EVALUATION OF AASHTO RULES FOR IMPLEMENTATION OF CLIMBING LANES ON TWO-LANE HIGHWAYS

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EVALUATION OF AASHTO RULES FOR
IMPLEMENTATION OF CLIMBING LANES ON
TWO-LANE HIGHWAYS

BY

LUISA SCHÜLKE

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
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OF

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ABSTRACT

Lack of passing opportunities, due to limited sight distance and heavy oncoming traffic volumes in dense platoons, results in traffic operational issues on two-lane highways. Climbing lanes extend an opportunity for breaking traffic platoons on two-lane highway upgrades, thus potentially improving traffic operations on these segments. The American Association of State Highway and Transportation Officials promulgates guidelines to implement climbing lanes on two-lane highways that have remained unchanged over its last four editions of "A policy on Geometric Design of Highways and Streets". The guidelines do not account for the combination of variables known to determine specifically performance on two-lane highways by the current state-of-the-practice, in particular the opposing flow or the percentage of no-passing zone. Most state Departments of Transportation base their implementation decisions on climbing lanes on these old guidelines. They either refer to the AASHTO guidelines or interpret those directly as warrants. This research study evaluates the efficacy of the guidelines in the face of new research results on two-lane highway performance. The research deploys the Highway Capacity Software to evaluate the performance achieved with and without climbing lanes for two-lane highways for varied scenarios with randomly generated input values. The data serves to contrast the AASHTO recommendations for implementing climbing lanes with their necessity and sufficiency, thereby assessing their sampled efficacy. AASHTO recommendations only prove beneficial for 36% of the scenarios analyzed. Although certain study limitations apply, results point to a need to further research the study theme and potentially update the AASHTO guidelines.
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CHAPTER 1

INTRODUCTION

1.1 STATEMENT OF THE PROBLEM

Many of the traffic operational problems on rural two-lane highways result from the lack of passing opportunities due to limited sight distance and heavy oncoming traffic volumes in dense platoons. Drivers forcibly spend an uncertain amount of time following other vehicles and pass using the lane dedicated to the other travel direction through gaps in the opposing traffic. This might be dangerous due to the passing habits of drivers and dependent upon the presence of non-passing zones. Climbing lanes provide an effective method for improving traffic operations on upgrades on two-lane highways by extending additional passing opportunities at lower costs than would be required for the construction of a four-lane highway (Transportation Research Board, 2010).

This thesis will seek to evaluate parts of the guidelines for the implementation of climbing lanes on two-lane highways as promulgated by AASHTO, 2011. Evaluation will probe the necessity for, and the sufficiency of, climbing lanes when developed per the guidelines’ recommendations. The thesis focuses only on Class I rural two-lane highways, with segment lengths that result in a 30-mph speed decrease on upgrades ranging from 6% to 10%, which connect to flat terrain on the grade’s approach and departure. The study assumes for the most part uniformly distributed variables.
1.2 JUSTIFICATION OF THE STUDY

Climbing and passing lanes are introduced on two-lane highways in the aim of increasing their performance levels, breaking down platoons, enhancing travel speed and safety (Roess et al., 2011). In practice, most state Departments of Transportation (DOTs) base their decisions about implementing climbing lanes on old guidelines by the American Association of State Highway and Transportation Officials (AASHTO). These guidelines are a set of general conditions in which to consider a climbing lane. They have existed for over twenty years now and remained unchanged over at least four different editions of “A Policy on Geometric Design of Highways and Streets” (AASHTO, 1994, 2001, 2004, 2011). While these guidelines are useful, they do not account for the combination of variables known by the state-of-the-practice to determine specifically two-lane highway level of service (LOS).

This research shall determine if the AASHTO guidelines still apply in the face of enhanced methodologies to determine performance on two-lane highways or they need much improvement. If the guidelines prove questionable or inadequate, it is hoped that the research results may spur future research toward the development of enhanced guidelines for the implementation of climbing lanes on two-lane highways. Thus, resulting enhanced access to, and mobility of, goods and persons may promote enhanced economic, defense and transportation systems’ performances. In addition, the resulting enhanced maneuverability may promote enhanced transportation system safety. If the guidelines prove to be adequate, then surely transportation operators, Departments of Transportation (DOTs) in particular, would benefit from enhanced confidence in their use.
1.3 ORGANIZATION OF THE RESEARCH

This thesis comprises five chapters. The first chapter gives a brief overview of the purpose and the goals of the study. The second is a brief review of the literature. It addresses the general performance of two-lane highways, as well as the effects of steep grades, no passing zones and heavy vehicles, such as trucks or agricultural vehicles, on performance. It also scrutinizes the design of climbing lanes and the nature of the factors affecting this design.

The third chapter further seeks to determine the distribution of performance and design setting variables, their averages and normal ranges, for simulation purposes within the universe of two-lane highways in the U.S. A random number generator simulates hypothetical two-lane highway input values for the HCS software given the assumed distribution of input variables. For the range of input simulated, performance is sought with and without a well-designed climbing lane. Then the methodology derives the validity of the AASHTO guidelines.

Chapter 4 analyzes the results from the experiments. Performance results achieved enable an assessment of the AASHTO guidelines for climbing lane implementation. Lastly, Chapter 5 summarizes the thesis, presents the limitations and outlines the study’s conclusions and recommendations for future applications.
CHAPTER 2
REVIEW OF LITERATURE

2.1 CHARACTERISTICS OF TWO-LANE HIGHWAYS

This research addresses climbing lanes on rural two-lane highways. Rural two-lane highways are an essential element in the American highway system. Two-lane highways have a two-lane cross section, with one lane in each direction. For that reason, overtaking slower moving vehicles is only possible while using the opposing lane. Considering this limitation, sufficient sight distance or no-passing zones must be provided on two-lane highways (Transportation Research Board, 2010).

To ensure safety, every point on a highway must provide the safe stopping sight distance to drivers at the selected design speed. Passing sight distance constitutes the minimum sight distance required to perform safely a passing maneuver. Not every point on the highway needs provide the safe passing sight distance contrarily to stopping sight distance. Where passing sight distance is insufficient to allow for passing safely, passing should simply be disallowed. Especially two-lane highways rely on this safety measure, as passing maneuvers occur in the opposing traffic lane. Hence there must be “no-passing” zones or highway markings that prohibit passing where unsafe (Roess et al., 2011).

Effective methods to break down platoons, formed through lack of passing opportunities, or prevent their formations include turnouts, passing lanes at given intervals in each direction and climbing lanes on upgrades. To provide an exhaustive
overview, the study revisits the fundamentals of the three methods, even though climbing lanes are the sole focus of this research.

Turnouts provide sufficient room for slower moving vehicles to pull out of the through traffic, and stop if necessary, to permit following vehicles to pass or provide room for emergency stops. The location of turnouts depends on the type of facility. They are mostly provided where passing opportunities are limited, a high frequency of slow-moving vehicles exists and cost for a full auxiliary lane would be inappropriate for the effect it causes (Washington State DOT, 2017). Turnouts are widened shoulder areas on two-lane highways, that are rather short, generally less than 625 ft (Transportation Research Board, 2010).

In general, climbing lanes allow for passing slow trucks through the provision of a short added lane to the right side of upgrades for the exclusive use of trucks. Climbing lanes are necessary, where slower moving vehicles like trucks or heavy, agricultural vehicles impede traffic flow as following drivers of faster vehicles have limited to no opportunities to overtake. In these situations, faster vehicles must follow closely behind slower ones until they are able to pass, resulting in platoon formations. In consequence, performance and safety may deteriorate (AASHTO, 2011; Polus and Reshetnik, 1987). Fig. 1 displays plan view examples of climbing lane designs on two-lane highways.

A passing lane is defined as an “additional lane on highways to facilitate the passing of all types of slow moving vehicles at locations other than sustained grades where passing opportunities are unavailable or very limited over a long stretch of highway” (Arizona DOT, 2015). Furthermore, a climbing lane is defined as an
“additional lane on steep upgrades to facilitate the passing of trucks and slow moving vehicles whose speed drops because of the sustained grade rather than a lack of passing opportunity over a long stretch of highway” (Arizona DOT, 2015).

Figure 1: Design of a Two-Lane Highway with Added Climbing Lanes
Source: A Policy on Geometric Design of Highways and Streets, 2011, by the American Association of State Highways and Transportation Officials, Washington, D.C. Used with permission.

Climbing lanes increase the total number of lanes on a two-lane highway for a short travel segment, where the added lane shall be used by slower moving vehicles to allow faster moving vehicles to pass while staying in the normal lane. This is the main
difference to a regular passing lane, in which faster vehicles move to the additional lane to overtake the slower moving vehicles, which stay in the normal lane (Transportation Research Board, 2010).

2.2 TWO-LANE HIGHWAY PERFORMANCE MEASURES

To convey the quality of traffic flow on two-lane highways, the Highway Capacity Manual’s (HCM) Level of service (LOS) analysis incorporates three measures of effectiveness; _ATS_ (the average travel speed), _PTSF_ (the percent-time-spent-following) and _PFFS_ (the percent free flow speed) (Transportation Research Board, 2010). In effect, the HCM conveys that travel speed and overall maneuverability, the both, can be indicators of highway performance or quality of service.

The HCM distinguishes between two classes of rural two-lane highways. Class I highways are relatively high-speed roads, arterials, primary highways that afford mobility. _ATS_ and _PTSF_ define the LOS of these highways. On Class II highways, drivers do not expect to travel at high speeds. These roads are access routes to Class I facilities or serve short trips. Only _PTSF_ determines their LOS. The Florida Department of Transportation (FDOT) defines an additional class, Class III highways. They serve moderately developed areas and often have more limited passing options and much reduced speed limits to reflect higher activity level. For this class, _PFFS_ determines the LOS (Transportation Research Board, 2010).

This research will investigate only the validity of the AASHTO guidelines for climbing lane implementation on rural Class I collector and arterial highways. Speed matters the most on these highway types and upgrades affect directly truck travel
speeds. Considering that *ATS* and *PTSF* are the measures used for class I highways, the worse of the two determines the LOS.

New York State Department of Transportation (NYSDOT) provides 2 graphs for the determination of the prevailing LOS on two-lane highway segments in Appendix D1 and D2 of Chapter 5 of its highway design manual (New York State DOT, 2015). The graphs classify into LOS “C” or better, LOS “D” and LOS “E” or worse for undeveloped and developed segments, respectively. Per the definitions provided for undeveloped and developed segments, it is safe to conclude that they represent Class I and II HCS two-lane highways, respectively.

“The undeveloped case applies to rural highways where relatively high speeds of travel are expected and that are major intercity routes, primary highways connecting major traffic generators, daily commuter routes, primary links in state/national highway networks or any facility that serves long-distance trips” (New York State DOT, 2015).

“The developed case applies to all highways with an urban Functional Class. It also applies to some highways with a Functional Class of rural, but that serve developed areas (for example, a village), or a scenic or recreational area where speeds are expected to be lower” (New York State DOT, 2015).

NYSDOT does not consider the potentially negative impacts of unusually intense truck traffic on LOS; input variables to the graphs only include the AADT, expressed in vehicle per hour rather than passenger cars per hour, and the prevailing 85th percentile flow speed.
2.3 AASHTO GUIDELINES FOR CLIMBING LANE IMPLEMENTATION

Per the guidelines, a consideration of climbing lanes on two-lane highways is justified by the below-stated conditions.

1. Traffic flow on the upgrade exceeds 200 veh/h,
2. Truck flow on the upgrade exceeds 20 trucks/h,
3. One or more of the following conditions apply:
   a. A 10 mph speed reduction of typical truck,
   b. LOS “E” or “F” on the upgrade without a climbing lane,
   c. A reduction of two or more LOS when driving between approach and grade.

In addition, crash frequencies may also justify a climbing lane, regardless of the grade or traffic flow. Therefore, safety considerations are another important aspect in the decision making on climbing lane implementation (AASHTO, 2011).

A cursory review of the AASHTO guidelines reveals their 3-conditional composition addressing flow, part 1 and 2, performance limits, part 3, as well as safety, the additional clause. Flow and performance conditions apply jointly while safety applies independently. If any independent condition of the guidelines proves ineffective then so do the overall guidelines. Further, the performance guidelines condition, Part 3, consists itself of three independent sub-conditions, applying/ firing independently.

Flow guideline conditions relate to vehicle interactions within a single direction of travel, the upgrade. Yet, flow interactions between both the travel
directions, as dictated by volume distribution over travel lanes and percentage of no-passing zones are also known to impact on two-lane highway performance. If climbing lanes are meant to alleviate platoon creation and enhance performance, it seems logical that the opposing flow, or flow distribution, and the percentage of no-passing zones should also matter in their implementation guidelines.

The lack of opposing flow consideration seems remedied within the direct performance guidelines and mainly the last two, aimed directly at LOS or LOS reductions on the upgrade. In their lack of specificity on flow distribution and highway operation characteristics (no-passing zones percentage) or their interactions, latter guidelines withstand the test of time, even as procedures for the determination of LOS on two-lane highways vary and as long as LOS “E” and “F” continue to convey conditions near and beyond capacity, respectively. However, these conditions speak more of a need for enhanced performance levels. They do not ensure or guarantee their achievements through climbing lane provision on two-lane highways. AASHTO thus seems to assume automatically that well-designed climbing lanes always enhance two-lane highway performance from unacceptable to acceptable levels regardless of field conditions (i.e. flows, roadway geometries and operations).

Hypothetically, implementation of a climbing lane enhances significantly either performance or safety where a need for such enhancements exists. Reductions in the LOS letter grade capture the enhancements due to climbing lane implementation. Reliable software for two-lane highway performance prediction affords confirmation of gains in performance through climbing lane deployment. This capability should be enacted prior to actual field implementation. Performance enhancement need-based
guidelines may fail to satisfy without ensuring that actual performance enhancement gains accrue.

2.4 STATE DEPARTMENT OF TRANSPORTATIONS’ GUIDELINES FOR CLIMBING LANE IMPLEMENTATION

Several DOTs in the United States follow the AASHTO guidelines while making a decision on implementing climbing lanes on upgrades. These include the DOTs of Arizona (ADOT), California (CalTrans), Colorado (CDOT), Michigan (MDOT), Missouri (MoDOT), Montana (MDT), Nebraska (NDOT), New Jersey (NJDOT), Pennsylvania (PENNDOT), South Dakota (SDDOT) and Texas (TxDOT). NYSDOT views the AASHTO guidelines as warrants for climbing lanes on 2-lane highways. NYSDOT states, “However, other conditions may arise on low-volume highways where sufficient passing opportunities are not available where it might be advantageous to provide a climbing lane even though the warrants are not met” (New York State DOT, 2017b). Thus, NYSDOT hints to the AASHTO guidelines as not being exhaustive enough to capture the realm of possibilities that would justify developing climbing lanes. Unfortunately, NYSDOT does not spell out the exceptional conditions that may justify climbing lanes outside of the AASHTO guidelines. It only hints to these conditions being possibly related to the opportunity to pass and thus possibly, the opposing flow and the percentage of no passing zones.

MoDOT repeats the AASHTO guidelines but specifies that “(t)he Highway Capacity Manual and the AASHTO Green Book can also be used to determine the need for climbing lanes.” Further, it construes the flow guidelines as economically
inspired. “For low-volume roadways, only an occasional car is delayed, and a climbing lane may not be justified economically” (Missouri DOT, n.d.). The extent of delays sustained in total vehicle hours, rather than hours per vehicle, is thus a main motivator for implementing a climbing lane. Unfortunately, ATS or PTSF do not solely reflect this overall delay extent as incurred by traveling in platoons at slow speed. The total volume, $v$, of vehicles impacted matters as well.

Furthermore, Washington State DOT (WSDOT) interprets the AASHTO flow and speed performance guidelines as warrants. The first warrant relates to a speed reduction of 10 mph below the posted speed limit, AASHTO’s Guideline 3a. The second warrant combines two AASHTO guidelines. It relates to traffic volume on the upgrade, AASHTO’s Guideline 1, in excess of 200 vph and to truck volume on the same, AASHTO’s Guideline 2, in excess of 20 vph (Washington State DOT, 2017). In general, both these warrants must be met to justify a climbing lane. Under certain conditions, satisfaction of a single warrant may justify climbing lane implementation. “Either warrant may be waived if, for example, slow-moving traffic is causing an identified collision trend or congestion that could be corrected by the addition of a climbing lane” (Washington State DOT, 2017). Hence, WSDOT replaces “and” by “or” in the consideration of performance warrants, which become alternates. In addition, congestion (with platoon creation as possible manifestation) that may ensue from exceptional conditions, outside of warrants, may also serve as warrants. Unfortunately, as with NYSDOT, WSDOT does not specify these exceptional conditions.
In addition to following the AASHTO guidelines, CalTrans’ Design Manual states that, in general, an investigation for climbing lane need should follow when the upgrade is greater than 2% and the total rise is greater than 250 ft (California DOT, 2017). Maryland DOT specifies that exceeding the critical length of grade, satisfaction of AASHTO’s Guideline 3a, shall not solely be a warrant for climbing lanes. But rather, where the critical lengths of grade are exceeded and moderate to heavy traffic volumes exist, considerations for implementing a climbing lane should follow (Maryland DOT, n.d.).

In summary, most DOTs adopt the AASHTO guidelines verbatim for implementing climbing lanes on two-lane highways. Some DOTs, such as NYSDOT and WSDOT, may implement climbing lanes outside of the AASHTO guidelines where unspecified conditions mandate. WSDOT further considers the flow and performance guidelines independently as warrants. In addition, it drops from consideration the last two sub-conditions of the performance warrant. Finally, MoDOT refers to the possibility of leveraging the HCM to determine the need for climbing lane implementation.

2.5 CLIMBING LANE DESIGN CONSIDERATIONS

The following paragraphs will state the considerations about the design of climbing lanes by AASHTO and varied DOTs: ADOT, CDOT, Illinois (IDOT), Maryland (Maryland DOT), Michigan (Michigan DOT), MoDOT, MDT, NDOT, NJDOT, NYSDOT, SDDOT, TxDOT, Wisconsin (WisDOT) and WSDOT. To avoid any confusion in DOTs, the study spells out Maryland and Michigan DOTs given the
same acronym utilized by the both. Table 1, below, gives a summary of the climbing lane design considerations by AASHTO and the state DOTs.

| Climbing lane design | AASHTO | State DOTs |
|----------------------|--------|------------|
| Startup Location     | Where trucks’ speeds are not tolerable anymore (critical length) | Per AASHTO |
| End Location         | Beyond crest, where truck reaches a speed up to 40 mph or only varies up to 10 mph to surrounding traffic | Per AASHTO |
| Width                | 12 ft. | Per AASHTO |
| Entry Taper Length   | At least 300 ft. with 25:1 ratio | 150 – 500 ft with 25:1 ratio |
| Exit Taper Length    | At least 600 ft given 50:1 ratio | Minimum of 200 ft with varying ratios depending on design speed (50:1, 60:1, 70:1) |
| Shoulder Width       | Maintained for whole segment | Maintained, but may be reduced to 4 ft. If climbing lane width is 11 ft, shoulder width must be 5 ft wide |

Table 1: Climbing Lane Design Considerations
Source: Based on AASHTO, 2011 and State DOTs

The startup location of the climbing lane depends on the trucks’ speeds when approaching the grade and on the sight distance limitations at the approach. When conditions permit, a climbing lane can be introduced beyond the beginning of an upgrade if the speed of trucks will not immediately reduce to an intolerable speed for following drivers up the grade. Still, no sight distance restriction or other limitations to the speed must be at play (AASHTO, 2011).

The critical length is defined as “the maximum length of a specific upgrade on which a loaded truck can operate without an unreasonable reduction in speed” (Illinois DOT, 2016). If the length of the upgrade is longer than the critical length, trucks are at
risk to attain speed reductions and operations that are unacceptable (AASHTO, 2011). Typically, drivers do not tolerate the speed reduction of trucks on an upgrade, when the critical length of grade is reached, i.e. truck operating speed is reduced about 10 mph (New York State DOT, 2017b).

SDDOT states in general that an upgrade should not exceed 2,000 ft to guarantee acceptable operations. SDDOT construes the critical length of grade to equal 2,000 ft, regardless of grade percentage. On grades longer than the critical length, consideration of an additional lane should be made (South Dakota DOT, n.d.).

“Fig. 2 shows the critical lengths of grades associated with varied upgrade slopes and for varied acceptable speed reductions given a representative truck of 200 lb/hp and a grade entry speed of 70 mph. The 10 mph speed-reduction graph needs to be paid special attention as this represents the general guideline for estimating critical length. In the past a speed reduction of 15 mph was used to determine this length of grade, however, the crash involvement of trucks experiences a significant increase when truck speed reduction is higher than 10 mph. This led to the recommendation to determine the critical length of grade by using the 10 mph curve” (AASHTO, 2011).

The chart for critical length of grade presented in Fig. 2, sourced from Fig. 3-63, AASHTO, 2011, considers a truck entry speed of 70 mph at the upgrade. Nevertheless, if the upgrade in question immediately follows a previous upgrade, the truck speed may already be lower than the design speed. In this case, the critical length of grade will be smaller. This consideration applies equally to an upgrade with an
immediately approaching downgrade, where it is known that truck drivers will accelerate to get a “running start” at it. The critical length of grade will be longer than with a level entrance in that case (Harwood et al., 2003). This research will only focus on level terrain approaches and departures to upgrades.

Figure 2: Critical Lengths of Grades Based on Truck Speed Reductions
Source: A Policy on Geometric Design of Highways and Streets, 2011, by the American Association of State Highways and Transportation Officials, Washington, D.C. Used with permission.

The critical length of grade is derived as the length of a tangent grade. An approximate equivalent length of tangent grade must be used where a vertical curve is part of a critical length of grade. When there are vertical curve tangents with only positive or only negative grades and the algebraic difference in grades is not too great, the measurement of critical length of grade is derived between the vertical points of intersection (VPI). Where vertical curves with positive and negative tangents are involved, particularly where the algebraic difference in grades is appreciable, about one-quarter of the vertical curve length may be considered as part of the grade under
consideration (AASHTO, 2011). As this research will only consider grade connections to flat terrain, where the algebraic difference in grades will have an average to small value, the former measurements of critical length applies.

AASHTO recommends that the climbing lane should be developed through a tapered entry section with a ratio of 25:1 and a length of at least 300 ft (AASHTO, 2011). WSDOT, 2017, also affords a climbing lane taper at the 25:1 rate, given lane width and cross slope identical to those of the adjoining through lane. Thus, taper length would be at 300 ft, as per AASHTO, 2011, only for 12-ft lane highways and assuming stated conditions are met. Most DOTs demand the 25:1 ratio with a minimum entry taper length of 150 ft (Maryland DOT, n.d; Missouri DOT, n.d; Colorado DOT, 2005; New Jersey DOT, 2015; New York State DOT, 2017b; Texas DOT, 2018). NJDOT, NDOT and SDDOT require 300 ft, whereas Michigan DOT even requires 500 ft long entry tapers (South Dakota DOT, n.d; Michigan DOT, 2011; Nebraska DOT, 2011; New Jersey DOT, 2015).

To be effective, the full-width climbing lane itself, excluding the tapers, should be at least 1,000 ft long per IDOT (IDOT, 2016). SDDOT states that the length of the full-width climbing lane should at least be 0.5 mi, 2,640 ft, (South Dakota DOT, n.d.) and NDOT demands 1,200 ft (Nebraska DOT, 2011). A study from ADOT states that the majority of passing and climbing lanes on two-lane highways in the state of Arizona have a length of 0.5 mi to more than 1.0 mi (Arizona DOT, 2015).

AASHTO recommends that lane and shoulder widths be maintained for roadway segments with climbing lanes (AASHTO, 2011). Still, “Whenever possible,
maintain a shoulder width equal to that of the adjacent roadway segments (preserve shoulder width continuity). On two-way two-lane highways, the shoulder may be reduced to 4 ft. If the shoulder width is reduced to 4 ft document the reasoning for the decision in the design parameter sheets. If the shoulder width is reduced to less than 4 ft, a design analysis is required.” (Washington State DOT, 2017). NJDOT echoes the general sentiment of AAHSTO and WSDOT. The climbing lane should be as wide as the through lane, desirably 12 ft, with a shoulder width of 4 ft. If the climbing lane width is only 11 ft, the shoulder should be 5 ft wide (New Jersey DOT, 2015).

The cross slope of a two-lane highway with a climbing lane is handled in the same manner as the addition of a lane to a multilane highway (AASHTO, 2011). WSDOT further limits entrance speed for trucks to 60 mph, regardless of the posted speed limit, for assessing whether the AASHTO speed performance warrant is met (Washington State DOT, 2017). Trucks’ approach speed at the grade should be estimated at 55 mph (Illinois DOT, 2016). WSDOT estimates approach speeds of 60 mph (Washington State DOT, 2017). AASHTO hints to the varied entry speeds as indicative of the variation in design speed for varied states.

Further, AASHTO legitimizes the practice of assuming varied entry speed to its critical length graphs, Fig. 2. Although Fig. 2 assumes a grade entry speed of 70 mph, it can be applied to any design speed (Montana DOT, 2007). The graphs can be viewed as entry speed insensitive and indicative only of speed reduction. Per AASHTO, if there is a difference in initial and minimum tolerable speeds because of a lower design speed, the critical length will still be the same for the 10 mph speed reduction with a design speed of 70 mph (AASHTO, 2011). Accordingly, a truck will
travel the same critical length to experience a speed reduction of 10 mph, whether starting at 70 mph and ending at 60 mph or traveling at 60 mph and ending at 50 mph.

The climbing lane shall be extended beyond the crest, at which point trucks could gain a speed of at least 40 mph and that only varies up to 10 mph to the speed of the vehicles in the normal lane. As trucks need a long distance to accelerate to the desired speed, this scenario might not be practical in many cases. Hence the climbing lane could end where trucks can merge to the normal lane without interfering with other traffic. This could be where the sight distance becomes sufficient or when there is no oncoming traffic. Two hundred (200) ft beyond the crest of the curve is a recommended point to end the full width climbing lane (South Dakota DOT, n.d; AASHTO, 2011; Nebraska DOT, 2011; Texas DOT, 2018).

