced by the highest percentage of flagged issues, as shown in table 14 and figure 13 for the pedestrian assessment. The percentage of red flags in the analysis of the conventional intersection was 25%, highlighting an 8% increase compared to the 17% of red flags for the thru-cut. However, it is important to note that the total number of flags in the thru-cut analysis was higher than that of the conventional intersection. This may be due to the conversion of most of the red flags in the conventional analysis into yellow flags in the thru-cut analysis.

A similar case is seen in the assessment of bicyclists, as presented in table 15 and figure 14. The thru-cut recorded a relatively higher number of total flags compared to the conventional intersection. However, the thru-cut performed better than the conventional intersection due to the lower percentage of red flags recorded. This may be due to the conversion of red flags in the assessment of the conventional intersection into yellow flags for the thru-cut intersection.

**Table 14. Pedestrian Flag Assessment for Site 7**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **Conventional** | | | | **THRU-CUT** | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 1 | Motor vehicle right turn | R | R | Y | R | R | R | Y | R |
| 2 | Uncomfortable/tight walking environment | - | - | - | - | - | - | - | - |
| 3 | Non-intuitive motor vehicle movement | - | - | - | - | - | - | - | - |
| 4 | Crossing yield or uncontrolled vehicle paths | - | - | - | - | - | - | - | - |
| 5 | Indirect paths | - | - | - | - | - | - | Y | Y |
| 6 | Executing unusual movements | - | - | - | - | - | - | Y | Y |
| 7 | Multilane crossing | Y | Y | R | R | Y | Y | R | R |
| 8 | Long red times | R | R | R | R | Y | Y | Y | Y |
| 9 | Undefined crossing at intersections | - | - | - | - | - | - | - | - |
| 10 | The motor vehicle left turn | R | R | R | R | R | R | R | R |
| 11 | Intersecting driveways and side streets | Y | - | - | - | Y | - | - | - |
| 12 | Sight distance for gap acceptance | - | - | - | - | - | - | - | - |
| 13 | Grade change | Y | Y | Y | Y | Y | Y | Y | Y |
| **Total Possible Flags** | | 52 | | | | 52 | | | |
| **Total Yellow Flags** | | 8 | | | | 17 | | | |
| **Total Red Flags** | | 13 | | | | 9 | | | |
| **Percentage of Yellow Flags** | | 15 | | | | 32 | | | |
| **Percentage of Red Flags** | | 25 | | | | 17 | | | |
| **Percentage Flagged** | | 40 | | | | 49 | | | |

*Note:* E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag and “-” = No Flag

**Figure 13. Summary of Pedestrian Flag Assessment for Site 7**

**Table 15. Bicyclists Flag Assessment for Site 7**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **Conventional** | | | | **THRU-CUT** | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 4 | Crossing yield or uncontrolled vehicle paths | - | - | - | - | - | - | - | - |
| 5 | Indirect paths | - | - | - | - | - | - | Y | Y |
| 6 | Executing unusual movements | - | - | - | - | - | - | Y | Y |
| 7 | Multilane crossing | Y | Y | R | R | Y | Y | R | R |
| 8 | Long red times | R | R | R | R | Y | Y | Y | Y |
| 9 | Undefined crossing at intersections | - | - | - | - | - | - | - | - |
| 10 | The motor vehicle left turn | R | R | R | R | R | R | R | R |
| 11 | Intersecting driveways and side streets | Y | - | - | - | Y | - | - | - |
| 12 | Sight distance for gap acceptance | - | - | - | - | - | - | - | - |
| 13 | Grade change | Y | Y | Y | Y | Y | Y | Y | Y |
| 14 | Riding in mixed traffic | R | R | R | R | R | R | R | R |
| 15 | Bicycle Clearance Times | R | R | R | R | R | R | R | R |
| 16 | Lane Change across motor vehicle travel lanes | R | R | R | R | R | R | R | R |
| 17 | Channelized Lanes | - | - | - | - | - | - | - | - |
| 18 | Turning motor vehicles crossing bike path | R | R | R | R | R | R | R | R |
| 19 | Riding between lanes | Y | Y | Y | Y | Y | Y | Y | Y |
| 20 | Off-tracking trucks in multi-lane curves | - | - | - | - | - | - | - | - |
| **Total Possible Flags** | | 68 | | | | 68 | | | |
| **Total Yellow Flags** | | 11 | | | | 20 | | | |
| **Total Red Flags** | | 24 | | | | 22 | | | |
| **Percentage of Yellow Flags** | | 16 | | | | 28 | | | |
| **Percentage of Red Flags** | | 35 | | | | 32 | | | |
| **Percentage Flagged** | | 51 | | | | 60 | | | |

*Note:* E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag and “-” = No Flag

**Figure 14. Summary of Bicyclists Flag Assessment for Site 7**

Table 16 and figure 15 present the results of the pedestrian assessment for the conventional, partial CFI, and CFI/MUT combo intersections for site 8. The partial CFI exhibited the highest total number of flags, constituting 40%, compared to the conventional and CFI/MUT combo, which showed total percentages flagged of 35% and 38%, respectively. The conventional and CFI/MUT combo showed the lowest percentage of red flags, while the partial CFI had the highest percentage of red flags at 27%.