In addition, an exit taper with an appropriate length needs to be provided to allow trucks to merge back into the normal lane. This exit taper should be at least 600 ft. long with a ratio of 50:1 (AASHTO, 2011). Most DOTs agree with this ratio, however, CDOT and Maryland DOT only require a minimum exit taper length of 200 ft (Maryland DOT, n.d; South Dakota DOT, n.d; Colorado DOT, 2005; Nebraska DOT, 2011). MDT states that the exit taper rate should vary, depending on the design speed. Hence, a 50 mph design speed would require a ratio of 50:1, a design speed of 60 mph would require a 60:1 ratio and a 70 mph design speed would require a 70:1 ratio for the exit taper (Montana DOT, 2007).

WSDOT recommends to “begin climbing lanes at the point where the speed reduction warrant is met, and end them where the warrant ends, for multilane highways, and 300 ft beyond for two-lane highways. Consider extending the auxiliary
lane over the crest to improve vehicle acceleration and sight distance” (WSDOT, 2018).

2.6 PERFORMANCE ASSESSMENT OF TWO-LANE HIGHWAYS WITH CLIMBING LANES

To assess the impact of climbing lanes on the operation of two-lane highways, the HCS analysis proceeds as with a passing lane in level or rolling terrain. As major procedural differences, the adjustment factors, $f_{pl}$, for estimating $ATS$ and $PTSF$ within a climbing lane takes on different values and the distances, $L_u$, length upstream of climbing lane, and $L_d$, length downstream of climbing lane beyond its effective length, are set to zero. If the lane ends before the grade does, the $L_{de}$, effective segment length, is also set to zero (Transportation Research Board, 2010).
CHAPTER 3

METHODOLOGY

Data impacting two-lane highway performance will be randomly generated for varied scenarios, with or without climbing lanes, based on the below outlined experimental scenarios. Performance data for simulated scenarios will be collected using McTrans’ Highway Capacity Software (HCS 7), which enacts the procedures defined in the Highway Capacity Manual (Transportation Research Board, 2010). Data analysis will determine whether the guidelines adequately predict the necessity and sufficiency of climbing lanes for the cases simulated given the HCS 7 predictions. To classify or interpret the performance enhancements reached due to the implementation of climbing lanes for simulated cases, the study gauges an acceptable LOS on two-lane highway, LOS “C”. Furthermore, it assesses the efficacy of the guidelines by interpreting their classification rates of sampled scenarios for the necessity and sufficiency of climbing lanes in view of the HCS 7 performance gains they achieve.

3.1 DATA GENERATION

3.1.1 Highway Capacity Software (HCS 7)

For the generated scenarios, HCS 7 establishes the performance of hypothetical two-lane highways, with or without a climbing lane. The software, developed and maintained by the McTrans Center, University of Florida, utilizes input information about the terrain, traffic volumes and geometric characteristics for highway segments
under study and provides the associated LOSs and additional data related to the operation of the facility.

3.1.2 HCS Default Values Utilized

Simulated scenarios utilize some default values, from HCS 7, as input variables. These include the default values for the recreational vehicle percentage, 4%, the access-point-density, 8 per mile, the lane width, 12 ft and the shoulder width, 6 ft. Cited lane and shoulder widths are common values for Class I two-lane highways (Transportation Research Board, 2010). The scenarios utilize the actual equivalents for trucks and RVs, $E_T$ and $E_R$, as tabulated by HCS 7 for the both, $ATS$ and $PTSF$. Peak hour factor, $PHF$, is set to a value 0.8, as the $PHF$ in rural areas generally varies between 0.7 and 0.98 (Roess et al., 2011).

As stated earlier in the literature review, grade approach speeds on two-lane highways for trucks are assessed at 55 mph to 60 mph (IDOT, 2016; WSDOT, 2017) per the default value of HCS 7. Research scenarios thus assume a free-flow speed of 60 mph. Given this entry-speed assumption, the critical length can easily be estimated using Fig. 2, Chapter 2.5, for varied grade percentages as the projection on the distance axis of the intersection point of the curves for a 10 mph speed reduction and grade percentage. Even though the figure is based on a 70 mph entering speed, it can be used for different entry speeds as it is entry-speed insensitive (AASHTO, 2011).

For example, using Fig. 2, the critical lengths associated with 9% and 6% slopes, equal 500 ft and 775 ft respectively. The lengths obtain from Fig. 2 and not calculations. Grade values utilized in the study are not necessarily integers, but real
values rounded up or down to a multiple of 0.5. Since HCS 7 only allows grade percentage values in the range between 3.0% and 9.9%, the highest percentage used in study equals 9.9%, even though displayed at times in the following tables at its rounded value of 10%.

The length of grade is estimated to be the critical length associated with a 30 mph speed reduction, \( L_{30} \), per Fig 2. Consequently, there will be a different length of grade for each grade percentage analyzed. The critical length ranges between 1,230 ft for the highest upgrade considered in simulated scenarios, 10%, and 2,250 ft for the smallest upgrade considered, 6%. Table 2 displays the derived lengths of grade and climbing lane lengths associated with each value of scenario upgrade. Unfortunately, HCS 7 allows only grade length values in the range of 0.25 mi to 4.0 mi. Therefore, the lowest length of grade must be 0.25 mi, which equals 1,320 ft. The length of grade for 9.5% and 10% thus rounds up to 0.25 mi.

As outlined in the literature review, AASHTO and the DOTs have different standards for climbing lane design. The climbing lane should include entry and exit
tapers of approximate lengths equal to 300 ft to 600 ft and 250 ft, respectively. The location, where the climbing lane should start, depends on the determination of critical grade length, typically associated with a 10 mph speed reduction on upgrades for a typical truck, $L_{-10}$. Thus, subtracting the critical length from the grade length derives the full-width climbing lane length on upgrade. This calculation repeats for every grade percentage analyzed. Given that the climbing lane should extend to a point 200 ft to 300 ft beyond the crest or where the truck has reached a speed that is only 10 mph below the speed of the surrounding vehicles, 3,200 ft, $L_{+20}$, shall be added to the climbing lane length. This length obtains from Figure 3-25, AASHTO (2011), as the projection on the distance axis of the intersection point of the 20 mph speed increase with the zero (0%) upgrade curve. In addition, 300 ft added to the climbing lane length account for the added distance afforded by AASHTO to deploy the exit taper.

The following equation, Eq. 1, sums up the stated considerations and derives the length of the full-width climbing lane. The full-width climbing lane, $L_{FW}$, should be at least 0.5 mi-, or 2,640 ft, long (AASHTO, 2011).

$$L_{FW} = L_{-30} - L_{-10} + L_{+20} + 300$$

When considering the equation above and the values in the table below, the actual climbing lane length, $L$, for each grade can be calculated by adding the entry taper length, 300 ft, and the exit taper length, 250 ft. The following equation derives the total length of the climbing lane.

$$L = 300 + L_{FW} + 250$$
Table 2 presents this length in its last column. Regarding the recommendations from AASHTO, a minimum climbing lane length to consider equals about 0.66 mi (300 ft + 2,640 ft + 300 ft + 250 ft = 3,490 ft).

It can be observed that the derived climbing lane lengths are longer than the minimum climbing lane length recommended by AASHTO.

| Grade % | $L_{-10}$ = Critical Grade Length, 10 mph speed reduction | $L_{-30}$ = Critical Grade Length, 30 mph speed reduction | $L_{FW}$ = Full-width Climbing Lane Length | L = Climbing Lane Length |
|---------|----------------------------------------------------------|----------------------------------------------------------|------------------------------------------|--------------------------|
|         | in ft | in ft | in mi | in ft | in ft | in mi |
| 6       | 775   | 2250  | 0.43  | 4975  | 5525  | 1.0   |
| 6.5     | 725   | 2062  | 0.39  | 4837  | 5387  | 1.0   |
| 7       | 650   | 1875  | 0.36  | 4725  | 5275  | 1.0   |
| 7.5     | 590   | 1745  | 0.33  | 4655  | 5205  | 1.0   |
| 8       | 575   | 1615  | 0.31  | 4540  | 5090  | 1.0   |
| 8.5     | 535   | 1500  | 0.28  | 4465  | 5015  | 0.9   |
| 9       | 500   | 1390  | 0.26  | 4390  | 4940  | 0.9   |
| 9.5     | 480   | 1310  | 0.25  | 4330  | 4880  | 0.9   |
| 10      | 460   | 1230  | 0.23  | 4270  | 4820  | 0.9   |

Table 2: Full-Width and Overall Climbing Lane Lengths
Source: Based on AASHTO, 2011

3.1.3 Input Variables

Main variables of interest to the software include slope, directional split, total flow, percentage of trucks and no passing zones. Table 3 below presents realistic ranges of these variables for US two-lane highways. To simulate the scenarios in the software, the values for these variables need be randomly generated and input in the software data panels. The study assumes a uniform distribution of variables. This distribution is not terribly realistic for flow. However, it helps generate data in all flow...
ranges as to more clearly pinpoint weakness regions for AASHTO’s flow guidelines (anticipated in future studies).

| Variables (Two-Lane Highway with Climbing Lane) | Slope (%) | Total Flow (vph) | D-Factor | Truck Percentage (%) | No-Passing Zone Percentage (%) |
|-----------------------------------------------|-----------|----------------|----------|----------------------|-------------------------------|
| Lower limit                                   | 6         | 0              | 0.54     | 2                    | 20                            |
| Upper limit                                   | 10        | 3200           | 0.85     | 20                   | 100                           |

Table 3: Range of Two-Lane Highway Input Variables Simulated

Source: Based on Transportation Research Board, 2010

The range of slopes on rural Class I two-lane collector and arterial highways in rolling terrain varies depending on the design speed. For the common travel speeds of 40 mph to 60 mph on these highways (New York State DOT, 2017a), the slope varies between 6% and 10%, where collector highways with grades of 10% represent the worst case scenario (AASHTO, 2011). The percentage of no-passing zones on two-lane highways, as linked with sight distance realized mostly on curves, varies between 20% and 100% (Transportation Research Board, 2010).

Flow on two-lane highways has a high variance, as high and low flows are combined into one distribution (Gerlough and Huber, 1975). The total flow, in both directions, on two-lane highways can reach up to 3,200 passenger cars per hour (pcph). Yet, the directional capacity reaches only 1,700 pcph with a maximum opposing flow of 1,500 pcph (Transportation Research Board, 2010).

The proportional factor between the opposed flows (D-Factor) sways usually the interval of 0.65 to 0.85 for two-lane highways (Roess et al., 2011). The truck percentage varies between 2%, the default value of the HCS, and 20% considered a
high percentage by NYSDOT, 2017a, and representing the upper limit of the Highway Capacity Manual (Transportation Research Board, 2010).

3.1.4 Random Generation

A random number generator derives performance-impacting input variables for varied scenarios on two-lane highways. These probabilities combine with the known distributions of the input variables to identify them uniquely. Variables are generated singly assuming their independence and an input entry covariance matrix with zero (0) entries. Random number generation is the generation of a sequence of numbers that is uniformly distributed and cannot be predicted reasonably better than by a random chance. A simple example is simulating the toss of a die (Hoover and Perry, 1989).

Microsoft Excel has two functions to generate random numbers, the RAND( ) and RANDBETWEEN() function. These functions are uniform. The study deploys both the functions to generate input values for the experiments, per their ranges stated in Table 3. The RAND( ) function generates a random decimal number between 0 and 1 and is used for the values of the D-Factor, no-passing zone and slope percentage. To generate a D-Factor for instance, the RAND( ) function result leads to the specific D-Factor value not exceeded at this specific result value considered for probability value. Assuming a uniform distribution of D-Factor within the range [0.54, 0.85], the RAND( ) function results can be manipulated as follows: 0.54 + 0.31 * RAND( ) to randomly generate them.

To generate random integers the RANDBETWEEN( ) function is used. It generates random integers (no decimal numbers) between two individually set
boundaries (Easy Excel, 2018). The function =RANDBETWEEN (x; y) determines flow in the analysis direction and the truck percentage.

Table 6 in Appendix A presents a listing of all randomly generated values. The study randomly generates flow in pcph, as restrained to observe the directional and total capacity limits on two-lane highways. Total flow does not exceed 3,200 pcph and directional flow 1,700 pcph. In addition, for high values of total flow, opposing flow does not exceed 1,500 pcph. Yet, HCS 7 requires flow entries in vph. However, the conversion of directional flows from pcph to vph is not evident as it depends on the opposing flow already pre-expressed in vph. Conversion thus of directional flows from pcph to vph is a nonlinear process for two-lane highways.

Random flow generation starts with the derivation of directional flows, whether in the analysis direction, upgrade or its opposite direction, downgrade. Simulated flow values vary from 0 up to the directional capacity limit, 1,700 pcph. Opposite flow is derived using the simulated D-factor to deduct total flow and hence opposite flow, thereby dividing the analysis directional flow by the D-Factor and multiplying the result by the difference (1 - D-Factor). The range of values taken by the D-Factor, was adjusted to naturally restrain total flow to verify its capacity limits, or to values lesser than 3,200 pcph. The range of 0.54 to 0.85 was adopted, modifying the lower range limit from pre-cited literature (Roess et al., 2011), HCM capacity values permitting.

It may well be that the study artificially restrained the D-Factor to sway a limited range. However, the relevant literature duly references the range utilized,
although the same documents other ranges that would not necessarily limit opposing flow to its upper bound.

Further, to bypass flow conversion, the analysis directly inputs generated flows in pcph, kept within their directional capacity limits, as HCS 7 flow entries in vph. Overshooting the required range of data input ensured its adequate coverage of the coveted range in pcph. Where generated flows within HCS 7, in pcph, exceed directional capacity within a scenario, the analysis eliminates this scenario and its results from further considerations. Table 8 in Appendix D documents every scenario’s ATS and PTSF directional flows. Scenarios with flows exceeding the limits of 1,700 pcph in one direction or 1,500 pcph in the other (assuming higher opposite directional flows), or the total capacity of 3,200 pcph are marked with a “0” in the last column of Table 8, *Capacity Compliance*. Scenarios with flows within the capacity boundaries are marked with a “1”.

Switching the direction of generated flow, upgrade versus downgrade, ensures that high flows are not limited to the analysis direction. Half of the software runs generate flows in the analysis direction and the other half in the opposite direction, leading to two different data streams. The analysis fused both the streams using a random scenario/record sorting method in Excel.

### 3.2 DESCRIPTIVE STATISTICS FOR GENERATED FLOW DATA

Flow input values to HCS 7 as randomly generated for the ATS analysis directional flows sway the range of 12 pcph to 1,697 pcph, with an average flow of 775 pcph. Fig. 4 shows a histogram of the ATS analysis directional flows.
Total ATS flow sways the range of 14 pcph to 3,071 pcph, with an average of 1,353 pcph. Fig. 5 shows a histogram of the ATS total flows.

Figure 4: Histogram ATS Analysis Direction Flow in pcph

Figure 5: Histogram ATS Total Flow in pcph
3.3 DATA COLLECTION

The experiments deploy the HCS 7 from McTrans to determine the LOS of hypothetical two-lane highways with randomly simulated input variables. These runs are performed in United States Customary units. The following figure shows the Input Data Panel for the analysis direction on the upgrade.

![Input Data Panel in HCS 7](image)

Prior to the analysis, certain entry values need set in the Input Data Panel to their scenario values for both, the analysis and opposing directions of travel. This, in addition to using the HCS 7 default values cited in Section 3.1.2 above. The terrain must be set to “Specific Grade”, which will enable the functional buttons for “grade percentage” and “length of slope”. PHF, truck percentage, no-passing zone percentage and Segment Length need to be input. The study assumes that the climbing lane length is equal to the segment length, which is the length of the section analyzed. The segment lengths obtain from Table 2. Flows obtained for the analysis and
opposing directions need also be set accordingly in the *Input Data Panel*. A listing of these values is enclosed in Table 7 in Appendix B.

Fig. 7 shows the *Passing Lane Analysis Panel*. For software runs that do not include a climbing lane, the “No Passing Lane” option needs to be selected in the *Input Data Passing Lane Analysis Panel* dropdown list. For software runs with an added climbing lane, the option “Climbing Lane” must be selected in the same. In this section the entry “Length of Two-Lane Highway Upstream of the passing lane” \( L_u \) is automatically set to zero, “0”, and the “Length of Passing Lane Including Tapers”, \( L_{pl} \), to the segment length. Therefore, the segment length equals the climbing lane length.

Following data entry, the software automatically executes, and the LOS of the two-lane highway is attained (Transportation Research Board, 2010). Fig. 8 shows the

![Figure 7: Input Data Panel Passing Lane Section](image)  
*Source: HCS 7*
result panel, *Level of Service and Other Performance Measures Panel*, for the analysis of a two-lane highway without climbing lane. A LOS “C” or better is satisfying.

| Level of Service and Other Performance Measures                  |
|------------------------------------------------------------------|
| Level of Service, LOS                                           | B |
| Volume-to-Capacity Ratio, v/c                                   | 0.14 |
| Peak 15-minute Vehicle Travel                                   | 51 veh mi |
| Peak-Hour Vehicle Travel                                        | 163 veh mi |
| Peak 15-minute Total Travel Time, TT                            | 1.0 veh hr |

**Figure 8: Level of Service and Other Performance Measures Panel**  
*Source: HCS 7*

Further execution results can be obtained from the *Free-Flow Speed Panel*, as displayed in Fig. 9. The average travel speed, *ATSd*, helps assess/confirm whether AASHTO’s Guideline 3-a holds true.

| Free-Flow Speed | Measured | Estimated |
|-----------------|----------|-----------|
| Field Measured Speed, SFM | mi/h | Base Free Flow Speed, BFFS | 60.0 mi/h |
| Observed Total Demand, v | veh/h | Adj. for Lane and Shoulder Width, ILS | 0.0 mi/h |
| Adj. for Access Point Density | 2.0 mi/h |
| Free Flow Speed, FFS | 58.0 mi/h |
| Adj. for No Passing Zones, frp | 2.5 mi/h |
| Average travel speed, ATSd | 51.0 mi/h |
| Percent Free Flow Speed, PFFS | 88.0 % |

**Figure 9: Free-Flow Speed Panel**  
*Source: HCS 7*

HCS 7 reports on the input data and results of software runs. Appendix C 1-5 show example reports for scenarios 68, 197, 307, 347 and 501.
3.4 DATA PROCESSING AND DATA ANALYSIS PROCEDURES

A preliminary review of the AASHTO guidelines on the implementation of climbing lanes (AASHTO, 2010) helps determine the logical clauses to test toward assessing their efficacy. If efficient, a climbing lane should be both, necessary and sufficient. Assuming necessity, for climbing lane implementation or non-implementation, then for a prevalence of cases the below logical clause should hold true.

1. If the guidelines are satisfied and no climbing lane exists, then unacceptable performance must prevail (proper classification).
2. If the guidelines are not satisfied and a climbing lane exists, then unacceptable performance must prevail (proper classification).

Further, sufficiency of the guidelines implies that the below logical clauses should hold true as well.

3. If the guidelines are satisfied and a climbing lane exists, then acceptable performance must prevail (proper classification).
4. If the guidelines are not satisfied and a climbing lane does not exist, then acceptable performance must prevail (proper classification).

Logical Clause 4 is not as restrictive as earlier clauses for conditions of low flows or given the violation of flow guidelines, as AASHTO considers the limited economic impact of engendered delays by such flows to advice against climbing lane implementation.

The analysis views the AASHTO guidelines as a scenario classifier for the efficacy of the implementation of a climbing lane. It tests logical clauses determining
the necessity and the sufficiency of the AASHTO guidelines using the HCS 7 performance predictions for the quasi-representative sample scenarios earlier generated. If the clauses are untrue, the guidelines misguide and thus misclassify on the efficacy, necessity or sufficiency, of climbing lanes. If true, the guidelines classify correctly on the same. The analysis further determines a running percentage of the AASHTO guideline classification rates, proper classification and types I or II classification error rates, with large enough a sample size to stabilize the rates achieved. The extent of these rates bears witness to the efficacy, necessity and sufficiency, of the AASHTO guidelines taken verbatim as warrants, a rather typical DOT practice.

An acceptable level of service on two-lane highways must be gauged to classify or interpret the performance enhancements reached due to the implementation of climbing lanes for simulated cases. In this study, LOS “C” constitutes the minimum acceptable level for the research question.

Table 9 in Appendix E documents the results of the software experiments in a spreadsheet. Records relate to individual software run, hence scenario, results as numbered consecutively in Column 1, entitled Scenario Number. Column 19 and 20, LOS (No Climbing Lane) and LOS (Climbing Lane), display the LOSs achieved for the scenarios without and with a climbing lane, respectively. Columns 21, 22, and 23 convey whether the scenarios per their traffic flow and performance conditions satisfy the AASHTO Guidelines 1, 2 and 3, Guideline 1 Satisfied, Guideline 2 Satisfied and Guideline 3 Satisfied, respectively. Entries of “0” and “1” in column 21, 22 and 23
point respectively to the dissatisfaction and to the satisfaction of the respective guideline.

Column 24, Guidelines Satisfied (overall), conveys the general satisfaction or dissatisfaction of the AASHTO guidelines. For simplicity of analysis and owing to the “OR” consideration for the performance conditions of the guidelines, guideline satisfaction is verified at its minimal acceptation. For instance, Guideline 3b does not have to necessarily be checked, if Guideline(s) 1, 2 and 3a are satisfied. And Guideline 3c needs not be checked if Guidelines 1 and 2, plus one of the Guideline(s) 3a or 3b are satisfied.

In Column 25, Acceptable Performance (No Climbing Lane), and 26 Acceptable Performance (Climbing Lane), entries denote the acceptability of scenario LOSs without and with a climbing lane. LOS grades of “C” or better are considered acceptable and thus entail column entries of “1”. Lower LOS grades relate to unacceptable performances and generate “0” entries.

Four spreadsheet columns, Columns 27, 28, 29 and 30, Logical Clause 1 Valid, Logical Clause 2 Valid, Logical Clause 3 Valid and Logical Clause 4 Valid, convey for each scenario the satisfaction of the Logical Clause(s) 1, 2, 3 and 4 earlier specified, Section 3.3, which establish the necessity and the sufficiency of a climbing lane. As with Guidelines 1, 2 and 3, entries of “0” and “1” convey the dissatisfaction and the satisfaction of a logical clause, respectively. Satisfaction of Logical Clause 1 entails
1) the satisfaction of overall AASHTO guidelines (“1” entry, Column 24) AND
2) an unacceptable performance without a climbing lane (“0” entry, Column 25).

Scenarios that satisfy Logical Clause 1 generate an entry of “1” in Column 27. Otherwise “0” entry registers in this column. Further, the satisfaction of Logical Clause 2 entails

3) the lack of satisfaction of overall AASHTO guidelines (“0” entry, Column 24) AND
4) an unacceptable performance with a climbing lane (“0” entry, Column 26).

Scenarios that satisfy Logical Clause 2 generate an entry of “1” in Column 28. Otherwise a “0” entry registers in this column. Further, the satisfaction of Logical Clause 3 entails

1) the satisfaction of overall AASHTO guidelines (“1” entry, Column 24) AND
2) an acceptable performance with a climbing lane (“1” entry, Column 26).

Scenarios that satisfy Logical Clause 3 generate an entry of “1” in Column 29. Otherwise a “0” entry registers in this column. Finally, satisfaction of Logical Clause 4 entails

1) the lack of satisfaction of the overall AASHTO guidelines (“0” entry, Column 24) AND
2) an acceptable performance without a climbing lane ("1" entry, Column 25)

Scenarios that satisfy Logical Clause 4 generate an entry of "1" in Column 30. Otherwise a "0" entry registers in this column.

Lastly, the efficacy of implementing a climbing lane per the AASHTO guidelines must be gauged for the scenarios simulated. Using the data generated, a climbing lane is determined as necessary or sufficient for a simulated scenario if this specific scenario satisfies the both, necessity, Logical Clause(s) 1 and 2, and sufficiency, Logical Clause(s) 3 and 4. The efficacy of the AASHTO guidelines relates to their proper classifications of the performance benefits realized by scenarios through climbing lane implementation. Thus, the classification rates of the scenario sample results point directly to this efficacy. Following paragraphs endeavor to compute proper and false classification rates using the scenario sample results as validation data.

Proper scenario classification ensues from recommendations for climbing lane implementation that lead to beneficial impacts for upgrade segment performance. Assuming the satisfaction of the AASHTO guidelines ("1" entry, Guidelines Satisfied (overall), Column 24), then a climbing lane implementation must be

1) necessary ("1" entry, Logical Clause 1 Valid, Column 27), AND

2) sufficient ("1" entry, Logical Clause 3 Valid, Column 29),
AND, Assuming the lack of satisfaction of the AASHTO guidelines (“0” entry, 
*Guidelines Satisfied (overall)*, Column 24), then the non-implementation of a 
climbing lane must be

3) not necessary (“1” entry, *Logical Clause 2 Valid*, Column 28), AND
4) not sufficient (“1” entry, *Logical Clause 4 Valid*, Column 30).

The proper classification rate thus equals the ratio of the number of scenarios 
that satisfy logical clause 1 and 3, when the guidelines are satisfied, plus the number 
that satisfy logical clauses 2 and 4, when the guidelines are not satisfied to the total 
number of scenarios analyzed.

Assuming the satisfaction of the AASHTO guidelines (“1” entry, *Guidelines 
Satisfied (overall)*, Column 24), a Type I classification error occurs, when a climbing 
lane implementation is

1) not necessary, “0” entry, *Logical Clause 1*, Column 27, OR
2) not sufficient, “0” entry, *Logical Clause 3*, Column 29.

The type I classification error rate thus equals the ratio of the total number of 
scenarios for which AASHTO recommends a climbing lane AND that do not satisfy 
*Logical Clause(s)* 1 OR 3 to the total number of scenarios simulated. Column 36 
*Type I Error Rate* displays a running computed value of Type I classification error 
rate, up to the scenario under consideration.
Assuming the lack of satisfaction of AASHTO guidelines ("0" entry, Guidelines Satisfied (overall), Column 24), a Type II classification error occurs when the non-implementation of a climbing lane is

1) not necessary, "0" entry, Logical Clause 2, Column 28, OR

2) not sufficient, "0" entry, Logical Clause 4, Column 30.

The type II classification error rate thus equals the ratio of the total number of scenarios for which AASHTO does not recommend a climbing lane AND that do not satisfy Logical Clause(s) 2 OR 4 to the total number of scenarios simulated. Column 39 Type II Error Rate displays a running computed value of Type II classification error rate, up to the scenario under consideration.
CHAPTER 4
FINDINGS / RESULTS

To assess the efficacy of the AASHTO guidelines, the HCS 7 was run 601 times with the randomly generated scenarios of Table 7 in Appendix B. In 197 scenarios, the flows exceed two-lane highway capacity, which leaves 404 scenarios to analyze. The wording “total number of studied scenarios” refers in the following to these 404 scenarios. Table 9 in Appendix E presents a summary of the LOS results achieved for the 404 scenarios without and with a climbing lane. In addition, the table points to the applicable AASHTO guidelines for each scenario. Thus, table entries enable a direct assessment of whether AASHTO recommends a climbing lane and of the acceptability of the scenario segment performances with and without a climbing lane. Lastly, it displays the classification of the scenarios per the four logical clauses and enhancement in LOS due to a climbing lane. Table 10, in Appendix F, displays the proper classification rate, as well as the type I and type II classification error rates achieved.

4.1 AASHTO GUIDELINES AND NECESSITY OF CLIMBING LANE IMPLEMENTATION

Two hundred and fourteen (214) scenarios satisfy the guidelines, an equivalent to 53% of the total number of studied scenarios, 404. Out of the 214 scenarios, 196 or 49% of total studied scenarios, satisfy Logical Clause 1, Column 27, which indicates that a climbing lane is necessary. For these scenarios, unacceptable performance, LOS “C”, prevails without a climbing lane. For the remaining 18 out of 214 scenarios
that satisfy the guidelines, representing 4% of total studied scenarios, acceptable performance prevails without a climbing lane (Type I errors). Table 4, below, displays these scenarios, where acceptable performance prevails without a climbing lane, even though AASHTO would suggest climbing lane implementation given guidelines’ satisfaction.

| Scenario Number | Analysis Direction Flow vpn | Opposing Direction Flow vpn | Sum Flows | ATS analysis direction pcph | ATS opposing direction pcph | Total ATS Flow | PTSF analysis direction pcph | PTSF opposing direction pcph | Total PTSF Flow | LOS (no Climbing Lane) | LOS (Climbing Lane) |
|-----------------|----------------------------|----------------------------|-----------|----------------------------|----------------------------|----------------|-----------------------------|-----------------------------|-----------------|------------------------|---------------------|
| 15              | 214                        | 378                        | 592       | 742                        | 487                        | 1229           | 267                         | 472                         | 739             | C                      | B                   |
| 38              | 320                        | 73                         | 393       | 1024                       | 104                        | 1128           | 400                         | 93                          | 493             | C                      | B                   |
| 54              | 257                        | 126                        | 383       | 823                        | 178                        | 1001           | 321                         | 160                         | 481             | C                      | B                   |
| 171             | 351                        | 547                        | 898       | 793                        | 689                        | 1482           | 439                         | 684                         | 1123            | C                      | B                   |
| 256             | 262                        | 350                        | 612       | 839                        | 462                        | 1301           | 327                         | 437                         | 764             | C                      | B                   |
| 277             | 290                        | 362                        | 652       | 781                        | 464                        | 1245           | 362                         | 452                         | 814             | C                      | B                   |
| 319             | 647                        | 336                        | 983       | 267                        | 444                        | 711            | 80                          | 420                         | 500             | B                      | B                   |
| 321             | 231                        | 48                         | 279       | 677                        | 65                         | 742            | 289                         | 61                          | 350             | C                      | A                   |
| 324             | 243                        | 410                        | 653       | 732                        | 527                        | 1259           | 304                         | 512                         | 816             | C                      | B                   |
| 372             | 252                        | 315                        | 567       | 726                        | 407                        | 1133           | 315                         | 398                         | 713             | C                      | B                   |
| 375             | 289                        | 55                         | 344       | 1180                       | 81                         | 1261           | 361                         | 70                          | 431             | C                      | B                   |
| 377             | 279                        | 156                        | 435       | 852                        | 209                        | 1061           | 349                         | 198                         | 547             | C                      | B                   |
| 449             | 212                        | 285                        | 497       | 591                        | 368                        | 959            | 265                         | 360                         | 625             | C                      | B                   |
| 463             | 218                        | 646                        | 864       | 643                        | 819                        | 1462           | 272                         | 807                         | 1079            | C                      | B                   |
| 488             | 344                        | 77                         | 421       | 812                        | 107                        | 919            | 430                         | 97                          | 527             | C                      | A                   |
| 507             | 228                        | 90                         | 318       | 918                        | 130                        | 1048           | 285                         | 114                         | 399             | C                      | A                   |
| 531             | 244                        | 544                        | 788       | 774                        | 688                        | 1462           | 305                         | 680                         | 985             | C                      | B                   |
| 589             | 268                        | 364                        | 632       | 902                        | 472                        | 1374           | 335                         | 455                         | 790             | C                      | B                   |

Table 4: Scenarios with Satisfied Guidelines and Acceptable Performance without Climbing Lane
One hundred ninety (190) scenarios do not satisfy the overall guidelines, or approximately 47% of the total number of studied ones. In 41 of these scenarios, representing 10% of total studied scenarios, a climbing lane is necessary to achieve an acceptable level of service (Type II errors). HCS 7 outputs for these 41 scenarios point to necessity; with LOS “D” or worse achieved on their upgrade segments without climbing lanes. Table 5 displays these scenarios. (Further analysis shows that the truck percentage is very low in most of these scenarios resulting in a flow of less than 20 trucks per hour, hence Guideline 2 is not satisfied. The lack of satisfaction of Guideline 2 engenders the lack of satisfaction of the overall guidelines.) In 149 scenarios, representing 37% of total studied scenarios, AASHTO does not recommend climbing lane implementations when indeed unnecessary. In summary, for an impressive 86% of simulated scenarios, the AASHTO guidelines point correctly to the necessity or non-necessity of climbing lanes.

| Scenario Number | Analysis Direction Flow vpm | Opposing Direction Flow vpm | Sum Flows | Truck% | Sum Trucks | LOS (no Climbing Lane) | LOS (Climbing Lane) |
|-----------------|-----------------------------|-----------------------------|-----------|--------|-----------|------------------------|---------------------|
| 19              | 1016                        | 1263                        | 2279      | 2      | 20        | E                      | E                   |
| 32              | 635                         | 848                         | 1483      | 3      | 19        | D                      | C                   |
| 45              | 192                         | 833                         | 1025      | 15     | 29        | D                      | C                   |
| 51              | 402                         | 904                         | 1306      | 5      | 20        | D                      | C                   |
| 122             | 897                         | 651                         | 1548      | 2      | 18        | E                      | C                   |
| 137             | 418                         | 745                         | 1163      | 3      | 13        | D                      | B                   |
| ID | Speed1 | Speed2 | Speed3 | Time | Grade | Lane |
|----|--------|--------|--------|------|-------|------|
| 151 | 669 | 946 | 1615 | 2 | 13 | E |
| 161 | 580 | 396 | 976 | 3 | 17 | B |
| 199 | 717 | 392 | 1109 | 2 | 14 | E |
| 234 | 272 | 1238 | 1510 | 3 | 8 | D |
| 236 | 359 | 120 | 479 | 3 | 11 | D |
| 240 | 200 | 992 | 1192 | 16 | 32 | D |
| 241 | 910 | 294 | 1204 | 2 | 18 | E |
| 243 | 258 | 748 | 1006 | 6 | 15 | D |
| 250 | 183 | 1025 | 1208 | 8 | 15 | D |
| 266 | 854 | 648 | 1502 | 2 | 17 | E |
| 275 | 232 | 1081 | 1313 | 8 | 19 | D |
| 276 | 392 | 253 | 645 | 4 | 16 | D |
| 286 | 249 | 895 | 1144 | 5 | 12 | D |
| 313 | 485 | 724 | 1209 | 3 | 15 | D |
| 327 | 474 | 862 | 1336 | 2 | 9 | D |
| 328 | 898 | 1194 | 2092 | 2 | 18 | E |
| 351 | 687 | 922 | 1609 | 2 | 14 | E |
| 387 | 390 | 1095 | 1485 | 3 | 12 | D |
| 388 | 432 | 1274 | 1706 | 4 | 17 | E |
| 391 | 440 | 574 | 1014 | 2 | 9 | D |
| 396 | 638 | 136 | 774 | 3 | 19 | E |
| 410 | 273 | 853 | 1126 | 4 | 11 | D |
| 423 | 354 | 74 | 428 | 4 | 14 | D |
| 450 | 711 | 165 | 876 | 2 | 14 | E |
| 456 | 476 | 209 | 685 | 3 | 14 | D |
| 458 | 490 | 936 | 1426 | 2 | 10 | D |
| 465 | 290 | 1113 | 1403 | 6 | 17 | D |
| 477 | 491 | 840 | 1331 | 3 | 15 | D |
| 517 | 491 | 157 | 648 | 2 | 10 | D |
| 545 | 448 | 265 | 713 | 4 | 18 | D |
| 549 | 474 | 130 | 604 | 3 | 14 | D |
| 559 | 399 | 912 | 1311 | 3 | 12 | D |
| 567 | 412 | 902 | 1314 | 3 | 12 | D |
| 573 | 781 | 156 | 937 | 2 | 16 | E |
| 584 | 226 | 1118 | 1344 | 6 | 14 | D |

Table 5: Scenarios with Non-Satisfied Guidelines and Unacceptable Performance without Climbing Lane
4.2 AASHTO GUIDELINES AND SUFFICIENCY OF CLIMBING LANE IMPLEMENTATION

Of the 214 scenarios that satisfy the AASHTO guidelines, 166 scenarios, or approximately 41% of the total studied scenarios, also satisfy Logical Clause 3, Column 29, which indicates that climbing lanes are indeed sufficient. HCS 7 outputs for these 166 scenarios point to sufficiency; with LOS “C” or better achieved on their upgrade segments with climbing lanes. Thus, in 41% of scenarios, the AASHTO guidelines identify properly the sufficiency of a climbing lane implementation. For the remaining 48 scenarios, out of 214 that satisfy the guidelines, representing 12% of total studied scenarios, unacceptable performance still prevails with implemented climbing lanes (Type I errors). Thus, in these scenarios the AASHTO suggested implementation of climbing lanes is not sufficient.

Out of the 190 scenarios that do not satisfy the overall guidelines, 149 scenarios, approximately 37% of the total studied, verify Logical clause 4, Column 30, which indicates the sufficiency of the non-implementation of a climbing lane. HCS 7 outputs for these 166 scenarios point to sufficiency; with LOS “C” or better achieved on their upgrade segments without climbing lanes. Thus, in 37% of scenarios, the AASHTO guidelines identify properly the non-sufficiency of a climbing lane to achieve an acceptable level of service. For the remaining 41 scenarios, out of 190 that do not satisfy the guidelines, representing 10% of the total scenarios, unacceptable performance prevails per HCS 7 when the AASHTO guidelines do not recommend a climbing lane (Type II errors). Thus in 10% of total scenarios the AASHTO suggested non-implementation of climbing lanes is not sufficient. In summary, for
78% of simulated scenarios, the AASHTO guidelines point correctly to the sufficiency or non-sufficiency of climbing lanes.

4.3 PERFORMANCE WITH AND WITHOUT A CLIMBING LANE

Further, the analysis of the 404 scenarios shows that in 167 scenarios, approximately 41% of studied scenarios, acceptable performances prevail and yet no climbing lane exists. The remaining 59%, or 237 scenarios, experience unacceptable performance with a LOS “D” or worse given no climbing lane.

When analyzing the performance of two-lane highways with implemented climbing lanes, in 352 scenarios, or approximately 87% of the total scenarios studied, performance is better or equal to LOS “C” and therefore acceptable. Of the remaining 52 scenarios, 48 scenarios, approximately 12% of the total scenarios analyzed, continue to have unacceptable performance per HCS 7 even though the guidelines are satisfied, and a climbing lane exists (Type I error). The remaining 4 scenarios, approximately 1% of the total scenarios studied, do not satisfy the guidelines and have unacceptable performance. In summary, the implementation of climbing lanes does enhance performance in the majority of scenarios studied.

4.4 CLASSIFICATION RATES AND GUIDELINES’ EFFICACY

The classification errors hinted above in Section 4.1 and 4.2 do not encompass those resulting from the interplay of necessity and sufficiency. Although AASHTO guidelines predict adequately necessity and sufficiency, it is not evident that they can predict their interplay successfully. To do so, the analysis derives proper and
erroneous classification rates. Table 10 in Appendix F displays the derived proper, type I error and type II error classification rates. **Figure 10: Proportions of Classification Rates**

One hundred forty-eight (148) scenarios have a proper classification per Column 32, “Proper Classification Count”. Column 33, “Proper Classification Rate”, displays a computed running value of the proper classification rate, up to the scenario under consideration. This rate stabilizes around the 331st scenario (actual scenario 489 given that 158 prior scenarios were not analyzed for being over-capacity) at the value of 0.36. The analysis of studied scenarios points to only 36% of the total amount of scenarios analyzed, 404, as classified properly, and thus to 64% as classified erroneously. Figure 11 displays the stabilization course of the proper classification rate.
Sixty-six (66) scenarios have type I classification errors. Column 36, *Type I Error Rate*, displays a computed running value of the Type I classification error rate, up to the scenario under consideration. This rate stabilizes/converges around the 348th valid scenario (actual scenario 509 given that the analysis ignored 161 prior scenarios for being over-capacity) at the value of 0.16. For 16% of the total number of analyzed scenarios, the AASHTO guidelines recommend the implementation of a climbing lane when it is not necessary or not sufficient. Figure 12 displays the stabilization course of the type I error rate.
Figure 12: Type I Error Rate

One hundred ninety (190) scenarios display type II classification errors. Column 39, Type II Error Rate, displays a computed running value of the Type II classification error rate, up to the scenario under consideration. This rate stabilizes/converges around the 354\textsuperscript{th} valid scenario (actual scenario 521 given that the analysis ignored 167 prior scenarios for being over-capacity) at the value of 0.48. For 48\% of all scenarios, the AASHTO guidelines do not suggest implementation of a climbing lane while non-implementation is not necessary or not sufficient. Figure 13 displays the stabilization course of the type II error rate.
Figure 13: Type II Error Rate
CHAPTER 5

CONCLUSIONS

5.1 SUMMARY

This study evaluates the flow and performance parts of the AASHTO guidelines on climbing lane implementation for rural two-lane highways to determine their continued applicability in the face of new research on these facilities’ performance. The evaluation targets the necessity and the sufficiency of the guidelines for upgrade segment lengths that cause a 30 mph speed decrease assuming flat terrain at their approaches and departures.

Chapter 1 presents the study purpose and justification. Although the guidelines seek to enhance performance on upgrade segments of cited highways, they have remained unchanged in the face of recent research development on this performance and do not reflect the state-of-the-practice on the same. For instance, they do not account for the variables known to determine specifically two-lane highway LOS, mainly opposing flow and percentage of no-passing zones. Still, most state DOTs base their decisions on implementing climbing lanes on these old guidelines. Questions about their efficacy seem valid and the study seeks to apprehend this efficacy. Study results could positively benefit the implementation practice of climbing lanes at varied DOTs.

Chapter 2 reviews the relevant literature and provides a detailed overview of the characteristics of two-lane highways, their performance measures, the AASHTO guidelines for climbing lane implementation as well as the state DOT’s practices and
considerations about climbing lane design. The guidelines consist of three parts, with two that apply jointly and one independently. If any independent guideline part can be proven inefficient, the guidelines themselves can be so proven. The study focused on the evaluation of the AASHTO flow and performance guidelines.

Chapter 3 describes the methodology utilized. The study views the set of AASHTO guidelines as a classifier of scenarios into the interplay of necessity and sufficiency, or efficacy, of an eventual climbing lane implementation. The methodology describes 1) the means of assessing the necessity and the sufficiency of the AASHTO guidelines, 2) the derivation of scenario analysis data, and 3) the data processing techniques toward the guidelines’ evaluation. Logical clauses enable assessment of the necessity and/or sufficiency of the guidelines. Random scenarios to analyze generate from the simulation of random variables of interest using random number generators. For these scenarios, performance is determined with and without climbing lanes using HCS 7 to assess the enhancement afforded by a climbing lane implementation or negated without it. The performance achieved for simulated scenarios, assuming the satisfaction or the non-satisfaction of the AASHTO guidelines, leads to the computation of the guidelines’ classification rates.

Chapter 4 presents the findings and results from the study. For 86% of simulated scenarios, the AASHTO guidelines point correctly to the necessity or non-necessity of climbing lanes and for 78% of simulated scenarios, the AASHTO guidelines point correctly to the sufficiency or non-sufficiency of climbing lanes. In addition, the analysis shows that the implementation of climbing lanes does enhance performance in the majority of scenarios studied. The proper classification rate
achieved, 0.36, points to a poor performance by the guideline parts studied. In essence, for the cases studied and given the study assumptions, the guidelines seem wanting of revisions. The study thus points to a need for its own extension to be more representative of field conditions, such as upgrade segment lengths engendering smaller speed decreases and to remove some study limitations that restrict applicability. Finally, for scenarios with severe drops in travel speed and flat terrain on approaches and departures, the study points to the need for a new classifier into the efficacy of climbing lane implementation. It may be noted that highway flows, and all variables simulated in general, were assumed uniformly distributed in the study. This distribution assumption may have introduced some biases in study results. Field recorded flows on rural highways tend to be low.

LIMITATIONS

Some study limitations apply. Firstly, this study only addresses Class I rural two-lane highways for upgrade segment lengths that result in a 30-mpm speed decrease given an entry speed of 60 mph. The speed reduction graph on upgrades utilized relates to an upgrade entry speed of 70 mph, assuming a typical 200 lb/hp, and admittedly applicable to 60 mph hour entry speeds as well (AASHTO, 2011). The study uses numerous HCS 7 entry default values and scenarios abide to HCS 7 data limitations. For instance, the software only allows grade percentages in the range of 3.0% to 9.9%. Higher grades could not be studied. Similarly, HCS 7 accepts only grade length values in the range of 0.25 mi to 4.0 mi. Therefore, the lowest scenario length of grade must be set to 0.25 mi or 1,320 ft. Overall, variables simulated were assumed uniformly distributed and independent. It is well known that flow
distributions in particular are non-uniform. The independence of variables led to a covariance with zero entries. This assumption afforded the independent generation of variables rather than their joint generation using a joint probability distribution.

However, as stated in the literature review, total flow on two-lane highways can reach up to 3,200 pcph while the directional capacity reaches as much as 1,700 pcph in one direction given a maximum opposing flow of 1,500 pcph. Thus there exist some dependencies, at least toward their upper limits, between directional flows. To abide by this constraint, still assuming no direct dependence, the study focused on analysis directional flow and $D$-factor to derive opposing flow. $D$-Factor range was made to sway a prescribed interval to naturally constrain opposite flow within its ascribed capacity limits per HCM, 2010.

### 5.2 RESULTS AND FUTURE WORK

The proper classification rate, outlined in chapter 4, implies that the AASHTO guidelines only classify correctly 36% of the 404 scenarios analyzed. In addition, in 16% of all scenarios the implementation of a climbing lane is recommended by the AASHTO guidelines, even though it is either unnecessary or insufficient. In 47% of the scenarios the lack of recommendation to implement a climbing lane is not necessary or nor sufficient. These results indicate that the AASHTO guidelines are not effective enough as implementation warrants of climbing lanes for scenarios of the type studied. Further research could improve on the AASHTO guidelines by designing classifiers for the necessity and sufficiency of the implementation of climbing lanes. In addition, future studies could simulate realistic distributions of two-lane highway characteristics, as this study used mostly uniform distributions. Short of using realistic
distributions, sensitivity analysis of study results to flow ranges can be conducted and could inform on the proper range of application of the guidelines viewed as warrants, if any. Furthermore, this study only investigates upgrade segments with slopes that extend to the point where typical trucks experience a 30 mph speed reduction. Due to this limitation, this research does not consider shorter or longer lengths of slopes whereas future studies could. An investigation into the different lengths of slope might provide insights valuable for proper classifier design.
Table 6: Randomly Generated Input Values