The results of the bicyclist assessment are presented in Table 17, with a summary of the analysis shown in figure 16. Similar to the pedestrian assessment, the conventional and CFI/MUT combo performed better than the partial CFI, with the conventional recording the lowest total number of flags. All three intersections showed a similar percentage of red flags at 35%.

**Table 16. Pedestrian Flag Assessment of Conventional, CFI and CFI/MUT Combo for Site 8**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **Conventional** | | | | **CFI** | | | | **CFI/MUT Combo** | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 1 | Motor vehicle right turn | R | R | R | R | R | R | R | R | R | R | R | R |
| 2 | Uncomfortable/tight walking environment | - | Y | - | - | - | Y | - | - | - | Y | - | - |
| 3 | Non-intuitive motor vehicle movement | - | - | - | - | - | - | - | - | - | - | - | - |
| 4 | Crossing yield or uncontrolled vehicle paths | - | - | - | - | R | R | - | - | R | - | - | - |
| 5 | Indirect paths | - | - | - | - | - | - | - | - | - | - | - | - |
| 6 | Executing unusual movements | - | - | - | - | Y | Y | - | - | Y | - | - | - |
| 7 | Multilane crossing | R | R | R | R | R | R | R | R | R | R | R | R |
| 8 | Long red times | R | R | R | R | R | R | R | R | R | R | R | R |
| 9 | Undefined crossing at intersections | - | - | Y | - | - | - | Y | - | - | - | Y | - |
| 10 | The motor vehicle left turn | - | - | - | - | - | - | - | - | - | - | - | - |
| 11 | Intersecting driveways and side streets | - | - | - | - | - | - | - | - | - | - | - | - |
| 12 | Sight distance for gap acceptance | - | - | - | - | - | - | - | - | - | - | - | - |
| 13 | Grade change | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| **Total Possible Flags** | | 52 | | | | 52 | | | | 52 | | | |
| **Total Yellow Flags** | | 6 | | | | 7 | | | | 7 | | | |
| **Total Red Flags** | | 12 | | | | 14 | | | | 13 | | | |
| **Percentage of Yellow Flags** | | 12 | | | | 13 | | | | 13 | | | |
| **Percentage of Red Flags** | | 23 | | | | 27 | | | | 25 | | | |
| **Percentage Flagged** | | 35 | | | | 40 | | | | 38 | | | |

*Note:* E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag and “-” = No Flag

**Figure 15. Summary of Pedestrian Flag Assessment for Site 8**

**Table 17. Bicyclists Flag Assessment for Conventional, CFI, and CFI/MUT Combo for Site 8**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Flag Description** | **Conventional** | | | | **CFI** | | | | **CFI/MUT Combo** | | | |
| **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** | **E** | **W** | **N** | **S** |
| 4 | Crossing yield or uncontrolled vehicle paths | - | - | - | - | R | R | - | - | R | - | - | - |
| 5 | Indirect paths | - | - | - | - | - | - | - | - | - | - | - | - |
| 6 | Executing unusual movements | - | - | - | - | Y | Y | - | - | Y | - | - | - |
| 7 | Multilane crossing | R | R | R | R | R | R | R | R | R | R | R | R |
| 8 | Long red times | R | R | R | R | R | R | R | R | R | R | R | R |
| 9 | Undefined crossing at intersections | - | - | Y | - | - | - | Y | - | - | - | Y | - |
| 10 | The motor vehicle left turn | - | - | - | - | - | - | - | - | - | - | - | - |
| 11 | Intersecting driveways and side streets | - | - | - | - | - | - | - | - | - | - | - | - |
| 12 | Sight distance for gap acceptance | - | - | - | - | - | - | - | - | - | - | - | - |
| 13 | Grade change | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 14 | Riding in mixed traffic | R | R | R | R | R | R | R | R | R | R | R | R |
| 15 | Bicycle Clearance Times | R | R | R | R | R | R | R | R | R | R | R | R |
| 16 | Lane Change across motor vehicle travel lanes | R | R | R | R | R | R | R | R | R | R | R | R |
| 17 | Channelized lanes | - | - | - | - | - | - | - | - | - | - | - | - |
| 18 | Turning motor vehicles crossing bike path | R | R | R | R | Y | Y | R | R | Y | Y | R | R |
| 19 | Riding between lanes | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 20 | Off-tracking trucks in multi-lane curves | - | - | - | - | - | - | - | - | - | - | - | - |
| **Total Possible Flags** | | 68 | | | | 68 | | | | 68 | | | |
| **Total Yellow Flags** | | 9 | | | | 13 | | | | 11 | | | |
| **Total Red Flags** | | 24 | | | | 24 | | | | 24 | | | |
| **Percentage of Yellow Flags** | | 13 | | | | 19 | | | | 16 | | | |
| **Percentage of Red Flags** | | 35 | | | | 35 | | | | 35 | | | |
| **Percentage Flagged** | | 48 | | | | 54 | | | | 51 | | | |

*Note:* E = Eastbound, W = Westbound, N = Northbound, S = Southbound, R = Red Flag, Y = Yellow Flag and “-” = No Flag

**Figure 16. Summary of Bicyclists Flag Assessment for Site 8**