| D-Factor | Analysis Direction Flow in vph | Slope in % | Trucks in % | No-Passing Zone in % |
|----------|--------------------------------|------------|-------------|----------------------|
| 0.551    | 538                            | 7.5        | 6           | 49                   |
| 0.557    | 122                            | 7.5        | 12          | 54                   |
| 0.783    | 60                             | 7.5        | 4           | 22                   |
| 0.668    | 1660                           | 9.5        | 4           | 57                   |
| 0.740    | 278                            | 6.5        | 17          | 55                   |
| 0.570    | 1258                           | 7.5        | 6           | 77                   |
| 0.607    | 591                            | 6.5        | 12          | 77                   |
| 0.579    | 249                            | 7.5        | 4           | 85                   |
| 0.543    | 1179                           | 9          | 14          | 81                   |
| 0.558    | 1124                           | 7          | 8           | 24                   |
| 0.756    | 1581                           | 6          | 4           | 45                   |
| 0.561    | 17                             | 8          | 3           | 57                   |
| 0.768    | 1691                           | 7          | 3           | 39                   |
| 0.722    | 1390                           | 8          | 7           | 30                   |
| 0.638    | 214                            | 6          | 15          | 46                   |
| 0.713    | 592                            | 8          | 11          | 68                   |
| 0.619    | 69                             | 8.5        | 5           | 44                   |
| 0.555    | 394                            | 9.5        | 19          | 82                   |
| 0.554    | 1016                           | 6          | 2           | 47                   |
| 0.848    | 1194                           | 7.5        | 14          | 35                   |
| 0.753    | 429                            | 8          | 7           | 35                   |
| 0.756    | 326                            | 8          | 20          | 38                   |
| 0.807    | 1351                           | 8.5        | 3           | 26                   |
| 0.593    | 62                             | 7          | 11          | 74                   |
| 0.677    | 121                            | 9.5        | 14          | 83                   |
| 0.829    | 1370                           | 9.5        | 3           | 60                   |
| 0.848    | 1608                           | 9.5        | 19          | 72                   |
| 0.839    | 1608                           | 9.5        | 19          | 72                   |
| 0.733    | 847                            | 6.5        | 5           | 44                   |
| 0.736    | 369                            | 7.5        | 7           | 77                   |
| 0.681    | 777                            | 7          | 16          | 71                   |
| 0.675    | 211                            | 8.5        | 8           | 65                   |
| 0.572    | 635                            | 9.5        | 3           | 24                   |
| 0.763    | 61                             | 8.5        | 10          | 36                   |
| 0.652 | 400 | 9.5 | 12 | 55 |
| 0.834 | 1510 | 9.5 | 17 | 48 |
| 0.827 | 785 | 9 | 3 | 84 |
| 0.645 | 928 | 6.5 | 8 | 90 |
| 0.813 | 320 | 6 | 16 | 38 |
| 0.593 | 925 | 8 | 7 | 53 |
| 0.729 | 1453 | 7.5 | 19 | 52 |
| 0.778 | 599 | 8 | 19 | 37 |
| 0.566 | 1188 | 7.5 | 10 | 45 |
| 0.569 | 1644 | 7.5 | 8 | 49 |
| 0.771 | 1228 | 9 | 2 | 85 |
| 0.812 | 192 | 10 | 15 | 85 |
| 0.615 | 172 | 9.5 | 2 | 24 |
| 0.655 | 489 | 9.5 | 9 | 26 |
| 0.608 | 455 | 8 | 17 | 60 |
| 0.776 | 133 | 8.5 | 7 | 39 |
| 0.553 | 6 | 7.5 | 8 | 78 |
| 0.692 | 402 | 9.5 | 5 | 47 |
| 0.841 | 924 | 10 | 16 | 33 |
| 0.698 | 626 | 7 | 10 | 76 |
| 0.672 | 257 | 10 | 19 | 77 |
| 0.617 | 347 | 8 | 9 | 72 |
| 0.680 | 329 | 9 | 3 | 24 |
| 0.809 | 135 | 7.5 | 19 | 44 |
| 0.756 | 348 | 8 | 9 | 68 |
| 0.821 | 440 | 9 | 5 | 73 |
| 0.675 | 1555 | 10 | 19 | 51 |
| 0.541 | 649 | 6.5 | 20 | 76 |
| 0.665 | 315 | 8.5 | 14 | 69 |
| 0.605 | 899 | 6.5 | 2 | 53 |
| 0.788 | 392 | 7 | 17 | 59 |
| 0.700 | 483 | 9 | 13 | 38 |
| 0.578 | 460 | 6.5 | 15 | 38 |
| 0.756 | 420 | 6.5 | 8 | 37 |
| 0.674 | 27 | 7 | 5 | 29 |
| 0.838 | 66 | 6.5 | 10 | 29 |
| 0.642 | 166 | 10 | 15 | 86 |
| 0.653 | 718 | 6 | 20 | 70 |
| 0.750 | 426 | 9.5 | 17 | 26 |
| 0.590 | 532 | 8.5 | 4 | 45 |
| 0.700 | 67 | 6.5 | 7 | 36 |
| 0.558 | 1013 | 9.5 | 18 | 32 |
| 0.785 | 10 | 8.5 | 8 | 34 |
| Value 1 | Value 2 | Value 3 | Value 4 | Value 5 |
|--------|--------|--------|--------|--------|
| 0.736  | 1276   | 8.5    | 7      | 71     |
| 0.703  | 718    | 8      | 2      | 38     |
| 0.829  | 479    | 8      | 8      | 82     |
| 0.701  | 3      | 8      | 16     | 50     |
| 0.743  | 532    | 7      | 9      | 26     |
| 0.717  | 27     | 6.5    | 3      | 52     |
| 0.676  | 704    | 6.5    | 16     | 41     |
| 0.547  | 83     | 7.5    | 7      | 45     |
| 0.613  | 822    | 8      | 5      | 61     |
| 0.760  | 1193   | 6      | 7      | 62     |
| 0.821  | 80     | 9.5    | 14     | 51     |
| 0.822  | 260    | 9.5    | 9      | 56     |
| 0.783  | 83     | 6.5    | 19     | 35     |
| 0.710  | 165    | 9      | 17     | 27     |
| 0.803  | 16     | 7.5    | 20     | 80     |
| 0.605  | 634    | 8.5    | 13     | 53     |
| 0.671  | 603    | 7      | 6      | 42     |
| 0.689  | 233    | 8.5    | 3      | 52     |
| 0.803  | 135    | 7.5    | 3      | 80     |
| 0.615  | 435    | 9      | 17     | 59     |
| 0.656  | 1061   | 8.5    | 6      | 35     |
| 0.833  | 1345   | 9.5    | 3      | 30     |
| 0.821  | 190    | 9.5    | 14     | 51     |
| 0.557  | 82     | 9.5    | 3      | 70     |
| 0.802  | 171    | 9      | 6      | 53     |
| 0.676  | 64     | 9      | 17     | 79     |
| 0.688  | 501    | 8      | 14     | 60     |
| 0.766  | 917    | 7      | 16     | 86     |
| 0.611  | 711    | 7      | 11     | 47     |
| 0.729  | 548    | 8      | 9      | 35     |
| 0.848  | 209    | 9      | 18     | 61     |
| 0.608  | 1055   | 9.5    | 8      | 58     |
| 0.707  | 110    | 9.5    | 18     | 56     |
| 0.543  | 34     | 9.5    | 18     | 28     |
| 0.671  | 839    | 8      | 3      | 76     |
| 0.690  | 616    | 9.5    | 16     | 29     |
| 0.652  | 480    | 6.5    | 15     | 34     |
| 0.779  | 1481   | 8.5    | 15     | 22     |
| 0.656  | 803    | 7.5    | 2      | 42     |
| 0.799  | 1498   | 7      | 16     | 55     |
| 0.648  | 1436   | 7.5    | 3      | 41     |
| 0.591  | 919    | 9      | 6      | 41     |
| 0.625  | 589    | 10     | 9      | 63     |
|    |    |    |    |    |    |
|----|----|----|----|----|----|
| 0.641 | 1333 | 6.5 | 2 | 67 |
| 0.573 | 1663 | 9.5 | 14 | 82 |
| 0.579 | 897 | 7.5 | 2 | 70 |
| 0.674 | 499 | 10 | 7 | 77 |
| 0.679 | 1606 | 6.5 | 17 | 28 |
| 0.691 | 593 | 7.5 | 17 | 50 |
| 0.546 | 1650 | 7 | 11 | 43 |
| 0.776 | 1278 | 6.5 | 10 | 53 |
| 0.680 | 362 | 8.5 | 12 | 71 |
| 0.728 | 1152 | 8 | 8 | 49 |
| 0.702 | 445 | 7.5 | 20 | 34 |
| 0.830 | 58 | 9.5 | 20 | 36 |
| 0.706 | 314 | 9.5 | 7 | 44 |
| 0.688 | 378 | 7.5 | 14 | 54 |
| 0.811 | 25 | 10 | 6 | 66 |
| 0.617 | 236 | 6.5 | 20 | 85 |
| 0.640 | 61 | 8 | 8 | 80 |
| 0.641 | 418 | 9.5 | 3 | 73 |
| 0.600 | 567 | 10 | 18 | 28 |
| 0.687 | 680 | 8 | 13 | 73 |
| 0.809 | 107 | 8 | 20 | 73 |
| 0.756 | 1631 | 7 | 20 | 45 |
| 0.784 | 1152 | 10 | 16 | 56 |
| 0.672 | 526 | 7 | 12 | 43 |
| 0.764 | 1155 | 9.5 | 17 | 39 |
| 0.779 | 520 | 9 | 6 | 68 |
| 0.544 | 1112 | 7 | 9 | 29 |
| 0.797 | 1692 | 9.5 | 4 | 59 |
| 0.726 | 1086 | 8.5 | 18 | 68 |
| 0.841 | 78 | 7.5 | 12 | 58 |
| 0.841 | 208 | 7.5 | 18 | 79 |
| 0.586 | 669 | 6.5 | 2 | 36 |
| 0.564 | 1283 | 6.5 | 6 | 75 |
| 0.641 | 1264 | 9.5 | 12 | 42 |
| 0.572 | 80 | 9.5 | 8 | 45 |
| 0.773 | 440 | 9.5 | 18 | 88 |
| 0.721 | 25 | 7.5 | 5 | 68 |
| 0.825 | 266 | 6.5 | 16 | 83 |
| 0.764 | 1161 | 9.5 | 16 | 31 |
| 0.651 | 1318 | 6.5 | 15 | 24 |
| 0.636 | 482 | 9.5 | 15 | 47 |
| 0.595 | 580 | 9 | 3 | 46 |
| 0.816 | 21 | 7 | 14 | 66 |
|    |    |    |    |    |    |
|----|----|----|----|----|----|
| 0.712 | 1454 | 7.5 | 2 | 80 |
| 0.723 | 539 | 8.5 | 4 | 69 |
| 0.702 | 726 | 6.5 | 20 | 45 |
| 0.820 | 211 | 7.5 | 12 | 69 |
| 0.790 | 206 | 7 | 12 | 73 |
| 0.846 | 120 | 9 | 19 | 41 |
| 0.743 | 679 | 8.5 | 9 | 45 |
| 0.685 | 363 | 6 | 9 | 49 |
| 0.609 | 351 | 7 | 7 | 26 |
| 0.844 | 370 | 8.5 | 6 | 70 |
| 0.552 | 1315 | 7.5 | 12 | 49 |
| 0.650 | 536 | 10 | 17 | 64 |
| 0.735 | 1286 | 8.5 | 11 | 52 |
| 0.735 | 35 | 7.5 | 19 | 43 |
| 0.541 | 385 | 7 | 8 | 89 |
| 0.586 | 853 | 8 | 13 | 62 |
| 0.642 | 44 | 7 | 19 | 68 |
| 0.831 | 1686 | 9.5 | 14 | 32 |
| 0.697 | 19 | 9.5 | 9 | 39 |
| 0.648 | 725 | 6 | 20 | 40 |
| 0.806 | 8 | 7 | 13 | 81 |
| 0.664 | 200 | 7.5 | 12 | 27 |
| 0.817 | 70 | 9.5 | 4 | 59 |
| 0.736 | 444 | 7.5 | 12 | 67 |
| 0.688 | 1273 | 7 | 5 | 70 |
| 0.641 | 773 | 6.5 | 2 | 35 |
| 0.628 | 668 | 8.5 | 15 | 88 |
| 0.657 | 347 | 8 | 6 | 46 |
| 0.787 | 285 | 8 | 14 | 63 |
| 0.781 | 44 | 6 | 5 | 32 |
| 0.658 | 854 | 6.5 | 8 | 31 |
| 0.547 | 757 | 7.5 | 4 | 30 |
| 0.751 | 1223 | 6.5 | 6 | 89 |
| 0.684 | 1163 | 6 | 17 | 52 |
| 0.669 | 161 | 9 | 19 | 67 |
| 0.654 | 1364 | 6 | 2 | 44 |
| 0.647 | 717 | 9.5 | 2 | 70 |
| 0.565 | 523 | 8 | 16 | 87 |
| 0.580 | 1438 | 8.5 | 10 | 40 |
| 0.645 | 998 | 6.5 | 16 | 50 |
| 0.753 | 536 | 8 | 16 | 69 |
| 0.711 | 43 | 8.5 | 6 | 68 |
| 0.642 | 614 | 9 | 11 | 76 |
|   |   |   |   |   |
|---|---|---|---|---|
| 0.787 | 1161 | 7.5 | 3 | 87 |
| 0.806 | 229  | 9.5 | 20 | 38 |
| 0.716 | 526  | 9   | 15 | 42 |
| 0.733 | 1265 | 10  | 7  | 85 |
| 0.650 | 735  | 8   | 13 | 45 |
| 0.675 | 326  | 8.5 | 6  | 52 |
| 0.613 | 271  | 6.5 | 19 | 84 |
| 0.818 | 13   | 7.5 | 14 | 23 |
| 0.729 | 273  | 9.5 | 9  | 47 |
| 0.786 | 53   | 6.5 | 10 | 68 |
| 0.545 | 1376 | 10  | 11 | 30 |
| 0.845 | 262  | 9.5 | 7  | 74 |
| 0.685 | 427  | 10  | 10 | 56 |
| 0.666 | 776  | 6   | 6  | 88 |
| 0.750 | 453  | 10  | 11 | 35 |
| 0.839 | 448  | 8.5 | 17 | 31 |
| 0.804 | 501  | 6   | 13 | 40 |
| 0.849 | 1668 | 10  | 11 | 46 |
| 0.716 | 753  | 9   | 16 | 25 |
| 0.578 | 573  | 9   | 10 | 53 |
| 0.620 | 1317 | 9.5 | 6  | 88 |
| 0.779 | 1399 | 9   | 19 | 26 |
| 0.559 | 1440 | 6.5 | 11 | 74 |
| 0.726 | 487  | 9   | 9  | 29 |
| 0.795 | 419  | 9.5 | 10 | 63 |
| 0.728 | 107  | 7.5 | 20 | 39 |
| 0.814 | 85   | 9   | 2  | 36 |
| 0.837 | 1485 | 9   | 17 | 36 |
| 0.820 | 272  | 8   | 3  | 77 |
| 0.730 | 804  | 9.5 | 7  | 83 |
| 0.750 | 359  | 9   | 3  | 85 |
| 0.548 | 668  | 8.5 | 5  | 72 |
| 0.652 | 1245 | 7   | 4  | 86 |
| 0.685 | 1666 | 9   | 19 | 29 |
| 0.832 | 200  | 8.5 | 16 | 67 |
| 0.756 | 910  | 9   | 2  | 68 |
| 0.815 | 20   | 7.5 | 2  | 38 |
| 0.743 | 258  | 6.5 | 6  | 69 |
| 0.723 | 781  | 10  | 19 | 25 |
| 0.772 | 679  | 8.5 | 16 | 81 |
| 0.615 | 437  | 8   | 12 | 29 |
| 0.750 | 95   | 10  | 5  | 85 |
| 0.772 | 1595 | 7.5 | 5  | 89 |
|   |     |   |   |   |   |
|---|-----|---|---|---|---|
| 0.633 | 334 | 10 | 6 | 49 |
| 0.849 | 183 | 8.5 | 8 | 31 |
| 0.817 | 241 | 9.5 | 2 | 27 |
| 0.649 | 1257 | 9.5 | 9 | 56 |
| 0.752 | 247 | 8 | 2 | 31 |
| 0.759 | 299 | 6 | 14 | 67 |
| 0.765 | 305 | 7 | 20 | 53 |
| 0.572 | 262 | 9.5 | 19 | 69 |
| 0.571 | 650 | 8 | 18 | 81 |
| 0.849 | 1645 | 7.5 | 9 | 75 |
| 0.567 | 181 | 10 | 18 | 76 |
| 0.566 | 1248 | 7.5 | 7 | 42 |
| 0.653 | 26 | 7 | 15 | 44 |
| 0.563 | 541 | 7.5 | 11 | 87 |
| 0.671 | 725 | 9.5 | 18 | 38 |
| 0.845 | 1441 | 6.5 | 11 | 50 |
| 0.566 | 1398 | 6.5 | 8 | 62 |
| 0.569 | 854 | 7 | 2 | 41 |
| 0.756 | 1021 | 9 | 3 | 81 |
| 0.824 | 92 | 8 | 8 | 76 |
| 0.742 | 1580 | 8.5 | 3 | 32 |
| 0.834 | 719 | 7 | 19 | 31 |
| 0.836 | 615 | 7 | 14 | 76 |
| 0.751 | 21 | 9 | 16 | 48 |
| 0.688 | 658 | 7 | 16 | 57 |
| 0.665 | 175 | 8.5 | 20 | 34 |
| 0.823 | 232 | 8.5 | 8 | 77 |
| 0.607 | 392 | 7.5 | 4 | 31 |
| 0.555 | 290 | 10 | 13 | 36 |
| 0.560 | 942 | 6 | 13 | 88 |
| 0.703 | 1129 | 7.5 | 16 | 28 |
| 0.753 | 43 | 8.5 | 11 | 66 |
| 0.601 | 351 | 8 | 10 | 54 |
| 0.557 | 1128 | 10 | 14 | 76 |
| 0.719 | 762 | 9.5 | 5 | 51 |
| 0.835 | 107 | 7.5 | 10 | 28 |
| 0.546 | 1027 | 10 | 9 | 49 |
| 0.782 | 249 | 8 | 5 | 86 |
| 0.672 | 910 | 7 | 13 | 38 |
| 0.590 | 139 | 7 | 8 | 76 |
| 0.662 | 218 | 9.5 | 4 | 59 |
| 0.597 | 1510 | 8.5 | 18 | 24 |
| 0.847 | 151 | 8 | 5 | 76 |
| 0.728 | 46  | 6  | 10  | 33  |
|-------|-----|----|-----|-----|
| 0.629 | 626 | 6.5| 20  | 73  |
| 0.572 | 55  | 7.5| 3   | 89  |
| 0.679 | 190 | 6  | 11  | 83  |
| 0.550 | 1587| 10 | 18  | 32  |
| 0.671 | 1172| 9  | 18  | 44  |
| 0.724 | 1363| 7  | 14  | 73  |
| 0.716 | 819 | 8  | 20  | 75  |
| 0.558 | 1183| 8  | 12  | 73  |
| 0.637 | 1267| 10 | 14  | 46  |
| 0.630 | 1084| 6.5| 15  | 51  |
| 0.680 | 80  | 6.5| 17  | 86  |
| 0.568 | 1020| 8.5| 13  | 72  |
| 0.825 | 1231| 9  | 2   | 35  |
| 0.718 | 63  | 8  | 11  | 87  |
| 0.749 | 560 | 9.5| 19  | 60  |
| 0.754 | 488 | 9  | 12  | 35  |
| 0.666 | 555 | 8.5| 16  | 78  |
| 0.644 | 351 | 9  | 11  | 74  |
| 0.766 | 30  | 8.5| 12  | 31  |
| 0.745 | 422 | 10 | 8   | 45  |
| 0.599 | 485 | 9  | 3   | 33  |
| 0.767 | 379 | 10 | 10  | 47  |
| 0.616 | 262 | 10 | 3   | 24  |
| 0.600 | 351 | 8  | 20  | 41  |
| 0.774 | 123 | 6.5| 6   | 22  |
| 0.639 | 1537| 9  | 13  | 55  |
| 0.658 | 647 | 9.5| 19  | 74  |
| 0.721 | 502 | 7  | 9   | 39  |
| 0.827 | 231 | 7  | 9   | 62  |
| 0.611 | 871 | 8.5| 17  | 37  |
| 0.576 | 125 | 7.5| 12  | 29  |
| 0.628 | 243 | 8.5| 14  | 22  |
| 0.697 | 428 | 8  | 17  | 32  |
| 0.663 | 825 | 8  | 11  | 65  |
| 0.645 | 474 | 9.5| 2   | 20  |
| 0.571 | 898 | 7.5| 2   | 41  |
| 0.598 | 550 | 6.5| 20  | 69  |
| 0.635 | 759 | 10 | 18  | 77  |
| 0.608 | 488 | 6.5| 15  | 52  |
| 0.634 | 139 | 9.5| 3   | 58  |
| 0.714 | 888 | 10 | 18  | 54  |
| 0.582 | 622 | 8  | 11  | 41  |
|   |   |   |   |   |
|---|---|---|---|---|
| 0.617 | 906 | 7.5 | 10 | 35 |
| 0.845 | 938 | 6.5 | 12 | 50 |
| 0.750 | 543 | 7.0 | 6.0 | 82 |
| 0.548 | 1468 | 7.0 | 19 | 49 |
| 0.663 | 136 | 6.0 | 19 | 69 |
| 0.850 | 399 | 9.0 | 10 | 43 |
| 0.582 | 1416 | 8.0 | 6.0 | 76 |
| 0.645 | 735 | 8.5 | 13 | 65 |
| 0.694 | 654 | 7.0 | 15 | 44 |
| 0.824 | 92 | 7.5 | 5.0 | 67 |
| 0.815 | 1662 | 7.5 | 12 | 58 |
| 0.562 | 1549 | 8.5 | 17 | 75 |
| 0.695 | 350 | 7.0 | 18 | 49 |
| 0.700 | 538 | 9.0 | 9.0 | 79 |
| 0.787 | 46 | 8.0 | 7.0 | 42 |
| 0.788 | 68 | 6.5 | 19 | 68 |
| 0.573 | 687 | 7.5 | 2.0 | 26 |
| 0.775 | 54 | 7.5 | 19 | 50 |
| 0.795 | 176 | 7.0 | 7.0 | 37 |
| 0.541 | 687 | 9.0 | 3.0 | 60 |
| 0.559 | 1273 | 9.0 | 5.0 | 80 |
| 0.580 | 506 | 6.5 | 15 | 53 |
| 0.797 | 667 | 8.5 | 4.0 | 32 |
| 0.838 | 30 | 8.0 | 20 | 28 |
| 0.590 | 415 | 9.0 | 8.0 | 85 |
| 0.693 | 1076 | 7.5 | 5.0 | 62 |
| 0.609 | 937 | 6.5 | 12 | 32 |
| 0.589 | 576 | 9.5 | 10 | 76 |
| 0.704 | 317 | 9.5 | 11 | 67 |
| 0.556 | 1127 | 7.0 | 8.0 | 60 |
| 0.744 | 1444 | 7.5 | 20 | 89 |
| 0.792 | 823 | 7.5 | 5.0 | 58 |
| 0.680 | 4 | 9.5 | 7.0 | 52 |
| 0.727 | 169 | 8.5 | 18 | 57 |
| 0.686 | 521 | 9.5 | 16 | 42 |
| 0.823 | 922 | 6.5 | 16 | 30 |
| 0.757 | 47 | 6.5 | 10 | 57 |
| 0.556 | 252 | 8.0 | 11 | 22 |
| 0.631 | 248 | 9.5 | 8.0 | 73 |
| 0.573 | 707 | 8.5 | 5.0 | 56 |
| 0.841 | 289 | 6.5 | 20 | 42 |
| 0.551 | 875 | 7.5 | 19 | 45 |
| 0.641 | 279 | 8.0 | 14 | 27 |
| 0.677 | 185 | 6.5 | 10 | 78 |
|-------|-----|-----|----|----|
| 0.731 | 64  | 6   | 18 | 40 |
| 0.732 | 996 | 7   | 12 | 69 |
| 0.599 | 113 | 6.5 | 7  | 67 |
| 0.634 | 951 | 10  | 9  | 50 |
| 0.769 | 735 | 7   | 14 | 66 |
| 0.789 | 123 | 8   | 3  | 27 |
| 0.802 | 802 | 9   | 11 | 82 |
| 0.765 | 472 | 6.5 | 18 | 73 |
| 0.737 | 390 | 9.5 | 3  | 90 |
| 0.747 | 432 | 7   | 4  | 78 |
| 0.805 | 41  | 9.5 | 17 | 25 |
| 0.653 | 1607| 8.5 | 20 | 49 |
| 0.566 | 440 | 6.5 | 2  | 25 |
| 0.824 | 1534| 6   | 6  | 42 |
| 0.710 | 1237| 7.5 | 5  | 90 |
| 0.845 | 79  | 7.5 | 6  | 36 |
| 0.667 | 227 | 6.5 | 8  | 33 |
| 0.825 | 638 | 7.5 | 3  | 84 |
| 0.586 | 1021| 6.5 | 11 | 83 |
| 0.762 | 5   | 7   | 18 | 89 |
| 0.546 | 1636| 8   | 10 | 80 |
| 0.750 | 248 | 9.5 | 20 | 27 |
| 0.716 | 202 | 9   | 12 | 62 |
| 0.843 | 1199| 6.5 | 5  | 89 |
| 0.551 | 854 | 10  | 3  | 77 |
| 0.708 | 89  | 10  | 14 | 84 |
| 0.677 | 28  | 8   | 17 | 79 |
| 0.739 | 513 | 6.5 | 3  | 25 |
| 0.621 | 786 | 9.5 | 7  | 83 |
| 0.549 | 387 | 9   | 14 | 81 |
| 0.657 | 1312| 6   | 13 | 55 |
| 0.757 | 273 | 8   | 4  | 58 |
| 0.846 | 232 | 8   | 12 | 76 |
| 0.679 | 1544| 8.5 | 6  | 27 |
| 0.603 | 395 | 8.5 | 14 | 62 |
| 0.573 | 117 | 9.5 | 9  | 28 |
| 0.701 | 1336| 8   | 16 | 39 |
| 0.653 | 100 | 7.5 | 16 | 41 |
| 0.769 | 1653| 9.5 | 18 | 38 |
| 0.687 | 528 | 9   | 13 | 44 |
| 0.831 | 77  | 10  | 11 | 79 |
| 0.811 | 169 | 9.5 | 19 | 87 |
| 0.779 | 337 | 8.5 | 13 | 80 |
| 0.801 | 50  | 6.5 | 5  | 65 |
| 0.828 | 354 | 7   | 4  | 43 |
| 0.747 | 287 | 8   | 20 | 21 |
| 0.788 | 78  | 6.5 | 16 | 56 |
| 0.790 | 52  | 9.5 | 11 | 32 |
| 0.732 | 621 | 6   | 4  | 34 |
| 0.846 | 1694| 8   | 12 | 74 |
| 0.845 | 697 | 9   | 12 | 37 |
| 0.714 | 576 | 7.5 | 7  | 81 |
| 0.635 | 1314| 6.5 | 17 | 75 |
| 0.626 | 571 | 6   | 12 | 53 |
| 0.591 | 1642| 8   | 10 | 76 |
| 0.580 | 1161| 9   | 12 | 87 |
| 0.591 | 110 | 10  | 2  | 66 |
| 0.615 | 1468| 8.5 | 15 | 84 |
| 0.611 | 69  | 6.5 | 20 | 79 |
| 0.594 | 193 | 8.5 | 19 | 32 |
| 0.804 | 189 | 9   | 14 | 46 |
| 0.654 | 361 | 9   | 14 | 70 |
| 0.627 | 922 | 9   | 2  | 36 |
| 0.784 | 424 | 10  | 7  | 81 |
| 0.775 | 610 | 7   | 15 | 63 |
| 0.695 | 310 | 8.5 | 16 | 85 |
| 0.643 | 547 | 8.5 | 4  | 88 |
| 0.708 | 661 | 6.5 | 15 | 36 |
| 0.755 | 313 | 10  | 15 | 87 |
| 0.760 | 18  | 7.5 | 8  | 52 |
| 0.574 | 212 | 9   | 11 | 59 |
| 0.811 | 711 | 8   | 2  | 71 |
| 0.685 | 372 | 9.5 | 9  | 66 |
| 0.768 | 749 | 6.5 | 7  | 77 |
| 0.559 | 1231| 9.5 | 6  | 48 |
| 0.553 | 602 | 9.5 | 6  | 81 |
| 0.624 | 748 | 8   | 19 | 46 |
| 0.695 | 476 | 9.5 | 3  | 58 |
| 0.624 | 748 | 10  | 11 | 27 |
| 0.656 | 490 | 8.5 | 2  | 34 |
| 0.787 | 379 | 8.5 | 8  | 47 |
| 0.685 | 644 | 9   | 12 | 88 |
| 0.822 | 446 | 6   | 6  | 34 |
| 0.696 | 48  | 10  | 9  | 25 |
| 0.748 | 218 | 9.5 | 14 | 42 |
| 0.745 | 255  | 9  | 6  | 20 |
|-------|------|----|----|----|
| 0.794 | 290  | 6.5| 6  | 51 |
| 0.819 | 245  | 9.5| 16 | 49 |
| 0.728 | 402  | 8.5| 11 | 33 |
| 0.621 | 1379 | 8  | 20 | 39 |
| 0.764 | 220  | 6.5| 20 | 23 |
| 0.802 | 789  | 7  | 16 | 29 |
| 0.757 | 483  | 8  | 12 | 74 |
| 0.569 | 333  | 9.5| 5  | 32 |
| 0.543 | 1311 | 6  | 19 | 29 |
| 0.690 | 59   | 8  | 10 | 57 |
| 0.552 | 904  | 10 | 12 | 25 |
| 0.702 | 77   | 6.5| 7  | 58 |
| 0.631 | 491  | 8  | 3  | 81 |
| 0.576 | 897  | 6.5| 12 | 57 |
| 0.688 | 450  | 9  | 6  | 38 |
| 0.585 | 292  | 8.5| 3  | 39 |
| 0.728 | 1524 | 8  | 8  | 88 |
| 0.797 | 26   | 8.5| 15 | 37 |
| 0.751 | 384  | 8.5| 15 | 65 |
| 0.543 | 684  | 7.5| 11 | 38 |
| 0.810 | 54   | 8.5| 2  | 69 |
| 0.617 | 890  | 7  | 13 | 44 |
| 0.830 | 208  | 7.5| 19 | 89 |
| 0.817 | 344  | 9.5| 12 | 27 |
| 0.838 | 449  | 9  | 11 | 88 |
| 0.549 | 953  | 9  | 17 | 74 |
| 0.843 | 512  | 7  | 11 | 76 |
| 0.576 | 261  | 9  | 6  | 49 |
| 0.769 | 171  | 6.5| 12 | 83 |
| 0.827 | 360  | 8  | 14 | 83 |
| 0.664 | 609  | 8  | 19 | 31 |
| 0.718 | 610  | 6  | 19 | 80 |
| 0.673 | 317  | 9.5| 8  | 71 |
| 0.710 | 38   | 7  | 3  | 81 |
| 0.635 | 45   | 8  | 14 | 31 |
| 0.788 | 1282 | 9  | 7  | 37 |
| 0.551 | 178  | 7  | 13 | 31 |
| 0.739 | 772  | 8.5| 4  | 26 |
| 0.734 | 216  | 6.5| 3  | 71 |
| 0.694 | 420  | 7.5| 19 | 34 |
| 0.697 | 945  | 6.5| 8  | 47 |
| 0.803 | 395  | 6  | 13 | 46 |
| 0.718 | 228 | 6.5 | 17 | 21 |
| 0.772 | 81  | 9.5 | 12 | 89 |
| 0.569 | 1555| 7   | 5  | 58 |
| 0.819 | 963 | 7   | 20 | 55 |
| 0.591 | 1514| 7.5 | 4  | 59 |
| 0.823 | 879 | 8   | 8  | 56 |
| 0.746 | 198 | 7.5 | 8  | 50 |
| 0.668 | 131 | 9.5 | 10 | 62 |
| 0.556 | 1195| 8   | 8  | 49 |
| 0.806 | 1515| 8.5 | 5  | 62 |
| 0.758 | 491 | 9.5 | 2  | 37 |
| 0.689 | 726 | 9   | 17 | 30 |
| 0.674 | 822 | 9.5 | 16 | 44 |
| 0.660 | 213 | 7.5 | 4  | 72 |
| 0.709 | 488 | 8.5 | 8  | 34 |
| 0.722 | 345 | 9   | 18 | 90 |
| 0.541 | 1053| 9.5 | 6  | 38 |
| 0.627 | 174 | 8   | 14 | 28 |
| 0.828 | 883 | 10  | 11 | 28 |
| 0.593 | 634 | 7.5 | 13 | 33 |
| 0.676 | 174 | 10  | 13 | 70 |
| 0.815 | 1697| 7   | 17 | 78 |
| 0.573 | 600 | 8.5 | 12 | 64 |
| 0.614 | 114 | 7   | 6  | 30 |
| 0.691 | 244 | 7   | 12 | 73 |
| 0.569 | 1411| 9   | 3  | 52 |
| 0.584 | 1100| 6.5 | 18 | 24 |
| 0.789 | 160 | 9.5 | 3  | 65 |
| 0.664 | 376 | 7   | 18 | 54 |
| 0.599 | 1361| 9   | 15 | 43 |
| 0.751 | 110 | 9   | 8  | 26 |
| 0.742 | 41  | 9.5 | 20 | 89 |
| 0.797 | 352 | 8   | 19 | 33 |
| 0.570 | 755 | 7.5 | 15 | 89 |
| 0.593 | 895 | 9   | 10 | 54 |
| 0.642 | 50  | 9.5 | 18 | 60 |
| 0.640 | 501 | 8.5 | 9  | 63 |
| 0.668 | 335 | 8   | 9  | 66 |
| 0.629 | 448 | 7.5 | 4  | 68 |
| 0.789 | 1313| 7.5 | 20 | 86 |
| 0.664 | 1682| 6.5 | 20 | 80 |
| 0.555 | 1210| 7.5 | 11 | 66 |
| 0.785 | 474 | 8.5 | 3  | 80 |
|    |     |     |  |  |    |
|----|-----|-----|---|---|----|
| 0.762 | 443 | 6.5 | 12 | 77 |
| 0.574 | 152 | 9   | 10 | 53 |
| 0.643 | 1392| 10  | 19 | 56 |
| 0.580 | 942 | 9   | 5  | 31 |
| 0.632 | 882 | 9.5 | 13 | 85 |
| 0.723 | 173 | 8.5 | 7  | 23 |
| 0.604 | 733 | 8   | 14 | 29 |
| 0.719 | 1416| 9.5 | 17 | 58 |
| 0.571 | 631 | 7   | 17 | 59 |
Appendix B:

Table 7: Input Parameters with Added Flows

| Scenario Number | Analysis Direction Flow in vph | Opposing Direction Flow in vph | Slope in % | Trucks in % | Truck Flow on Upgrade | No-Passing Zone in % |
|-----------------|-------------------------------|-------------------------------|------------|-------------|-----------------------|----------------------|
| 1               | 538                           | 438                           | 7.5        | 6           | 32                    | 49                   |
| 2               | 122                           | 154                           | 7.5        | 12          | 15                    | 54                   |
| 3               | 60                            | 217                           | 7.5        | 4           | 2                     | 22                   |
| 4               | 1660                          | 825                           | 9.5        | 4           | 66                    | 57                   |
| 5               | 278                           | 792                           | 6.5        | 17          | 47                    | 55                   |
| 6               | 1258                          | 951                           | 7.5        | 6           | 75                    | 77                   |
| 7               | 591                           | 382                           | 6.5        | 12          | 71                    | 77                   |
| 8               | 249                           | 342                           | 7.5        | 4           | 10                    | 85                   |
| 9               | 1179                          | 994                           | 9          | 14          | 165                   | 81                   |
| 10              | 1124                          | 1422                          | 7          | 8           | 90                    | 24                   |
| 11              | 1581                          | 509                           | 6          | 4           | 63                    | 45                   |
| 12              | 17                            | 13                             | 8          | 3           | 1                     | 57                   |
| 13              | 1691                          | 510                           | 7          | 3           | 51                    | 39                   |
| 14              | 1390                          | 536                           | 8          | 7           | 97                    | 30                   |
| 15              | 214                           | 378                           | 6          | 15          | 32                    | 46                   |
| 16              | 592                           | 1474                          | 8          | 11          | 65                    | 68                   |
| 17              | 69                            | 42                             | 8.5        | 5           | 3                     | 44                   |
| 18              | 394                           | 493                           | 9.5        | 19          | 75                    | 82                   |
| 19              | 1016                          | 1263                          | 6          | 2           | 20                    | 47                   |
| 20              | 1194                          | 215                           | 7.5        | 14          | 167                   | 35                   |
| 21              | 429                           | 1307                          | 8          | 7           | 30                    | 35                   |
| 22              | 326                           | 1009                          | 8          | 20          | 65                    | 38                   |
| 23              | 1351                          | 324                           | 8.5        | 3           | 41                    | 26                   |
| 24              | 62                            | 43                             | 7          | 11          | 7                     | 74                   |
| 25              | 121                           | 58                             | 9.5        | 14          | 17                    | 83                   |
| 26              | 1370                          | 282                           | 9.5        | 3           | 41                    | 60                   |
| 27              | 1608                          | 308                           | 9.5        | 19          | 306                   | 72                   |
| 28              | 847                           | 309                           | 6.5        | 5           | 42                    | 44                   |
| 29              | 369                           | 132                           | 7.5        | 7           | 26                    | 77                   |
| 30              | 777                           | 1657                          | 7          | 16          | 124                   | 71                   |
| 31              | 211                           | 439                           | 8.5        | 8           | 17                    | 65                   |
| 32              | 635                           | 848                           | 9.5        | 3           | 19                    | 24                   |
| 33              | 61                            | 197                            | 8.5        | 10          | 6                     | 36                   |
| 34              | 400                           | 749                            | 9.5        | 12          | 48                    | 55                   |
| 35              | 1510                          | 302                            | 9.5        | 17          | 257                   | 48                   |
|   |     |     |   |   |     |     |
|---|-----|-----|---|---|-----|-----|
|36| 785 | 164 | 9 | 3 | 24  | 84  |
|37| 928 | 510 | 6.5 | 8 | 74  | 90  |
|38| 320 | 73  | 6 | 16 | 51  | 38  |
|39| 925 | 634 | 8 | 7 | 65  | 53  |
|40| 1453| 540 | 7.5 | 19 | 276 | 52  |
|41| 599 | 171 | 8 | 19 | 114 | 37  |
|42| 1188| 1547| 7.5 | 10 | 119 | 45  |
|43| 1644| 1243| 7.5 | 8 | 132 | 49  |
|44| 1228| 366 | 9 | 2 | 25  | 85  |
|45| 192 | 833 | 10 | 15 | 29  | 85  |
|46| 172 | 108 | 9.5 | 2 | 3 | 24  |
|47| 489 | 257 | 9.5 | 9 | 44  | 26  |
|48| 455 | 706 | 8 | 17 | 77  | 60  |
|49| 133 | 462 | 8.5 | 7 | 9 | 39  |
|50| 6 | 8 | 7.5 | 8 | 1 | 78  |
|51| 402 | 904 | 9.5 | 5 | 20 | 47  |
|52| 924 | 175 | 10 | 16 | 148 | 33  |
|53| 626 | 1446| 7 | 10 | 63  | 76  |
|54| 257 | 126 | 10 | 19 | 49  | 77  |
|55| 347 | 558 | 8 | 9 | 31  | 72  |
|56| 329 | 698 | 9 | 3 | 10 | 24  |
|57| 135 | 574 | 7.5 | 19 | 26  | 44  |
|58| 348 | 1078| 8 | 9 | 31  | 68  |
|59| 440 | 96  | 9 | 5 | 22  | 73  |
|60| 1555| 750 | 10 | 19 | 295 | 51  |
|61| 649 | 550 | 6.5 | 20 | 130 | 76  |
|62| 315 | 159 | 8.5 | 14 | 44  | 69  |
|63| 899 | 1376| 6.5 | 2 | 18  | 53  |
|64| 392 | 1460| 7 | 17 | 67  | 59  |
|65| 483 | 1128| 9 | 13 | 63  | 38  |
|66| 460 | 631 | 6.5 | 15 | 69  | 38  |
|67| 420 | 1303| 6.5 | 8 | 34  | 37  |
|68| 27 | 55  | 7 | 5 | 1 | 29  |
|69| 66 | 340 | 6.5 | 10 | 7 | 29  |
|70| 166 | 297 | 10 | 15 | 25 | 86  |
|71| 718 | 1351| 6 | 20 | 144 | 70  |
|72| 426 | 1279| 9.5 | 17 | 72  | 26  |
|73| 532 | 765 | 8.5 | 4 | 21 | 45  |
|74| 67 | 156 | 6.5 | 7 | 5 | 36  |
|75| 1013| 803 | 9.5 | 18 | 182 | 32  |
|76| 10 | 35 | 8.5 | 8 | 1 | 34  |
|77| 1276| 458 | 8.5 | 7 | 89 | 71  |
|78| 718 | 1698| 8 | 2 | 14 | 38  |
|   |     |     |   |   |   |   |
|---|-----|-----|---|---|---|---|
| 79 | 479 | 99  | 8 | 8 | 38| 82 |
| 80 | 3   | 1   | 8 | 16| 0 | 50 |
| 81 | 532 | 184 | 7 | 9 | 48| 26 |
| 82 | 27  | 68  | 6.5| 3 | 1 | 52 |
| 83 | 704 | 1467| 6.5| 16| 113| 41|
| 84 | 83  | 100 | 7.5| 7 | 6 | 45 |
| 85 | 822 | 519 | 8 | 5 | 41| 61 |
| 86 | 1193| 377 | 6 | 7 | 84| 62 |
| 87 | 80  | 368 | 9.5| 14| 11| 51 |
| 88 | 260 | 1206| 9.5| 9 | 23| 56 |
| 89 | 83  | 300 | 6.5| 19| 16| 35 |
| 90 | 165 | 67  | 9 | 17| 28| 27 |
| 91 | 16  | 66  | 7.5| 20| 3 | 80 |
| 92 | 634 | 970 | 8.5| 13| 82| 53 |
| 93 | 603 | 1229| 7 | 6 | 36| 42 |
| 94 | 233 | 105 | 8.5| 3 | 7 | 52 |
| 95 | 135 | 33  | 7.5| 3 | 4 | 80 |
| 96 | 435 | 695 | 9 | 17| 74| 59 |
| 97 | 1061| 557 | 8.5| 6 | 64| 35 |
| 98 | 1345| 270 | 9.5| 3 | 40| 30 |
| 99 | 190 | 41  | 9.5| 14| 27| 51 |
|100 | 82  | 103 | 9.5| 3 | 2 | 70 |
|101 | 171 | 691 | 9 | 6 | 10| 53 |
|102 | 64  | 31  | 9 | 17| 11| 79 |
|103 | 501 | 1103| 8 | 14| 70| 60 |
|104 | 917 | 281 | 7 | 16| 147| 86|
|105 | 711 | 453 | 7 | 11| 78| 47 |
|106 | 548 | 204 | 8 | 9 | 49| 35 |
|107 | 209 | 1167| 9 | 18| 38| 61 |
|108 | 1055| 679 | 9.5| 8 | 84| 58 |
|109 | 110 | 265 | 9.5| 18| 20| 56 |
|110 | 34  | 40  | 9.5| 18| 6 | 28 |
|111 | 839 | 412 | 8 | 3 | 25| 76 |
|112 | 616 | 1372| 9.5| 16| 99| 29 |
|113 | 480 | 257 | 6.5| 15| 72| 34 |
|114 | 1481| 419 | 8.5| 15| 222| 22|
|115 | 803 | 1533| 7.5| 2 | 16| 42 |
|116 | 1498| 378 | 7 | 16| 240| 55 |
|117 | 1436| 780 | 7.5| 3 | 43| 41 |
|118 | 919 | 637 | 9 | 6 | 55| 41 |
|119 | 589 | 980 | 10| 9 | 53| 63 |
|120 | 1333| 746 | 6.5| 2 | 27| 67 |
|121 | 1663| 1238| 9.5| 14| 233| 82 |
|     |     |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|-----|
| 122 | 897 | 651 | 7.5 | 2   | 18  | 70  |
| 123 | 499 | 242 | 10  | 7   | 35  | 77  |
| 124 | 1606| 758 | 6.5 | 17  | 273 | 28  |
| 125 | 593 | 1328| 7.5 | 17  | 101 | 50  |
| 126 | 1650| 1373| 7   | 11  | 182 | 43  |
| 127 | 1278| 368 | 6.5 | 10  | 128 | 53  |
| 128 | 362 | 767 | 8.5 | 12  | 43  | 71  |
| 129 | 1152| 429 | 8   | 8   | 92  | 49  |
| 130 | 445 | 1045| 7.5 | 20  | 89  | 34  |
| 131 | 58  | 12  | 9.5 | 20  | 12  | 36  |
| 132 | 314 | 756 | 9.5 | 7   | 22  | 44  |
| 133 | 378 | 172 | 7.5 | 14  | 53  | 54  |
| 134 | 25  | 108 | 10  | 6   | 2   | 66  |
| 135 | 236 | 381 | 6.5 | 20  | 47  | 85  |
| 136 | 61  | 108 | 8   | 8   | 5   | 80  |
| 137 | 418 | 745 | 9.5 | 3   | 13  | 73  |
| 138 | 567 | 851 | 10  | 18  | 102 | 28  |
| 139 | 680 | 1494| 8   | 13  | 88  | 73  |
| 140 | 107 | 455 | 8   | 20  | 21  | 73  |
| 141 | 1631| 527 | 7   | 20  | 326 | 45  |
| 142 | 1152| 318 | 10  | 16  | 184 | 56  |
| 143 | 526 | 1075| 7   | 12  | 63  | 43  |
| 144 | 1155| 357 | 9.5 | 17  | 196 | 39  |
| 145 | 520 | 148 | 9   | 6   | 31  | 68  |
| 146 | 1112| 1328| 7   | 9   | 100 | 29  |
| 147 | 1692| 430 | 9.5 | 4   | 68  | 59  |
| 148 | 1086| 411 | 8.5 | 18  | 195 | 68  |
| 149 | 78  | 412 | 7.5 | 12  | 9   | 58  |
| 150 | 208 | 1095| 7.5 | 18  | 37  | 79  |
| 151 | 669 | 946 | 6.5 | 2   | 13  | 36  |
| 152 | 1283| 1662| 6.5 | 6   | 77  | 75  |
| 153 | 1264| 708 | 9.5 | 12  | 152 | 42  |
| 154 | 80  | 60  | 9.5 | 8   | 6   | 45  |
| 155 | 440 | 1496| 9.5 | 18  | 79  | 88  |
| 156 | 25  | 64  | 7.5 | 5   | 1   | 68  |
| 157 | 266 | 1251| 6.5 | 16  | 43  | 83  |
| 158 | 1161| 359 | 9.5 | 16  | 186 | 31  |
| 159 | 1318| 708 | 6.5 | 15  | 198 | 24  |
| 160 | 482 | 842 | 9.5 | 15  | 72  | 47  |
| 161 | 580 | 396 | 9   | 3   | 17  | 46  |
| 162 | 21  | 92  | 7   | 14  | 3   | 66  |
| 163 | 1454| 588 | 7.5 | 2   | 29  | 80  |
| 164 | 539 | 1404| 8.5 | 4   | 22  | 69  |
|    |      |      |    |    |    |    |    |
|----|------|------|----|----|----|----|----|
| 165| 726  | 308  | 6.5| 20 | 145| 45 |
| 166| 211  | 962  | 7.5| 12 | 25 | 69 |
| 167| 206  | 775  | 7  | 12 | 25 | 73 |
| 168| 120  | 657  | 9  | 19 | 23 | 41 |
| 169| 679  | 235  | 8.5| 9  | 61 | 45 |
| 170| 363  | 789  | 6  | 9  | 33 | 49 |
| 171| 351  | 547  | 7  | 7  | 25 | 26 |
| 172| 370  | 68   | 8.5| 6  | 22 | 70 |
| 173| 1315 | 1620 | 7.5| 12 | 158| 49 |
| 174| 536  | 994  | 10 | 17 | 91 | 64 |
| 175| 1286 | 464  | 8.5| 11 | 141| 52 |
| 176| 35   | 97   | 7.5| 19 | 7  | 43 |
| 177| 385  | 454  | 7  | 8  | 31 | 89 |
| 178| 853  | 1208 | 8  | 13 | 111| 62 |
| 179| 44   | 25   | 7  | 19 | 8  | 68 |
| 180| 1686 | 344  | 9.5| 14 | 236| 32 |
| 181| 19   | 43   | 9.5| 9  | 2  | 39 |
| 182| 725  | 1334 | 6  | 20 | 145| 40 |
| 183| 8    | 2    | 7  | 13 | 1  | 81 |
| 184| 200  | 395  | 7.5| 12 | 24 | 27 |
| 185| 70   | 312  | 9.5| 4  | 3  | 59 |
| 186| 444  | 1242 | 7.5| 12 | 53 | 67 |
| 187| 1273 | 577  | 7  | 5  | 64 | 70 |
| 188| 773  | 1381 | 6.5| 2  | 15 | 35 |
| 189| 668  | 395  | 8.5| 15 | 100| 88 |
| 190| 347  | 181  | 8  | 6  | 21 | 46 |
| 191| 285  | 1050 | 8  | 14 | 40 | 63 |
| 192| 44   | 158  | 6  | 5  | 2  | 32 |
| 193| 854  | 443  | 6.5| 8  | 68 | 31 |
| 194| 757  | 912  | 7.5| 4  | 30 | 30 |
| 195| 1223 | 405  | 6.5| 6  | 73 | 89 |
| 196| 1163 | 538  | 6  | 17 | 198| 52 |
| 197| 161  | 80   | 9  | 19 | 31 | 67 |
| 198| 1364 | 720  | 6  | 2  | 27 | 44 |
| 199| 717  | 392  | 9.5| 2  | 14 | 70 |
| 200| 523  | 680  | 8  | 16 | 84 | 87 |
| 201| 1438 | 1040 | 8.5| 10 | 144| 40 |
| 202| 998  | 548  | 6.5| 16 | 160| 50 |
| 203| 536  | 176  | 8  | 16 | 86 | 69 |
| 204| 43   | 105  | 8.5| 6  | 3  | 68 |
| 205| 614  | 1099 | 9  | 11 | 68 | 76 |
| 206| 1161 | 314  | 7.5| 3  | 35 | 87 |
| 207| 229  | 953  | 9.5| 20 | 46 | 38 |

75
|   |      |      |   |   |   |
|---|-----|-----|---|---|---|
| 208 | 526 | 1328 | 9 | 15 | 79 |
| 209 | 1265 | 462 | 10 | 7 | 89 |
| 210 | 735 | 396 | 8 | 13 | 96 |
| 211 | 326 | 676 | 8.5 | 6 | 20 |
| 212 | 271 | 428 | 6.5 | 19 | 51 |
| 213 | 13 | 58 | 7.5 | 14 | 2 |
| 214 | 273 | 732 | 9.5 | 9 | 25 |
| 215 | 53 | 14 | 6.5 | 10 | 5 |
| 216 | 1376 | 1151 | 10 | 11 | 151 |
| 217 | 262 | 1429 | 9.5 | 7 | 18 |
| 218 | 427 | 196 | 10 | 10 | 43 |
| 219 | 776 | 1550 | 6 | 6 | 47 |
| 220 | 453 | 151 | 10 | 11 | 50 |
| 221 | 448 | 86 | 8.5 | 17 | 76 |
| 222 | 501 | 122 | 6 | 13 | 65 |
| 223 | 1668 | 296 | 10 | 11 | 183 |
| 224 | 753 | 298 | 9 | 16 | 120 |
| 225 | 573 | 784 | 9 | 10 | 57 |
| 226 | 1317 | 806 | 9.5 | 6 | 79 |
| 227 | 1399 | 397 | 9 | 19 | 266 |
| 228 | 1440 | 1134 | 6.5 | 11 | 158 |
| 229 | 487 | 184 | 9 | 9 | 44 |
| 230 | 419 | 1621 | 9.5 | 10 | 42 |
| 231 | 107 | 40 | 7.5 | 20 | 21 |
| 232 | 85 | 375 | 9 | 2 | 2 |
| 233 | 1485 | 290 | 9 | 17 | 252 |
| 234 | 272 | 1238 | 8 | 3 | 8 |
| 235 | 804 | 298 | 9.5 | 7 | 56 |
| 236 | 359 | 120 | 9 | 3 | 11 |
| 237 | 668 | 810 | 8.5 | 5 | 33 |
| 238 | 1245 | 665 | 7 | 4 | 50 |
| 239 | 1666 | 767 | 9 | 19 | 317 |
| 240 | 200 | 992 | 8.5 | 16 | 32 |
| 241 | 910 | 294 | 9 | 2 | 18 |
| 242 | 20 | 86 | 7.5 | 2 | 0 |
| 243 | 258 | 748 | 6.5 | 6 | 15 |
| 244 | 781 | 299 | 10 | 19 | 148 |
| 245 | 679 | 201 | 8.5 | 16 | 109 |
| 246 | 437 | 697 | 8 | 12 | 52 |
| 247 | 95 | 285 | 10 | 5 | 5 |
| 248 | 1595 | 472 | 7.5 | 5 | 80 |
| 249 | 334 | 577 | 10 | 6 | 20 |
| 250 | 183 | 1025 | 8.5 | 8 | 15 |
|   |   |   |   |   |   |
|---|---|---|---|---|---|
| 251 | 252 | 253 | 254 | 255 | 256 |
| 241 | 1257 | 247 | 942 | 305 | 262 |
| 54  | 680  | 749 | 6    | 994  | 350  |
| 9.5 | 9.5  | 8   | 6    | 7    | 9.5  |
| 2   | 9    | 2   | 14   | 20   | 19   |
| 5   | 113  | 5   | 42   | 61   | 50   |
| 27  | 56   | 31  | 67   | 53   | 69   |
|   |   |   |   |   |   |
| 257 | 258 | 259 | 260 | 261 | 262 |
| 650 | 1645 | 181 | 1248 | 26 | 541 |
| 866 | 294  | 238 | 1629 | 49  | 698  |
| 8   | 7.5  | 10  | 7.5  | 7    | 7.5  |
|   | 18   | 18  | 18   | 15   | 11   |
| 81  | 75   | 76  | 87   | 44   | 87   |
|   |   |   |   |   |   |
| 263 | 264 | 265 | 266 | 267 | 268 |
| 725 | 1441 | 1398 | 854  | 1021 | 92   |
| 1478 | 263 | 1071 | 648  | 329  | 432  |
| 9.5 | 6.5  | 6.5 | 7    | 9    | 8    |
| 18  | 1159 | 8  | 2  | 31 | 76   |
| 38  | 50   | 62  | 41   | 81   | 76   |
|   |   |   |   |   |   |
| 269 | 270 | 271 | 272 | 273 | 274 |
| 1580 | 719 | 615 | 21   | 658  | 175  |
| 549 | 144  | 121 | 62   | 299  | 349  |
| 8.5 | 7  | 7  | 9    | 7   | 8.5  |
| 3   | 19   | 14 | 16   | 16   | 20   |
| 47  | 137  | 86  | 48   | 105  | 35   |
| 32  | 31   | 76  | 57   | 34   | 77   |
|   |   |   |   |   |   |
| 275 | 276 | 277 | 278 | 279 | 280 |
| 232 | 392  | 290 | 942  | 1129 | 43   |
| 1081 | 253 | 362 | 1200 | 478  | 14   |
| 8.5 | 7.5 | 10 | 6   | 7.5  | 8.5  |
| 8   | 4    | 13 | 13  | 16   | 11   |
| 77  | 31   | 36  | 88   | 28   | 66   |
|   |   |   |   |   |   |
| 281 | 282 | 283 | 284 | 285 | 286 |
| 351 | 1128 | 762 | 107  | 1027 | 249  |
| 527 | 896  | 298 | 542  | 1234 | 895  |
| 8   | 10   | 9.5 | 7.5  | 10   | 8    |
| 10  | 14   | 5  | 10   | 9    | 5    |
| 54  | 76   | 51  | 28   | 49   | 86   |
|   |   |   |   |   |   |
| 287 | 288 | 289 | 290 | 291 | 292 |
| 910 | 139  | 218 | 1510 | 151 | 46   |
| 444 | 200  | 426 | 1020 | 27  | 17   |
| 7   | 7   | 9.5 | 8.5  | 8    | 6    |
| 13  | 8    | 4   | 18   | 5    | 10   |
| 118 | 76   | 59  | 24   | 76   | 33   |
|   |   |   |   |   |   |
| 293 | 626 | 1063 | 6.5 | 20 | 125 |
|   |   |   |   |   |   |
|   |   |   |   |   |   |
|   |   |   |   |   |   |
|   |   |   |   |   |   |
|   | 55 | 73 | 7.5 | 3  | 2  | 89 |
|---|----|----|-----|----|----|----|
| 294 | 190 | 403 | 6   | 11 | 21 | 83 |
| 295 | 1587 | 1299 | 10  | 18 | 286 | 32 |
| 296 | 1172 | 575 | 9   | 18 | 211 | 44 |
| 297 | 1363 | 520 | 7   | 14 | 191 | 73 |
| 298 | 819 | 324 | 8   | 20 | 164 | 75 |
| 299 | 1183 | 938 | 8   | 12 | 142 | 73 |
| 300 | 1267 | 722 | 10  | 14 | 177 | 46 |
| 301 | 1084 | 1340 | 8.5 | 13 | 133 | 72 |
| 302 | 80 | 38 | 6.5 | 17 | 14 | 86 |
| 303 | 1020 | 1340 | 8.5 | 13 | 133 | 72 |
| 304 | 1231 | 261 | 9   | 2  | 25  | 35 |
| 305 | 63 | 25 | 8   | 11 | 7   | 87 |
| 306 | 560 | 1667 | 9.5 | 19 | 106 | 60 |
| 307 | 488 | 1497 | 9   | 12 | 59  | 35 |
| 308 | 555 | 1105 | 8.5 | 16 | 89  | 78 |
| 309 | 351 | 194 | 9   | 11 | 39  | 74 |
| 310 | 30 | 9 | 8.5 | 12 | 4   | 31 |
| 311 | 422 | 1232 | 10  | 8  | 34  | 45 |
| 312 | 485 | 724 | 9   | 3  | 15  | 33 |
| 313 | 379 | 1247 | 10  | 10 | 38  | 47 |
| 314 | 262 | 420 | 10  | 3  | 8   | 24 |
| 315 | 351 | 234 | 8   | 20 | 70  | 41 |
| 316 | 123 | 36 | 6.5 | 6  | 7   | 22 |
| 317 | 1537 | 870 | 9   | 13 | 200 | 55 |
| 318 | 647 | 336 | 9.5 | 19 | 123 | 74 |
| 319 | 502 | 1296 | 7   | 9  | 45  | 39 |
| 320 | 231 | 48 | 7   | 9  | 21  | 62 |
| 321 | 871 | 1368 | 8.5 | 17 | 148 | 37 |
| 322 | 125 | 92 | 7.5 | 12 | 15  | 29 |
| 323 | 243 | 410 | 8.5 | 14 | 34  | 22 |
| 324 | 428 | 985 | 8   | 17 | 73  | 32 |
| 325 | 825 | 1626 | 8   | 11 | 91  | 65 |
| 326 | 474 | 862 | 9.5 | 2  | 9   | 20 |
| 327 | 898 | 1194 | 7.5 | 2  | 18  | 41 |
| 328 | 550 | 818 | 6.5 | 20 | 110 | 69 |
| 329 | 759 | 436 | 10  | 18 | 137 | 77 |
| 330 | 488 | 755 | 6.5 | 15 | 73  | 52 |
| 331 | 139 | 80 | 9.5 | 3  | 4   | 58 |
| 332 | 888 | 355 | 10  | 18 | 160 | 54 |
| 333 | 622 | 865 | 8   | 11 | 68  | 41 |
| 334 | 906 | 1456 | 7.5 | 10 | 91  | 35 |
| 335 | 938 | 172 | 6.5 | 12 | 113 | 50 |
|    |     |     | |  |  |    |    |
|----|-----|-----||  |  |  |    |
| 337 | 543 | 1628 | 7 | 6 | 33 | 82 |
| 338 | 1468 | 1210 | 7 | 19 | 279 | 49 |
| 339 | 136 | 267 | 6 | 19 | 26 | 69 |
| 340 | 399 | 71 | 9 | 10 | 40 | 43 |
| 341 | 1416 | 1019 | 8 | 6 | 85 | 76 |
| 342 | 735 | 404 | 8.5 | 13 | 96 | 65 |
| 343 | 654 | 1481 | 7 | 15 | 98 | 44 |
| 344 | 92 | 431 | 7.5 | 5 | 5 | 67 |
| 345 | 1662 | 378 | 7.5 | 12 | 199 | 58 |
| 346 | 1549 | 1208 | 8.5 | 17 | 263 | 75 |
| 347 | 350 | 795 | 7 | 18 | 63 | 49 |
| 348 | 538 | 1252 | 9 | 9 | 48 | 79 |
| 349 | 46 | 169 | 8 | 7 | 3 | 42 |
| 350 | 68 | 253 | 6.5 | 19 | 13 | 68 |
| 351 | 687 | 922 | 7.5 | 2 | 14 | 26 |
| 352 | 54 | 16 | 7.5 | 19 | 10 | 50 |
| 353 | 176 | 681 | 7 | 7 | 12 | 37 |
| 354 | 687 | 583 | 9 | 3 | 21 | 60 |
| 355 | 1273 | 1005 | 9 | 5 | 64 | 80 |
| 356 | 506 | 367 | 6.5 | 15 | 76 | 53 |
| 357 | 667 | 170 | 8.5 | 4 | 27 | 32 |
| 358 | 30 | 157 | 8 | 20 | 6 | 28 |
| 359 | 415 | 288 | 9 | 8 | 33 | 85 |
| 360 | 1076 | 477 | 7.5 | 5 | 54 | 62 |
| 361 | 937 | 1458 | 6.5 | 12 | 112 | 32 |
| 362 | 576 | 401 | 9.5 | 10 | 58 | 76 |
| 363 | 317 | 754 | 9.5 | 11 | 35 | 67 |
| 364 | 1127 | 899 | 7 | 8 | 90 | 60 |
| 365 | 1444 | 496 | 7.5 | 20 | 289 | 89 |
| 366 | 823 | 216 | 7.5 | 5 | 41 | 58 |
| 367 | 4 | 8 | 9.5 | 7 | 0 | 52 |
| 368 | 169 | 448 | 8.5 | 18 | 30 | 57 |
| 369 | 521 | 1140 | 9.5 | 16 | 83 | 42 |
| 370 | 922 | 198 | 6.5 | 16 | 148 | 30 |
| 371 | 47 | 147 | 6.5 | 10 | 5 | 57 |
| 372 | 252 | 315 | 8 | 11 | 28 | 22 |
| 373 | 248 | 424 | 9.5 | 8 | 20 | 73 |
| 374 | 707 | 949 | 8.5 | 5 | 35 | 56 |
| 375 | 289 | 55 | 6.5 | 20 | 58 | 42 |
| 376 | 875 | 713 | 7.5 | 19 | 166 | 45 |
| 377 | 279 | 156 | 8 | 14 | 39 | 27 |
| 378 | 185 | 88 | 6.5 | 10 | 19 | 78 |
| 379 | 64 | 174 | 6 | 18 | 12 | 40 |
|   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|
| 380 | 996 | 364 | 7 | 12 | 120 | 69 |
| 381 | 113 | 76 | 6.5 | 7 | 8 | 67 |
| 382 | 951 | 1646 | 10 | 9 | 86 | 50 |
| 383 | 735 | 221 | 7 | 14 | 103 | 66 |
| 384 | 123 | 459 | 8 | 3 | 4 | 27 |
| 385 | 802 | 198 | 9 | 11 | 88 | 82 |
| 386 | 472 | 145 | 6.5 | 18 | 85 | 73 |
| 387 | 390 | 1095 | 9.5 | 3 | 12 | 90 |
| 388 | 432 | 1274 | 7 | 4 | 17 | 78 |
| 389 | 41 | 10 | 9.5 | 17 | 7 | 25 |
| 390 | 1607 | 852 | 8.5 | 20 | 321 | 49 |
| 391 | 440 | 574 | 6.5 | 2 | 9 | 25 |
| 392 | 1534 | 329 | 6 | 6 | 92 | 42 |
| 393 | 1237 | 506 | 7.5 | 5 | 62 | 90 |
| 394 | 79 | 433 | 7.5 | 6 | 5 | 36 |
| 395 | 227 | 456 | 6.5 | 8 | 18 | 33 |
| 396 | 638 | 136 | 7.5 | 3 | 19 | 84 |
| 397 | 1021 | 720 | 6.5 | 11 | 112 | 83 |
| 398 | 5 | 16 | 7 | 18 | 1 | 89 |
| 399 | 1636 | 1362 | 8 | 10 | 164 | 80 |
| 400 | 248 | 743 | 9.5 | 20 | 50 | 27 |
| 401 | 202 | 80 | 9 | 12 | 24 | 62 |
| 402 | 1199 | 223 | 6.5 | 5 | 60 | 89 |
| 403 | 854 | 1048 | 10 | 3 | 26 | 77 |
| 404 | 89 | 217 | 10 | 14 | 13 | 84 |
| 405 | 28 | 13 | 8 | 17 | 5 | 79 |
| 406 | 513 | 1454 | 6.5 | 3 | 15 | 25 |
| 407 | 786 | 480 | 9.5 | 7 | 55 | 83 |
| 408 | 387 | 318 | 9 | 14 | 54 | 81 |
| 409 | 1312 | 685 | 6 | 13 | 171 | 55 |
| 410 | 273 | 853 | 8 | 4 | 11 | 58 |
| 411 | 232 | 1272 | 8 | 12 | 28 | 76 |
| 412 | 1544 | 729 | 8.5 | 6 | 93 | 27 |
| 413 | 395 | 260 | 8.5 | 14 | 55 | 62 |
| 414 | 117 | 87 | 9.5 | 9 | 11 | 28 |
| 415 | 1336 | 571 | 8 | 16 | 214 | 39 |
| 416 | 100 | 53 | 7.5 | 16 | 16 | 41 |
| 417 | 1653 | 497 | 9.5 | 18 | 298 | 38 |
| 418 | 528 | 240 | 9 | 13 | 69 | 44 |
| 419 | 77 | 16 | 10 | 11 | 8 | 79 |
| 420 | 169 | 727 | 9.5 | 19 | 32 | 87 |
| 421 | 337 | 1190 | 8.5 | 13 | 44 | 80 |
| 422 | 50 | 200 | 6.5 | 5 | 2 | 65 |
|   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|
| 423 | 354 | 74 | 7 | 4 | 14 | 43 |
| 424 | 287 | 847 | 8 | 20 | 57 | 21 |
| 425 | 78 | 21 | 6.5 | 16 | 12 | 56 |
| 426 | 52 | 197 | 9.5 | 11 | 6 | 32 |
| 427 | 621 | 1695 | 6 | 4 | 25 | 34 |
| 428 | 1694 | 310 | 8 | 12 | 203 | 74 |
| 429 | 697 | 128 | 9 | 12 | 84 | 37 |
| 430 | 576 | 1439 | 7.5 | 7 | 40 | 81 |
| 431 | 1314 | 754 | 6.5 | 17 | 223 | 75 |
| 432 | 571 | 341 | 6 | 12 | 69 | 53 |
| 433 | 1642 | 1137 | 8 | 10 | 164 | 76 |
| 434 | 1161 | 839 | 9 | 12 | 139 | 87 |
| 435 | 110 | 76 | 10 | 2 | 2 | 66 |
| 436 | 1468 | 919 | 8.5 | 15 | 220 | 84 |
| 437 | 69 | 108 | 6.5 | 20 | 14 | 79 |
| 438 | 193 | 132 | 8.5 | 19 | 37 | 32 |
| 439 | 189 | 774 | 9 | 14 | 26 | 46 |
| 440 | 361 | 191 | 9 | 14 | 51 | 70 |
| 441 | 922 | 1551 | 9 | 2 | 18 | 36 |
| 442 | 424 | 1533 | 10 | 7 | 30 | 81 |
| 443 | 610 | 177 | 7 | 15 | 92 | 63 |
| 444 | 310 | 709 | 8.5 | 16 | 50 | 85 |
| 445 | 547 | 304 | 8.5 | 4 | 22 | 88 |
| 446 | 661 | 1599 | 6.5 | 15 | 99 | 36 |
| 447 | 313 | 964 | 10 | 15 | 47 | 87 |
| 448 | 18 | 58 | 7.5 | 8 | 1 | 52 |
| 449 | 212 | 285 | 9 | 11 | 23 | 59 |
| 450 | 711 | 165 | 8 | 2 | 14 | 71 |
| 451 | 372 | 811 | 9.5 | 9 | 33 | 66 |
| 452 | 749 | 227 | 6.5 | 7 | 52 | 77 |
| 453 | 1231 | 1562 | 9.5 | 6 | 74 | 48 |
| 454 | 602 | 745 | 9.5 | 6 | 36 | 81 |
| 455 | 748 | 1243 | 8 | 19 | 142 | 46 |
| 456 | 476 | 209 | 9.5 | 3 | 14 | 58 |
| 457 | 748 | 450 | 10 | 11 | 82 | 27 |
| 458 | 490 | 936 | 8.5 | 2 | 10 | 34 |
| 459 | 379 | 1400 | 8.5 | 8 | 30 | 47 |
| 460 | 644 | 1400 | 9 | 12 | 77 | 88 |
| 461 | 446 | 97 | 6 | 6 | 27 | 34 |
| 462 | 48 | 21 | 10 | 9 | 4 | 25 |
| 463 | 218 | 646 | 9.5 | 14 | 30 | 42 |
| 464 | 255 | 745 | 9 | 6 | 15 | 20 |
| 465 | 290 | 1113 | 6.5 | 6 | 17 | 51 |
|   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|
|466| 245| 1107| 9.5| 16| 39| 49|
|467| 402| 1075| 8.5| 11| 44| 33|
|468| 1379| 843| 8| 20| 276| 39|
|469| 220| 715| 6.5| 20| 44| 23|
|470| 789| 195| 7| 16| 126| 29|
|471| 483| 1505| 8| 12| 58| 74|
|472| 333| 252| 9.5| 5| 17| 32|
|473| 1311| 1559| 6| 19| 249| 29|
|474| 59| 26| 8| 10| 6| 57|
|475| 904| 733| 10| 12| 108| 25|
|476| 77| 182| 6.5| 7| 5| 58|
|477| 491| 840| 8| 3| 15| 81|
|478| 897| 1219| 6.5| 12| 108| 57|
|479| 450| 204| 9| 6| 27| 38|
|480| 292| 412| 8.5| 3| 9| 39|
|481| 1524| 569| 8| 8| 122| 88|
|482| 26| 101| 8.5| 15| 4| 37|
|483| 384| 1162| 8.5| 15| 58| 65|
|484| 684| 812| 7.5| 11| 75| 38|
|485| 54| 229| 8.5| 2| 1| 69|
|486| 890| 1433| 7| 13| 116| 44|
|487| 208| 1017| 7.5| 19| 40| 89|
|488| 344| 77| 9.5| 12| 41| 27|
|489| 449| 87| 9| 11| 49| 88|
|490| 953| 782| 9| 17| 162| 74|
|491| 512| 95| 7| 11| 56| 76|
|492| 261| 354| 9| 6| 16| 49|
|493| 171| 570| 6.5| 12| 21| 83|
|494| 360| 75| 8| 14| 50| 83|
|495| 609| 1203| 8| 19| 116| 31|
|496| 610| 1556| 6| 19| 116| 80|
|497| 317| 654| 9.5| 8| 25| 71|
|498| 38| 92| 7| 3| 1| 81|
|499| 45| 26| 8| 14| 6| 31|
|500| 1282| 345| 9| 7| 90| 37|
|501| 178| 218| 7| 13| 23| 31|
|502| 772| 273| 8.5| 4| 31| 26|
|503| 216| 78| 6.5| 3| 6| 71|
|504| 420| 954| 7.5| 19| 80| 34|
|505| 945| 411| 6.5| 8| 76| 47|
|506| 395| 97| 6| 13| 51| 46|
|507| 228| 90| 6.5| 17| 39| 21|
|508| 81| 275| 9.5| 12| 10| 89|
|   |      |      |   |   |   |   |
|---|------|------|---|---|---|---|
| 509| 1555 | 1176 | 7 | 5 | 78 | 58 |
| 510| 963  | 213  | 7 | 20| 193| 55 |
| 511| 1514 | 1048 | 7.5| 4 | 61 | 59 |
| 512| 879  | 189  | 8 | 8 | 70 | 56 |
| 513| 198  | 68   | 7.5| 8 | 16 | 50 |
| 514| 131  | 65   | 9.5| 10| 13 | 62 |
| 515| 1195 | 1494 | 8 | 8 | 96 | 49 |
| 516| 1515 | 364  | 8.5| 5 | 76 | 62 |
| 517| 491  | 157  | 9.5| 2 | 10 | 37 |
| 518| 726  | 1611 | 9 | 17| 123| 30 |
| 519| 822  | 398  | 9.5| 16| 132| 44 |
| 520| 213  | 110  | 7.5| 4 | 9  | 72 |
| 521| 488  | 1190 | 8.5| 8 | 39 | 34 |
| 522| 345  | 133  | 9 | 18| 62 | 90 |
| 523| 1053 | 1240 | 9.5| 6 | 63 | 38 |
| 524| 174  | 103  | 8 | 14| 24 | 28 |
| 525| 883  | 183  | 10| 11| 97 | 28 |
| 526| 634  | 434  | 7.5| 13| 82 | 33 |
| 527| 174  | 363  | 10| 13| 23 | 70 |
| 528| 1697 | 386  | 7 | 17| 288| 78 |
| 529| 600  | 447  | 8.5| 12| 72 | 64 |
| 530| 114  | 182  | 7 | 6 | 7  | 30 |
| 531| 244  | 544  | 7 | 12| 29 | 73 |
| 532| 1411 | 1070 | 9 | 3 | 42 | 52 |
| 533| 1100 | 1542 | 6.5| 18| 198| 24 |
| 534| 160  | 43   | 9.5| 3 | 5  | 65 |
| 535| 376  | 742  | 7 | 18| 68 | 54 |
| 536| 1361 | 912  | 9 | 15| 204| 43 |
| 537| 110  | 330  | 9 | 8 | 9  | 26 |
| 538| 41   | 119  | 9.5| 20| 8  | 89 |
| 539| 352  | 1380 | 8 | 19| 67 | 33 |
| 540| 755  | 1003 | 7.5| 15| 113| 89 |
| 541| 895  | 1305 | 9 | 10| 90 | 54 |
| 542| 50   | 28   | 9.5| 18| 9  | 60 |
| 543| 501  | 892  | 8.5| 9 | 45 | 63 |
| 544| 335  | 672  | 8 | 9 | 30 | 66 |
| 545| 448  | 265  | 7.5| 4 | 18 | 68 |
| 546| 1313 | 351  | 7.5| 20| 263| 86 |
| 547| 1682 | 850  | 6.5| 20| 336| 80 |
| 548| 1210 | 1508 | 7.5| 11| 133| 66 |
| 549| 474  | 130  | 8.5| 3 | 14 | 80 |
| 550| 1679 | 628  | 6 | 16| 269| 62 |
| 551| 207  | 72   | 8.5| 2 | 4  | 52 |
|   | 1007 | 1427 | 9.5 | 10 | 101 | 23 |
|---|------|------|-----|----|-----|----|
| 552 | 817  | 1110 | 7   | 11 | 90  | 66 |
| 553 | 69   | 160  | 8   | 9  | 6   | 40 |
| 554 | 215  | 979  | 9   | 13 | 28  | 54 |
| 555 | 813  | 441  | 10  | 13 | 106 | 81 |
| 556 | 1508 | 766  | 7   | 7  | 106 | 48 |
| 557 | 1238 | 223  | 8   | 10 | 124 | 69 |
| 558 | 399  | 912  | 7.5 | 3  | 12  | 23 |
| 559 | 744  | 1673 | 6   | 20 | 149 | 67 |
| 560 | 521  | 281  | 7.5 | 10 | 52  | 42 |
| 561 | 335  | 66   | 10  | 11 | 37  | 87 |
| 562 | 1027 | 659  | 7   | 19 | 195 | 77 |
| 563 | 1646 | 712  | 10  | 18 | 296 | 83 |
| 564 | 596  | 488  | 9   | 7  | 42  | 60 |
| 565 | 616  | 1547 | 7.5 | 14 | 86  | 51 |
| 566 | 412  | 902  | 7   | 3  | 12  | 82 |
| 567 | 603  | 240  | 7   | 14 | 84  | 88 |
| 568 | 959  | 1200 | 8   | 13 | 125 | 26 |
| 569 | 127  | 22   | 9   | 8  | 10  | 69 |
| 570 | 1297 | 878  | 6.5 | 2  | 26  | 73 |
| 571 | 1301 | 442  | 8.5 | 12 | 156 | 67 |
| 572 | 781  | 156  | 8.5 | 2  | 16  | 58 |
| 573 | 762  | 1370 | 8.5 | 14 | 107 | 74 |
| 574 | 266  | 607  | 7   | 17 | 45  | 73 |
| 575 | 364  | 799  | 7   | 13 | 47  | 69 |
| 576 | 1562 | 1004 | 7.5 | 9  | 141 | 34 |
| 577 | 151  | 184  | 9   | 11 | 17  | 36 |
| 578 | 1624 | 679  | 7.5 | 2  | 32  | 41 |
| 579 | 1177 | 1624 | 10  | 2  | 24  | 33 |
| 580 | 679  | 1505 | 7   | 12 | 82  | 40 |
| 581 | 405  | 194  | 6   | 12 | 49  | 50 |
| 582 | 533  | 1324 | 7   | 4  | 21  | 42 |
| 583 | 226  | 1118 | 9.5 | 6  | 14  | 70 |
| 584 | 440  | 1199 | 7.5 | 20 | 88  | 53 |
| 585 | 215  | 500  | 9.5 | 6  | 13  | 82 |
| 586 | 381  | 1206 | 8.5 | 7  | 27  | 40 |
| 587 | 431  | 269  | 9.5 | 13 | 56  | 57 |
| 588 | 268  | 364  | 8.5 | 19 | 51  | 62 |
| 589 | 368  | 858  | 7.5 | 19 | 70  | 47 |
| 590 | 40   | 219  | 7   | 5  | 2   | 58 |
| 591 | 923  | 383  | 10  | 15 | 138 | 49 |
| 592 | 443  | 138  | 6.5 | 12 | 53  | 77 |
| 593 | 152  | 205  | 9   | 10 | 15  | 53 |
|   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|
| 595 | 1392 | 773 | 10 | 19 | 264 | 56 |
| 596 | 942 | 1302 | 9 | 5 | 47 | 31 |
| 597 | 882 | 1515 | 9.5 | 13 | 115 | 85 |
| 598 | 173 | 453 | 8.5 | 7 | 12 | 23 |
| 599 | 733 | 1119 | 8 | 14 | 103 | 29 |
| 600 | 1416 | 554 | 9.5 | 17 | 241 | 58 |
| 601 | 631 | 473 | 7 | 17 | 107 | 59 |
Appendix C-1: Details for Software run 68

HCS7: Two-Lane Highways Release 7.3

directional Two-Lane Highway Segment Analysis

Analyst: Luisa Schuelke
Agency/Co.: University of Rhode Island
Date Performed: 07/28/2018
Highway: Hypothetical Two-Lane Highway
Analysis Year: 2018
Description: 68

Input Data

Highway class: Class 1
Shoulder width: 6.0 ft
Lane width: 12.0 ft
Segment length: 1.0 mi
Terrain type: Specific Grade
Grade: Length 0.35 mi
Up/down 7.0 %
Analysis direction volume, Vd 27 veh/h
Opposing direction volume, Vo 55 veh/h

Average Travel Speed

| Direction      | Analysis (d) | Opposing (o) |
|----------------|--------------|--------------|
| PCE for trucks, ET | 6.2          | 1.9          |
| PCE for RVs, ER   | 1.6          | 1.0          |
| Heavy-vehicle adj. factor, (note-5) fHV | 0.779        | 0.957        |
| Grade adj. factor, (note-1) fg    | 0.50         | 1.00         |
Directional flow rate, vi: 87 pc/h, 72 pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, S FM: - mi/h
Observed total demand, V: - veh/h

Estimated Free-Flow Speed:

Base free-flow speed, BFFS: 60.0 mi/h
Adj. for lane and shoulder width, fLS: 0.0 mi/h
Adj. for access point density, fA: 2.0 mi/h
Free-flow speed, FFSd: 58.0 mi/h
Adjustment for no-passing zones, fnp: 1.0 mi/h
Average travel speed, ATSd: 55.8 mi/h
Percent Free Flow Speed, PFFS: 96.1%

Percent Time-Spent-Following:

Direction | Analysis (d) | Opposing (o)
---|---|---
PCE for trucks, ET | 1.0 | 1.1
PCE for RVs, ER | 1.0 | 1.0
Heavy-vehicle adjustment factor, fHV | 1.000 | 0.995
Grade adjustment factor, fg | 1.00 | 1.00
Directional flow rate, vi | 34 pc/h | 69 pc/h
Base percent time-spent-following, BPTSFd: 4.2%
Adjustment for no-passing zones, fnp: 33.4%
Percent time-spent-following, PTSFd: 15.2%

Level of Service and Other Performance Measures:

Level of service, LOS: A
Volume to capacity ratio, v/c: 0.02
Peak 15-min vehicle-miles of travel, VMT15  8 veh-mi
Peak-hour vehicle-miles of travel, VMT60  27 veh-mi
Peak 15-min total travel time, TT15  0.1 veh-h
Capacity from ATS, CdATS  1374 veh/h
Capacity from PTSF, CdPTSF  1700 veh/h
Directional Capacity  1374 veh/h

________Passing Lane Analysis________
Total length of analysis segment, Lt  1.0 mi
Length of two-lane highway upstream of the passing lane, Lu  0.0 mi
Length of passing lane including tapers, Lpl  1.0 mi
Average travel speed, ATSd (from above)  55.8 mi/h
Percent time-spent-following, PTSFd (from above)  15.2
Level of service, LOSd (from above)  A

________Average Travel Speed with Passing Lane________
Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde  0.00 mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld  0.00 mi
Adj. factor for the effect of passing lane on average speed, fpl  1.02
Average travel speed including passing lane, ATSpl  56.9
Percent free flow speed including passing lane, PFFSpl  98.0 %

________Percent Time-Spent-Following with Passing Lane________
Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde  0.00 mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld  0.00 mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl  0.20
Percent time-spent-following including passing lane, PTSFpl 3.0 %  

Level of Service and Other Performance Measures with Passing Lane

| Measure                                                                 | Value  |
|------------------------------------------------------------------------|--------|
| Level of service including passing lane, LOSpl                         | A      |
| Peak 15-min total travel time, TT15                                    | 0.1 veh-h |

Bicycle Level of Service

| Measure                   | Value  |
|---------------------------|--------|
| Posted speed limit, Sp    | 55     |
| Percent of segment with occupied on-highway parking                    | 0      |
| Pavement rating, P        | 3      |
| Flow rate in outside lane, vOL                                      | 33.8   |
| Effective width of outside lane, We                                | 39.57  |
| Effective speed factor, St                                          | 4.79   |
| Bicycle LOS Score, BLOS                                            | -2.29  |
| Bicycle LOS                                                           | A      |

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.

2. If \( v_i (v_d \text{ or } v_o) \geq 1,700 \text{ pc/h} \), terminate analysis-the LOS is F.

3. For the analysis direction only and for \( v > 200 \text{ veh/h} \).

4. For the analysis direction only.

5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.
Appendix C-2: Details for Software run 197

HCS7: Two-Lane Highways Release 7.3

________Directional Two-Lane Highway Segment Analysis________

Analyst: Luisa Schuelke
Agency/Co.: University of Rhode Island
Date Performed: 07/28/2018
Highway: Hypothetical Two-Lane Highway
Analysis Year: 2018
Description: 197

________Input Data________

| Highway class: | Class 1 | Peak hour factor, PHF: | 0.80 |
| Shoulder width: | 6.0 ft | % Trucks and buses: | 19 % |
| Lane width: | 12.0 ft | % Trucks crawling: | 0.0 % |
| Segment length: | 0.9 mi | Truck crawl speed: | 0.0 mi/hr |
| Terrain type: | Specific Grade | % Recreational vehicles: | 4 % |
| Grade: Length | 0.26 mi | % No-passing zones | 67 % |
| Up/down | 9.0 % | Access point density: | 8 /mi |

Analysis direction volume, Vd 161 veh/h
Opposing direction volume, Vo 397 veh/h

________Average Travel Speed________

| Direction | Analysis (d) | Opposing (o) |
| PCE for trucks, ET | 5.2 | 1.2 |
| PCE for RVs, ER | 1.4 | 1.0 |
| Heavy-vehicle adj. factor, (note-5) fHV | 0.551 | 0.963 |
| Grade adj. factor, (note-1) fg | 0.64 | 1.00 |

90
Directional flow rate,\(^{(2)}\) vi \(571\) pc/h \(515\) pc/h

Free-Flow Speed from Field Measurement:

Field measured speed,\(^{(3)}\) S FM - mi/h

Observed total demand,\(^{(3)}\) V - veh/h

Estimated Free-Flow Speed:

Base free-flow speed,\(^{(3)}\) BFFS \(60.0\) mi/h

Adj. for lane and shoulder width,\(^{(3)}\) fLS \(0.0\) mi/h

Adj. for access point density,\(^{(3)}\) fA \(2.0\) mi/h

Free-flow speed, FFSd \(58.0\) mi/h

Adjustment for no-passing zones, fnp \(2.1\) mi/h

Average travel speed, ATSD \(47.5\) mi/h

Percent Free Flow Speed, PFFS \(81.9\) %

_______Percent Time-Spent-Following_______

Direction Analysis (d) Opposing (o)

PCE for trucks, ET \(1.0\) \(1.0\)

PCE for RVs, ER \(1.0\) \(1.0\)

Heavy-vehicle adjustment factor, fHV \(1.000\) \(1.000\)

Grade adjustment factor,\(^{(1)}\) fg \(1.00\) \(1.00\)

Directional flow rate,\(^{(2)}\) vi \(201\) pc/h \(496\) pc/h

Base percent time-spent-following,\(^{(4)}\) BPTSFd \(27.1\) %

Adjustment for no-passing zones, fnp \(38.6\)

Percent time-spent-following, PTSDf \(38.2\) %

_______Level of Service and Other Performance Measures_______

Level of service, LOS C

Volume to capacity ratio, v/c \(0.20\)
Peak 15-min vehicle-miles of travel, VMT15  45  veh-mi
Peak-hour vehicle-miles of travel, VMT60  145  veh-mi
Peak 15-min total travel time, TT15  0.9  veh-h
Capacity from ATS, CdATS  1017  veh/h
Capacity from PTSF, CdPTSF  1700  veh/h
Directional Capacity  1017  veh/h

________Passing Lane Analysis________
Total length of analysis segment, Lt  0.9  mi
Length of two-lane highway upstream of the passing lane, Lu  0.0  mi
Length of passing lane including tapers, Lpl  0.9  mi
Average travel speed, ATSD (from above)  47.5  mi/h
Percent time-spent-following, PTSD (from above)  38.2
Level of service, LOSD (from above)  C

________Average Travel Speed with Passing Lane________
Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde  0.00  mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld  0.00  mi
Adj. factor for the effect of passing lane on average speed, fpl  1.07
Average travel speed including passing lane, ATSpl  50.8
Percent free flow speed including passing lane, PFFSpl  87.7  %

________Percent Time-Spent-Following with Passing Lane________
Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde  0.00  mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld  0.00  mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl  0.20
Percent time-spent-following including passing lane, PTSFpl 7.6 %

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl B
Peak 15-min total travel time, TT15 0.9 veh-h

Bicycle Level of Service

Posted speed limit, Sp 55
Percent of segment with occupied on-highway parking 0
Pavement rating, P 3
Flow rate in outside lane, vOL 201.3
Effective width of outside lane, We 24.00
Effective speed factor, St 4.79
Bicycle LOS Score, BLOS 9.82
Bicycle LOS F

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.

2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis—the LOS is F.

3. For the analysis direction only and for v>200 veh/h.

4. For the analysis direction only.

5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.
Appendix C-3: Details for Software run 307

HCS7: Two-Lane Highways Release 7.3

________Directional Two-Lane Highway Segment Analysis________

Analyst:        Luisa Schuelke
Agency/Co.:     University of Rhode Island
Date Performed: 07/28/2018
Highway:        Hypothetical Two-Lane Highway
Analysis Year:  2018
Description:   307

________Input Data________

Highway class: Class 1  Peak hour factor, PHF: 0.80
Shoulder width: 6.0 ft  % Trucks and buses: 19 %
Lane width: 12.0 ft  % Trucks crawling: 0.0 %
Segment length: 0.9 mi  Truck crawl speed: 0.0 mi/hr
Terrain type: Specific Grade % Recreational vehicles: 4 %
Grade: Length 0.25 mi  % No-passing zones 60 %
Up/down 9.5 %  Access point density: 8 /mi
Analysis direction volume, Vd 560 veh/h
Opposing direction volume, V0 1667 veh/h

________Average Travel Speed________

Direction Analysis(d) Opposing (o)
PCE for trucks, ET 4.7 1.0
PCE for RVs, ER 1.0 1.0
Heavy-vehicle adj. factor,(note-5) fHV 0.587 1.000
Grade adj. factor,(note-1) fg 0.92 1.00
Directional flow rate,(note-2) vi 1296 pc/h 2084 pc/h

Free-Flow Speed from Field Measurement:

Field measured speed,(note-3) S FM - mi/h
Observed total demand,(note-3) V - veh/h

Estimated Free-Flow Speed:

Base free-flow speed,(note-3) BFFS 60.0 mi/h
Adj. for lane and shoulder width,(note-3) fLS 0.0 mi/h
Adj. for access point density,(note-3) fA 2.0 mi/h

Free-flow speed, FFSd 58.0 mi/h
Adjustment for no-passing zones, fnp 0.7 mi/h
Average travel speed, ATSD 31.1 mi/h
Percent Free Flow Speed, PFFS 53.6 %

Percent Time-Spent-Following

Direction Analysis (d) Opposing (o)
PCE for trucks, ET 1.0 1.0
PCE for RVs, ER 1.0 1.0

Heavy-vehicle adjustment factor, fHV 1.000 1.000
Grade adjustment factor,(note-1) fg 1.00 1.00

Directional flow rate,(note-2) vi 700 pc/h 2084 pc/h

Base percent time-spent-following,(note-4) BPTSFd 73.0 %
Adjustment for no-passing zones, fnp 11.7
Percent time-spent-following, PTSFd 75.9 %

Level of service, LOS F
Volume to capacity ratio, v/c 0.68
Peak 15-min vehicle-miles of travel, VMT15  157  veh-mi
Peak-hour vehicle-miles of travel, VMT60  504  veh-mi
Peak 15-min total travel time, TT15  5.0  veh-h
Capacity from ATS, CdATS  1034  veh/h
Capacity from PTSF, CdPTSF  1700  veh/h
Directional Capacity  1034  veh/h

_______Passing Lane Analysis________

Total length of analysis segment, Lt  0.9  mi
Length of two-lane highway upstream of the passing lane, Lu  0.0  mi
Length of passing lane including tapers, Lpl  0.9  mi
Average travel speed, ATSd (from above)  31.1  mi/h
Percent time-spent-following, PTSFd (from above)  75.9
Level of service, LOSd (from above)  F

_______Average Travel Speed with Passing Lane________

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde  0.00  mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld  0.00  mi
Adj. factor for the effect of passing lane on average speed, fpl  1.14
Average travel speed including passing lane, ATSpl  35.5
Percent free flow speed including passing lane, PFFSpl  61.1  %

_______Percent Time-Spent-Following with Passing Lane________

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde  0.00  mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld  0.00  mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl  0.23
Percent time-spent-following including passing lane, PTSFpl 17.5%

_____Level of Service and Other Performance Measures with Passing Lane_____

Level of service including passing lane, LOSpl E
Peak 15-min total travel time, TT15 4.4 veh-h

_______Bicycle Level of Service_______

Posted speed limit, Sp
Percent of segment with occupied on-highway parking 0
Pavement rating, P 3
Flow rate in outside lane, vOL 700.0
Effective width of outside lane, We 24.00
Effective speed factor, St 4.79
Bicycle LOS Score, BLOS 10.45
Bicycle LOS F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.

2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.

3. For the analysis direction only and for v>200 veh/h.

4. For the analysis direction only.

5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.
Appendix C-4: Details for Software run 347

HCS7: Two-Lane Highways Release 7.3

Directional Two-Lane Highway Segment Analysis

Analyst: Luisa Schuelke
Agency/Co.: University of Rhode Island
Date Performed: 07/28/2018
Highway: Hypothetical Two-Lane Highway
Analysis Year: 2018
Description: 347

Input Data

| Highway class: | Class 1 | Peak hour factor, PHF: | 0.80 |
| Shoulder width: | 6.0 ft | % Trucks and buses: | 18 % |
| Lane width: | 12.0 ft | % Trucks crawling: | 0.0 % |
| Segment length: | 1.0 mi | Truck crawl speed: | 0.0 mi/hr |
| Terrain type: | Specific Grade | % Recreational vehicles: | 4 % |
| Grade: Length | 0.35 mi | % No-passing zones | 49 % |
| Up/down | 7.0 % | Access point density: | 8 /mi |
| Analysis direction volume, Vd | 350 veh/h |
| Opposing direction volume, Vo | 795 veh/h |

Average Travel Speed

| Direction | Analysis(d) | Opposing (o) |
|-----------|-------------|--------------|
| PCE for trucks, ET | 6.1 | 1.0 |
| PCE for RVs, ER | 1.0 | 1.0 |
| Heavy-vehicle adj. factor,(note-5) fHV | 0.523 | 1.000 |
| Grade adj. factor,(note-1) fg | 0.74 | 1.00 |
Directional flow rate, (note-2) vi 1130 pc/h 994 pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, (note-3) S FM - mi/h

Observed total demand, (note-3) V - veh/h

Estimated Free-Flow Speed:

Base free-flow speed, (note-3) BFFS 60.0 mi/h

Adj. for lane and shoulder width, (note-3) fLS 0.0 mi/h

Adj. for access point density, (note-3) fA 2.0 mi/h

Free-flow speed, FFSd 58.0 mi/h

Adjustment for no-passing zones, fnp 0.8 mi/h

Average travel speed, ATSD 40.8 mi/h

Percent Free Flow Speed, PFFS 70.3 %

Percent Time-Spent-Following

Direction Analysis (d) Opposing (o)
PCE for trucks, ET 1.0 1.0
PCE for RVs, ER 1.0 1.0

Heavy-vehicle adjustment factor, fHV 1.000 1.000

Grade adjustment factor, (note-1) fg 1.00 1.00

Directional flow rate, (note-2) vi 437 pc/h 994 pc/h

Base percent time-spent-following, (note-4) BPTSFd 53.1 %

Adjustment for no-passing zones, fnp 19.0

Percent time-spent-following, PTSFd 58.9 %

Level of Service and Other Performance Measures

Level of service, LOS D

Volume to capacity ratio, v/c 0.48
Peak 15-min vehicle-miles of travel, VMT15 109 veh-mi
Peak-hour vehicle-miles of travel, VMT60 350 veh-mi
Peak 15-min total travel time, TT15 2.7 veh-h
Capacity from ATS, CdATS 916 veh/h
Capacity from PTSF, CdPTSF 1700 veh/h
Directional Capacity 916 veh/h

_______Passing Lane Analysis________

Total length of analysis segment, Lt 1.0 mi
Length of two-lane highway upstream of the passing lane, Lu 0.0 mi
Length of passing lane including tapers, Lpl 1.0 mi
Average travel speed, ATSD (from above) 40.8 mi/h
Percent time-spent-following, PTSD (from above) 58.9
Level of service, LOSD (from above) D

_______Average Travel Speed with Passing Lane________

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde 0.00 mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld 0.00 mi
Adj. factor for the effect of passing lane on average speed, fpl 1.14
Average travel speed including passing lane, ATSp 46.5
Percent free flow speed including passing lane, PFFSp 80.1 %

_______Percent Time-Spent-Following with Passing Lane________

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde 0.00 mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld 0.00 mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl 0.21
Percent time-spent-following including passing lane, PTSFpl 12.4 %

_____Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl C
Peak 15-min total travel time, TT15 2.3 veh-h

_______Bicycle Level of Service ________

Posted speed limit, Sp 55
Percent of segment with occupied on-highway parking 0
Pavement rating, P 3
Flow rate in outside lane, vOL 437.5
Effective width of outside lane, We 24.00
Effective speed factor, St 4.79
Bicycle LOS Score, BLOS 9.63
Bicycle LOS F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.
Appendix C-5: Details for Software run 501

HCS7: Two-Lane Highways Release 7.3

_______Directional Two-Lane Highway Segment Analysis_______

Analyst: Luisa Schuelke
Agency/Co.: University of Rhode Island
Date Performed: 07/28/2018
Highway: Hypothetical Two-Lane Highway
Analysis Year: 2018
Description: 501

_______Input Data_______

Highway class: Class 1
Peak hour factor, PHF: 0.80
Shoulder width: 6.0 ft
% Trucks and buses: 13 %
Lane width: 12.0 ft
% Trucks crawling: 0.0 %
Segment length: 1.0 mi
Truck crawl speed: 0.0 mi/hr
Terrain type: Specific Grade
% Recreational vehicles: 4 %
Grade: Length 0.35 mi
% No-passing zones 31 %
Up/down 7.0 %
Access point density: 8 /mi
Analysis direction volume, Vd 178 veh/h
Opposing direction volume, Vo 218 veh/h

_______Average Travel Speed_______

| Direction       | Analysis (d) | Opposing (o) |
|-----------------|--------------|--------------|
| PCE for trucks, ET | 6.2          | 1.4          |
| PCE for RVs, ER  | 1.4          | 1.0          |
| Heavy-vehicle adj. factor,(note-5) fHV | 0.593 | 0.951 |
| Grade adj. factor,(note-1) fg | 0.60 | 1.00 |
Directional flow rate, *(note-2)* \(v_1\) 625 pc/h 287 pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, *(note-3)* \(S_{FM}\) - mi/h

Observed total demand, *(note-3)* \(V\) - veh/h

Estimated Free-Flow Speed:

Base free-flow speed, *(note-3)* \(BFFS\) 60.0 mi/h

Adj. for lane and shoulder width, *(note-3)* \(f_{LS}\) 0.0 mi/h

Adj. for access point density, *(note-3)* \(f_{A}\) 2.0 mi/h

Free-flow speed, \(FFS_d\) 58.0 mi/h

Adjustment for no-passing zones, \(f_{np}\) 2.0 mi/h

Average travel speed, \(ATS_d\) 48.9 mi/h

Percent Free Flow Speed, \(PFFS\) 84.3 %

_______Percent Time-Spent-Following________

Direction Analysis\((d)\) Opposing \((o)\)

PCE for trucks, \(ET\) 1.0 1.1

PCE for RVs, \(ER\) 1.0 1.0

Heavy-vehicle adjustment factor, \(f_{HV}\) 1.000 0.987

Grade adjustment factor, *(note-1)* \(f_{g}\) 1.00 1.00

Directional flow rate, *(note-2)* \(v_1\) 222 pc/h 276 pc/h

Base percent time-spent-following, *(note-4)* \(BPTSFd\) 25.5 %

Adjustment for no-passing zones, \(f_{np}\) 43.4

Percent time-spent-following, \(PTSFd\) 44.8 %

_______Level of Service and Other Performance Measures________

Level of service, \(LOS\) C

Volume to capacity ratio, \(v/c\) 0.21
Peak 15-min vehicle-miles of travel, VMT15 56 veh-mi
Peak-hour vehicle-miles of travel, VMT60 178 veh-mi
Peak 15-min total travel time, TT15 1.1 veh-h
Capacity from ATS, C_dATS 1051 veh/h
Capacity from PTSF, C_dPTSF 1700 veh/h
Directional Capacity 1051 veh/h

________Passing Lane Analysis________
Total length of analysis segment, L_t 1.0 mi
Length of two-lane highway upstream of the passing lane, L_u 0.0 mi
Length of passing lane including tapers, L_p 1.0 mi
Average travel speed, AT_Sd (from above) 48.9 mi/h
Percent time-spent-following, PT_SF_d (from above) 44.8
Level of service, LOS_d (from above) C

________Average Travel Speed with Passing Lane________
Downstream length of two-lane highway within effective length of passing lane for average travel speed, L_d 0.00 mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, L_d 0.00 mi
Adj. factor for the effect of passing lane on average speed, f_p 1.14
Average travel speed including passing lane, AT_Spl 55.8
Percent free flow speed including passing lane, P_FF_Spl 96.1 %

________Percent Time-Spent-Following with Passing Lane________
Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, L_de 0.00 mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, L_d 0.00 mi
Adj. factor for the effect of passing lane on percent time-spent-following, f_p: 0.20
Percent time-spent-following including passing lane, PTSFpl: 9.0%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl A
Peak 15-min total travel time, TT15 1.0 veh-h

Bicycle Level of Service

Posted speed limit, Sp 55
Percent of segment with occupied on-highway parking 0
Pavement rating, P 3
Flow rate in outside lane, vOL 222.5
Effective width of outside lane, We 24.00
Effective speed factor, St 4.79
Bicycle LOS Score, BLOS 6.69
Bicycle LOS F

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.

2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.

3. For the analysis direction only and for v>200 veh/h.

4. For the analysis direction only.

5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.
### Table 8: Directional Flows in pcp and Capacity Compliance

| Scenario Number | Analysis Direction Flow vpn | Opposing Direction Flow vpn | Sum Flows    | ATS analysis direction pcp | ATS opposing direction pcp | Total ATS Flow | PTSF analysis direction pcp | PTSF opposing direction pcp | Total PTSF Flow | Capacity Compliance |
|-----------------|-----------------------------|-----------------------------|--------------|----------------------------|----------------------------|-----------------|-----------------------------|-----------------------------|-----------------|----------------------|
| 1               | 538                         | 438                         | 976          | 969                        | 554                        | 1523            | 672                         | 2075                        | 1219           | 1                    |
| 2               | 122                         | 154                         | 276          | 249                        | 204                        | 644             | 3055                        | 1031                        | 347            | 1                    |
| 3               | 60                          | 217                         | 277          | 183                        | 276                        | 459             | 75                          | 272                         | 347            | 1                    |
| 4               | 1660                        | 825                         | 2485         | 2356                       | 1031                       | 3387            | 2075                        | 1031                        | 3106           | 0                    |
| 5               | 278                         | 792                         | 1070         | 1060                       | 990                        | 2050            | 347                         | 2990                        | 1337           | 1                    |
| 6               | 1258                        | 951                         | 2209         | 1966                       | 1189                       | 3185            | 1572                        | 1189                        | 2761           | 0                    |
| 7               | 591                         | 382                         | 973          | 1323                       | 489                        | 1812            | 739                         | 477                         | 1216           | 1                    |
| 8               | 249                         | 342                         | 591          | 576                        | 433                        | 1009            | 311                         | 427                         | 738            | 1                    |
| 9               | 1179                        | 994                         | 2173         | 2203                       | 1242                       | 3445            | 1474                        | 1242                        | 2716           | 0                    |
| 10              | 1124                        | 1422                        | 2546         | 1941                       | 1777                       | 3718            | 1405                        | 1777                        | 3182           | 0                    |
| 11              | 1581                        | 509                         | 2090         | 2372                       | 639                        | 3011            | 1976                        | 636                         | 2612           | 0                    |
| 12              | 17                          | 13                          | 30           | 49                         | 17                         | 66              | 21                          | 16                          | 37             | 1                    |
| 13              | 1691                        | 510                         | 2201         | 2416                       | 639                        | 3055            | 2114                        | 637                         | 2751           | 0                    |
| 14              | 1390                        | 536                         | 1926         | 2251                       | 675                        | 2926            | 1737                        | 670                         | 2407           | 0                    |
| 15              | 214                         | 378                         | 592          | 742                        | 487                        | 1229            | 267                         | 472                         | 739            | 1                    |
| 16              | 592                         | 1474                        | 2066         | 1166                       | 1842                       | 3008            | 740                         | 1842                        | 2582           | 0                    |
| 17              | 69                          | 42                          | 111          | 203                        | 55                         | 258             | 86                          | 53                          | 139            | 1                    |
| 18              | 394                         | 493                         | 887          | 976                        | 628                        | 1604            | 492                         | 616                         | 1108           | 1                    |
| 19              | 1016                        | 1263                        | 2279         | 1397                       | 1579                       | 2976            | 1270                        | 1579                        | 2849           | 1                    |
| 20              | 1194                        | 215                         | 1409         | 2431                       | 284                        | 2715            | 1492                        | 273                         | 1765           | 0                    |
| 21              | 429                         | 1307                        | 1736         | 810                        | 1634                       | 2444            | 536                         | 1634                        | 2170           | 1                    |
| 22              | 326                         | 1009                        | 1335         | 1108                       | 1261                       | 2369            | 407                         | 1261                        | 1668           | 1                    |
| 23              | 1351                        | 324                         | 1675         | 1883                       | 409                        | 2292            | 1689                        | 405                         | 2094           | 0                    |
| 24              | 62                          | 43                          | 105          | 247                        | 59                         | 306             | 77                          | 54                          | 131            | 1                    |
| 25              | 121                         | 58                          | 179          | 409                        | 82                         | 491             | 151                         | 74                          | 225            | 1                    |
| 26              | 1370                        | 282                         | 1652         | 1888                       | 356                        | 2244            | 1712                        | 354                         | 2066           | 0                    |
| 27              | 1608                        | 308                         | 1916         | 3306                       | 407                        | 3713            | 2010                        | 392                         | 2402           | 0                    |
| 28              | 847                         | 309                         | 1156         | 1340                       | 392                        | 1732            | 1059                        | 388                         | 1447           | 1                    |
|    | 29 | 369 | 132 | 501 | 781 | 172 | 953 | 461 | 166 | 627 | 1 |
|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---|
| 30 | 777 | 1657| 2434| 1710| 2071| 3781| 971 | 2071| 3042| 0  |   |
| 31 | 211 | 439 | 650 | 554 | 558 | 1112| 264 | 549 | 813 | 1  |   |
| 32 | 635 | 848 | 1483| 877 | 1060| 1937| 794 | 1060| 1854| 1  |   |
| 33 | 61  | 197 | 258 | 211 | 259 | 470 | 76  | 249 | 325 | 1  |   |
| 34 | 400 | 749 | 1149| 827 | 936 | 1763| 500 | 936 | 1436| 1  |   |
| 35 | 1510| 302 | 1812| 2977| 397 | 3374| 1887| 384 | 2271| 0  |   |
| 36 | 785 | 164 | 949 | 1085| 208 | 1293| 981 | 206 | 1187| 1  |   |
| 37 | 928 | 510 | 1438| 1652| 643 | 2295| 1160| 637 | 1797| 1  |   |
| 38 | 320 | 73  | 393 | 1024| 104 | 1128| 400 | 93  | 493 | 1  |   |
| 39 | 925 | 634 | 1559| 1498| 798 | 2296| 1156| 792 | 1948| 1  |   |
| 40 | 1453| 540 | 1993| 3363| 688 | 4051| 1816| 675 | 2491| 0  |   |
| 41 | 599 | 171 | 770 | 1444| 234 | 1678| 749 | 218 | 967 | 1  |   |
| 42 | 1188| 1547| 2735| 2152| 1934| 4086| 1485| 1934| 3419| 0  |   |
| 43 | 1644| 1243| 2887| 2792| 1554| 4346| 2055| 1554| 3609| 0  |   |
| 44 | 1228| 366 | 1594| 1643| 459 | 2102| 1535| 457 | 1992| 1  |   |
| 45 | 192 | 833 | 1025| 591 | 1041| 1632| 240 | 1041| 1281| 1  |   |
| 46 | 172 | 108 | 280 | 363 | 137 | 500 | 215 | 135 | 350 | 1  |   |
| 47 | 489 | 257 | 746 | 906 | 333 | 1239| 611 | 324 | 935 | 1  |   |
| 48 | 455 | 706 | 1161| 1151| 882 | 2033| 569 | 882 | 1451| 1  |   |
| 49 | 133 | 462 | 595 | 375 | 582 | 957 | 166 | 577 | 743 | 1  |   |
| 50 | 6   | 8   | 14  | 21  | 11  | 32  | 7   | 10  | 17  | 1  |   |
| 51 | 402 | 904 | 1306| 680 | 1130| 1810| 502 | 1130| 1632| 1  |   |
| 52 | 924 | 175 | 1099| 1782| 236 | 2018| 1155| 222 | 1377| 0  |   |
| 53 | 626 | 1446| 2072| 1197| 193 | 1390| 782 | 184 | 966 | 1  |   |
| 54 | 257 | 126 | 383 | 823 | 178 | 1001| 321 | 160 | 481 | 1  |   |
| 55 | 347 | 558 | 905 | 808 | 704 | 1512| 434 | 697 | 1131| 1  |   |
| 56 | 329 | 698 | 1027| 624 | 872 | 1496| 411 | 872 | 1283| 1  |   |
| 57 | 135 | 574 | 709 | 582 | 731 | 1313| 169 | 717 | 886 | 1  |   |
| 58 | 348 | 1078| 1426| 811 | 1347| 2158| 435 | 1347| 1782| 1  |   |
| 59 | 440 | 96  | 536 | 737 | 125 | 862 | 550 | 121 | 671 | 1  |   |
| 60 | 1555| 750 | 2305| 3197| 937 | 4134| 1944| 937 | 2881| 0  |   |
| 61 | 649 | 550 | 1199| 1697| 701 | 2398| 811 | 687 | 1498| 1  |   |
| 62 | 315 | 159 | 474 | 896 | 213 | 1109| 394 | 202 | 596 | 1  |   |
| 63 | 899 | 1376| 2275| 1243| 1720| 2963| 1124| 1720| 2844| 0  |   |
| 64 | 392 | 1460| 1852| 1093| 1825| 2918| 490 | 1825| 2315| 0  |   |
| 65 | 483 | 1128| 1611| 1004| 1410| 2414| 604 | 1410| 2014| 1  |   |
| 66 | 460 | 631 | 1091| 1230| 801 | 2031| 575 | 789 | 1364| 1  |   |
| 67 | 420 | 1303| 1723| 898 | 1629| 2527| 525 | 1629| 2154| 1  |   |
| 68 | 27  | 55  | 82  | 87  | 72  | 159 | 34  | 69  | 103 | 1  |   |
| 69 | 66  | 340 | 406 | 272 | 438 | 710 | 82  | 425 | 507 | 1  |   |
| 70 | 166 | 297 | 463 | 528 | 388 | 916 | 207 | 377 | 584 | 1  |   |
| 71 | 718 | 1351| 2069| 1795| 1689| 3484| 897 | 1689| 2586| 0  |   |
| 115 | 803 | 1533 | 2336 | 1093 | 1916 | 3009 | 1004 | 1916 | 2920 | 0 |
| 116 | 1498 | 378 | 1876 | 3297 | 488 | 3785 | 1872 | 472 | 2344 | 0 |
| 117 | 1436 | 780 | 2216 | 2037 | 975 | 3012 | 1795 | 975 | 2770 | 0 |
| 118 | 919 | 637 | 1556 | 1392 | 801 | 2193 | 1149 | 796 | 1945 | 1 |
| 119 | 589 | 980 | 1569 | 1028 | 1225 | 2253 | 736 | 1225 | 1961 | 1 |
| 120 | 1333 | 746 | 2079 | 1843 | 932 | 2775 | 1666 | 932 | 2598 | 0 |
| 121 | 1663 | 1238 | 2901 | 3066 | 1545 | 4613 | 2079 | 1547 | 3626 | 0 |
| 122 | 897 | 651 | 1548 | 1221 | 815 | 2036 | 1121 | 814 | 1935 | 1 |
| 123 | 499 | 242 | 741 | 873 | 311 | 1184 | 624 | 305 | 929 | 1 |
| 124 | 1606 | 758 | 2364 | 3817 | 947 | 4764 | 2007 | 947 | 2954 | 0 |
| 125 | 593 | 1328 | 1921 | 1411 | 1660 | 3071 | 741 | 1660 | 2401 | 1 |
| 126 | 1650 | 1373 | 3023 | 3144 | 1716 | 4860 | 2062 | 1716 | 3778 | 0 |
| 127 | 1278 | 368 | 1646 | 2446 | 469 | 2915 | 1597 | 460 | 2057 | 0 |
| 128 | 362 | 767 | 1129 | 853 | 959 | 1812 | 452 | 959 | 1411 | 1 |
| 129 | 1152 | 429 | 1581 | 1925 | 545 | 2470 | 1440 | 536 | 1976 | 0 |
| 130 | 445 | 1045 | 1490 | 1258 | 1306 | 2564 | 556 | 1306 | 1862 | 1 |
| 131 | 58 | 12 | 70 | 248 | 18 | 266 | 72 | 15 | 87 | 1 |
| 132 | 314 | 756 | 1070 | 693 | 945 | 1638 | 392 | 945 | 1337 | 1 |
| 133 | 378 | 172 | 550 | 975 | 230 | 1205 | 472 | 218 | 690 | 1 |
| 134 | 25 | 108 | 133 | 74 | 141 | 215 | 31 | 136 | 167 | 1 |
| 135 | 236 | 381 | 617 | 1015 | 495 | 1510 | 295 | 476 | 771 | 1 |
| 136 | 61 | 108 | 169 | 210 | 144 | 354 | 76 | 136 | 212 | 1 |
| 137 | 418 | 745 | 1163 | 661 | 931 | 1592 | 522 | 931 | 1453 | 1 |
| 138 | 567 | 851 | 1418 | 1268 | 1064 | 2332 | 709 | 1064 | 1773 | 1 |
| 139 | 680 | 1494 | 2174 | 1320 | 1867 | 3187 | 850 | 1867 | 2717 | 0 |
| 140 | 107 | 455 | 562 | 479 | 580 | 1059 | 134 | 569 | 703 | 1 |
| 141 | 1631 | 527 | 2158 | 3982 | 672 | 4654 | 2039 | 659 | 2698 | 0 |
| 142 | 1152 | 318 | 1470 | 2222 | 417 | 2639 | 1440 | 404 | 1844 | 0 |
| 143 | 526 | 1075 | 1601 | 1190 | 1344 | 2534 | 657 | 1344 | 2001 | 1 |
| 144 | 1155 | 357 | 1512 | 2277 | 469 | 2746 | 1444 | 446 | 1890 | 0 |
| 145 | 520 | 148 | 668 | 879 | 192 | 1071 | 650 | 186 | 836 | 1 |
| 146 | 1112 | 1328 | 2440 | 1986 | 1660 | 3646 | 1390 | 1660 | 3050 | 0 |
| 147 | 1692 | 430 | 2122 | 2403 | 542 | 2945 | 2115 | 537 | 2652 | 0 |
| 148 | 1086 | 411 | 1497 | 2289 | 532 | 2821 | 1357 | 514 | 1871 | 0 |
| 149 | 78 | 412 | 490 | 316 | 527 | 843 | 97 | 515 | 612 | 1 |
| 150 | 208 | 1095 | 1303 | 785 | 1369 | 2154 | 260 | 1369 | 1629 | 1 |
| 151 | 669 | 946 | 1615 | 934 | 1182 | 2116 | 836 | 1182 | 2018 | 1 |
| 152 | 1283 | 1662 | 2945 | 2113 | 2077 | 4190 | 1604 | 2077 | 3681 | 0 |
| 153 | 1264 | 708 | 1972 | 2225 | 885 | 3110 | 1580 | 885 | 2465 | 0 |
| 154 | 80 | 60 | 140 | 250 | 80 | 330 | 100 | 76 | 176 | 1 |
| 155 | 440 | 1496 | 1936 | 1035 | 1870 | 2905 | 550 | 1870 | 2420 | 0 |
| 156 | 25 | 64 | 89 | 80 | 84 | 164 | 31 | 80 | 111 | 1 |
| 157 | 266 | 1251 | 1517 | 1001 | 1564 | 2565 | 332 | 1564 | 1896 | 1 |
|   |   |   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 201 | 1438 | 1040 | 2478 | 2483 | 1300 | 3783 | 1797 | 1300 | 3097 | 0 |
| 202 | 998  | 548  | 1546 | 2306 | 696  | 3002 | 1247 | 685  | 1932 | 0 |
| 203 | 536  | 176  | 712  | 1275 | 238  | 1513 | 670  | 224  | 894  | 1 |
| 204 | 43   | 105  | 148  | 131  | 138  | 269  | 54   | 132  | 186  | 1 |
| 205 | 614  | 1099 | 1713 | 1113 | 1374 | 2487 | 767  | 1374 | 2141 | 1 |
| 206 | 1161 | 314  | 1475 | 1647 | 396  | 2043 | 1451 | 394  | 1845 | 1 |
| 207 | 229  | 953  | 1182 | 777  | 1191 | 1968 | 286  | 1191 | 1477 | 1 |
| 208 | 526  | 1328 | 1854 | 1138 | 1660 | 2798 | 657  | 1660 | 2317 | 1 |
| 209 | 1265 | 462  | 1727 | 1957 | 582  | 2539 | 1581 | 577  | 2158 | 0 |
| 210 | 735  | 396  | 1131 | 1422 | 508  | 1930 | 919  | 495  | 1414 | 1 |
| 211 | 326  | 676  | 1002 | 703  | 850  | 1553 | 407  | 845  | 1252 | 1 |
| 212 | 271  | 428  | 699  | 1094 | 555  | 1649 | 339  | 535  | 874  | 1 |
| 213 | 13   | 58   | 71   | 56   | 82   | 138  | 16   | 74   | 90   | 1 |
| 214 | 273  | 732  | 1005 | 667  | 915  | 1582 | 341  | 915  | 1256 | 1 |
| 215 | 53   | 14   | 46   | 219  | 58   | 44   | 116  | 44   | 126  | 1 |
| 216 | 1376 | 1151 | 2527 | 2363 | 1439 | 3802 | 1720 | 1439 | 3159 | 0 |
| 217 | 262  | 1429 | 1691 | 612  | 1786 | 2398 | 327  | 1786 | 2113 | 0 |
| 218 | 427  | 196  | 623  | 826  | 257  | 1083 | 534  | 247  | 781  | 1 |
| 219 | 776  | 1550 | 2326 | 1261 | 1937 | 3198 | 970  | 1937 | 2907 | 0 |
| 220 | 453  | 151  | 604  | 897  | 199  | 1096 | 566  | 191  | 757  | 1 |
| 221 | 448  | 86   | 534  | 1080 | 124  | 1204 | 560  | 109  | 669  | 1 |
| 222 | 501  | 122  | 623  | 1148 | 166  | 1314 | 626  | 154  | 780  | 1 |
| 223 | 1668 | 296  | 1964 | 2864 | 382  | 3246 | 2085 | 374  | 2459 | 0 |
| 224 | 753  | 298  | 1051 | 1473 | 390  | 1863 | 941  | 378  | 1319 | 1 |
| 225 | 573  | 784  | 1357 | 1062 | 980  | 2042 | 716  | 980  | 1696 | 1 |
| 226 | 1317 | 806  | 2123 | 1981 | 1007 | 2988 | 1646 | 1007 | 2653 | 0 |
| 227 | 1399 | 397  | 1796 | 2924 | 515  | 3439 | 1749 | 496  | 2245 | 0 |
| 228 | 1440 | 1134 | 2574 | 2848 | 1417 | 4265 | 1800 | 1417 | 3217 | 0 |
| 229 | 487  | 184  | 671  | 909  | 240  | 1149 | 609  | 232  | 841  | 1 |
| 230 | 419  | 1621 | 2040 | 820  | 2026 | 2846 | 524  | 2026 | 2550 | 0 |
| 231 | 107  | 40   | 147  | 498  | 59   | 557  | 134  | 51   | 185  | 1 |
| 232 | 85   | 375  | 460  | 217  | 471  | 688  | 106  | 469  | 575  | 1 |
| 233 | 1485 | 290  | 1775 | 258  | 1856 | 2114 | 80   | 1856 | 1936 | 0 |
| 234 | 272  | 1238 | 1510 | 583  | 1547 | 2130 | 340  | 1547 | 1887 | 1 |
| 235 | 804  | 298  | 1102 | 1244 | 380  | 1624 | 1005 | 375  | 1380 | 1 |
| 236 | 359  | 120  | 479  | 629  | 152  | 781  | 449  | 150  | 599  | 1 |
| 237 | 668  | 810  | 1478 | 996  | 1012 | 2008 | 835  | 1012 | 1847 | 1 |
| 238 | 1245 | 665  | 1910 | 1853 | 835  | 2688 | 1556 | 831  | 2387 | 0 |
| 239 | 1666 | 767  | 2433 | 3482 | 959  | 4441 | 2082 | 959  | 3041 | 0 |
| 240 | 200  | 992  | 1192 | 661  | 1240 | 1901 | 250  | 1240 | 1490 | 1 |
| 241 | 910  | 294  | 1204 | 1218 | 370  | 1588 | 1137 | 368  | 1505 | 1 |
| 242 | 20   | 86   | 106  | 56   | 109  | 165  | 25   | 108  | 133  | 1 |
| 243 | 258  | 748  | 1006 | 687  | 935  | 1622 | 322  | 935  | 1257 | 1 |
|   |   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 330 | 759 | 436 | 1195 | 1530 | 565 | 2095 | 949 | 545 | 1494 | 1 |
| 331 | 488 | 755 | 1243 | 1287 | 944 | 2231 | 610 | 944 | 1554 | 1 |
| 332 | 139 | 80 | 219 | 326 | 103 | 429 | 174 | 100 | 274 | 1 |
| 333 | 888 | 355 | 1243 | 1790 | 468 | 2258 | 1110 | 444 | 1554 | 0 |
| 334 | 622 | 865 | 1487 | 1182 | 1081 | 2263 | 777 | 1081 | 1858 | 1 |
| 335 | 906 | 1456 | 2362 | 1641 | 1820 | 3461 | 1132 | 1820 | 2952 | 0 |
| 336 | 938 | 172 | 1110 | 1919 | 228 | 2147 | 1172 | 218 | 1390 | 0 |
| 337 | 543 | 1628 | 2171 | 989 | 2035 | 3024 | 678 | 2035 | 2713 | 0 |
| 338 | 1468 | 1210 | 2678 | 3495 | 1512 | 5007 | 1835 | 1512 | 3347 | 0 |
| 339 | 136 | 267 | 403 | 573 | 359 | 932 | 170 | 340 | 510 | 1 |
| 340 | 399 | 71 | 470 | 798 | 97 | 895 | 499 | 90 | 589 | 1 |
| 341 | 1416 | 1019 | 2435 | 2218 | 1274 | 3492 | 1770 | 1274 | 3044 | 0 |
| 342 | 735 | 404 | 1139 | 1373 | 518 | 1891 | 919 | 505 | 1424 | 1 |
| 343 | 654 | 1481 | 2135 | 1421 | 1851 | 3272 | 817 | 1851 | 2668 | 0 |
| 344 | 92 | 431 | 523 | 280 | 544 | 824 | 115 | 539 | 654 | 1 |
| 345 | 1662 | 378 | 2040 | 3196 | 484 | 3680 | 2077 | 472 | 2549 | 0 |
| 346 | 1549 | 1208 | 2757 | 3190 | 1510 | 4700 | 1936 | 1510 | 3446 | 0 |
| 347 | 350 | 795 | 1145 | 1130 | 994 | 2124 | 437 | 994 | 1431 | 1 |
| 348 | 538 | 1252 | 1790 | 993 | 1565 | 2558 | 672 | 1565 | 2237 | 1 |
| 349 | 46 | 169 | 215 | 153 | 219 | 372 | 57 | 213 | 270 | 1 |
| 350 | 68 | 253 | 321 | 370 | 340 | 710 | 85 | 322 | 407 | 1 |
| 351 | 687 | 922 | 1609 | 936 | 1152 | 2088 | 859 | 1152 | 2011 | 1 |
| 352 | 54 | 16 | 70 | 266 | 23 | 289 | 67 | 20 | 87 | 1 |
| 353 | 176 | 681 | 857 | 505 | 851 | 1356 | 220 | 851 | 1071 | 1 |
| 354 | 687 | 583 | 1270 | 951 | 731 | 1682 | 859 | 729 | 1588 | 1 |
| 355 | 1273 | 1005 | 2278 | 1872 | 1256 | 3128 | 1591 | 1256 | 2847 | 0 |
| 356 | 506 | 367 | 873 | 1335 | 473 | 1808 | 632 | 459 | 1091 | 1 |
| 357 | 667 | 170 | 837 | 963 | 217 | 1180 | 834 | 213 | 1047 | 1 |
| 358 | 30 | 157 | 187 | 145 | 216 | 361 | 37 | 200 | 237 | 1 |
| 359 | 415 | 288 | 703 | 774 | 369 | 1143 | 519 | 363 | 882 | 1 |
| 360 | 1076 | 477 | 1553 | 1646 | 599 | 2245 | 1345 | 596 | 1941 | 1 |
| 361 | 937 | 1458 | 2395 | 1917 | 1822 | 3739 | 1171 | 1822 | 2993 | 0 |
| 362 | 576 | 401 | 977 | 1046 | 511 | 1557 | 720 | 501 | 1221 | 1 |
| 363 | 317 | 754 | 1071 | 786 | 942 | 1728 | 396 | 942 | 1338 | 1 |
| 364 | 1127 | 899 | 2026 | 1946 | 1124 | 3070 | 1409 | 1124 | 2533 | 0 |
| 365 | 1444 | 496 | 1940 | 3425 | 632 | 4057 | 1805 | 620 | 2425 | 0 |
| 366 | 823 | 216 | 1039 | 1259 | 275 | 1534 | 1029 | 271 | 1300 | 1 |
| 367 | 4 | 8 | 12 | 12 | 11 | 23 | 5 | 10 | 15 | 1 |
| 368 | 169 | 448 | 617 | 607 | 570 | 1177 | 211 | 560 | 771 | 1 |
| 369 | 521 | 1140 | 1661 | 1140 | 1425 | 2565 | 651 | 1425 | 2076 | 1 |
| 370 | 922 | 198 | 1120 | 2130 | 267 | 2397 | 1152 | 251 | 1403 | 0 |
| 371 | 47 | 147 | 194 | 194 | 195 | 389 | 59 | 186 | 245 | 1 |
| 372 | 252 | 315 | 567 | 726 | 407 | 1133 | 315 | 398 | 713 | 1 |
|   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 373 | 248 | 424 | 672 | 597 | 538 | 1135 | 310 | 530 | 840 | 1 |
| 374 | 707 | 949 | 1656 | 1052 | 1186 | 2238 | 884 | 1186 | 2070 | 1 |
| 375 | 289 | 55 | 344 | 1180 | 81 | 1261 | 361 | 70 | 431 | 1 |
| 376 | 875 | 713 | 1588 | 2025 | 891 | 2916 | 1094 | 891 | 1985 | 0 |
| 377 | 279 | 156 | 435 | 852 | 209 | 1061 | 349 | 198 | 547 | 1 |
| 378 | 185 | 88 | 273 | 617 | 120 | 737 | 231 | 111 | 342 | 1 |
| 379 | 64 | 174 | 238 | 304 | 237 | 541 | 80 | 221 | 301 | 1 |
| 380 | 996 | 364 | 1360 | 1958 | 466 | 2424 | 1245 | 455 | 1700 | 0 |
| 381 | 113 | 76 | 189 | 384 | 101 | 485 | 141 | 96 | 237 | 1 |
| 382 | 951 | 1646 | 2597 | 1552 | 2057 | 3609 | 1189 | 2057 | 3246 | 0 |
| 383 | 735 | 221 | 956 | 1531 | 292 | 1823 | 919 | 280 | 1199 | 1 |
| 384 | 123 | 459 | 582 | 314 | 575 | 889 | 154 | 574 | 728 | 1 |
| 385 | 802 | 198 | 1000 | 1392 | 261 | 1653 | 1002 | 250 | 1252 | 1 |
| 386 | 472 | 145 | 617 | 1374 | 201 | 1575 | 590 | 185 | 775 | 1 |
| 387 | 390 | 1095 | 1485 | 632 | 1369 | 2001 | 487 | 1369 | 1856 | 1 |
| 388 | 432 | 1274 | 1706 | 762 | 1592 | 2354 | 540 | 1592 | 2132 | 1 |
| 389 | 41 | 10 | 51 | 163 | 14 | 177 | 51 | 13 | 64 | 1 |
| 390 | 1607 | 852 | 2459 | 3537 | 1065 | 4602 | 2009 | 1065 | 3074 | 0 |
| 391 | 440 | 574 | 1014 | 726 | 719 | 1445 | 550 | 717 | 1267 | 1 |
| 392 | 1534 | 329 | 1863 | 2493 | 419 | 2912 | 1917 | 411 | 2328 | 0 |
| 393 | 1237 | 506 | 1743 | 1893 | 636 | 2529 | 1546 | 632 | 2178 | 0 |
| 394 | 79 | 433 | 512 | 261 | 548 | 809 | 99 | 541 | 640 | 1 |
| 395 | 227 | 456 | 683 | 680 | 575 | 1255 | 284 | 570 | 854 | 1 |
| 396 | 638 | 136 | 774 | 915 | 173 | 1088 | 797 | 171 | 968 | 1 |
| 397 | 1021 | 720 | 1741 | 2019 | 900 | 2919 | 1276 | 900 | 2176 | 0 |
| 398 | 5 | 16 | 21 | 24 | 23 | 47 | 6 | 20 | 26 | 1 |
| 399 | 1636 | 1362 | 2998 | 2909 | 1702 | 4611 | 2045 | 1702 | 3747 | 0 |
| 400 | 248 | 743 | 991 | 812 | 929 | 1741 | 310 | 929 | 1239 | 1 |
| 401 | 202 | 80 | 282 | 580 | 111 | 691 | 252 | 101 | 353 | 1 |
| 402 | 1199 | 223 | 1422 | 1897 | 284 | 2181 | 1499 | 280 | 1779 | 0 |
| 403 | 854 | 1048 | 1902 | 1177 | 1310 | 2487 | 1067 | 1310 | 2377 | 1 |
| 404 | 89 | 217 | 306 | 323 | 286 | 609 | 111 | 275 | 386 | 1 |
| 405 | 28 | 13 | 41 | 126 | 19 | 145 | 35 | 17 | 52 | 1 |
| 406 | 513 | 1454 | 1967 | 857 | 1817 | 2674 | 641 | 1817 | 2458 | 0 |
| 407 | 786 | 480 | 1266 | 1216 | 604 | 1820 | 982 | 600 | 1582 | 1 |
| 408 | 387 | 318 | 705 | 884 | 414 | 1298 | 484 | 403 | 887 | 1 |
| 409 | 1312 | 685 | 1997 | 2706 | 856 | 3562 | 1640 | 856 | 2496 | 0 |
| 410 | 273 | 853 | 1126 | 609 | 1066 | 1675 | 341 | 1066 | 1407 | 1 |
| 411 | 232 | 1272 | 1504 | 704 | 1590 | 2294 | 290 | 1590 | 1880 | 1 |
| 412 | 1544 | 729 | 2273 | 2371 | 911 | 3282 | 1930 | 911 | 2841 | 0 |
| 413 | 395 | 260 | 655 | 910 | 343 | 1253 | 494 | 330 | 824 | 1 |
| 414 | 117 | 87 | 204 | 344 | 118 | 462 | 146 | 110 | 256 | 1 |
| 415 | 1336 | 571 | 1907 | 2797 | 725 | 3522 | 1670 | 714 | 2384 | 0 |

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|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 416 100 53 153 428 76 504 125 67 192 1 | 417 1653 497 2150 3333 632 3965 2066 621 2687 0 | 418 528 240 768 1086 316 1402 660 304 964 1 | 419 77 16 93 263 22 285 96 20 116 1 |
| 420 169 727 896 592 909 1501 211 909 1120 1 | 421 337 1190 1527 876 1487 2363 421 1487 1908 1 | 422 50 200 250 170 255 425 62 251 313 1 | 423 354 74 428 710 96 806 442 93 535 1 |
| 424 287 847 1134 1024 1059 2083 359 1059 1418 1 | 425 78 21 99 391 30 421 97 27 124 1 | 426 52 197 249 178 260 438 65 249 314 1 | 427 621 1695 2316 954 2119 3073 776 2119 2895 0 |
| 428 1694 310 2004 3189 401 3590 2117 392 2509 0 | 429 697 128 825 1245 173 1418 871 162 1033 1 | 430 576 1439 2015 1038 1799 2837 720 1799 2519 0 | 431 1314 754 2068 3123 942 4065 1642 942 2584 0 |
| 432 571 341 912 1235 442 1677 714 426 1140 1 | 433 1642 1137 2779 2920 1421 4341 2052 1421 3473 0 | 434 1161 839 2000 2067 1049 3116 1451 1049 2500 0 | 435 110 76 186 261 97 358 137 95 232 1 |
| 436 1468 919 2387 2885 1149 4034 1835 1149 2984 0 | 437 69 108 177 386 157 543 86 138 224 1 | 438 193 132 325 697 184 881 241 168 409 1 | 439 189 774 963 582 967 1549 236 967 1203 1 |
| 440 361 191 552 881 255 1136 451 242 693 1 | 441 922 1551 2473 1234 1939 3173 1152 1939 3091 0 | 442 424 1533 1957 753 1916 2669 530 1916 2446 0 | 443 610 177 787 1389 238 1627 762 225 987 1 |
| 444 310 709 1019 928 886 1814 387 886 1273 1 | 445 547 304 851 874 385 1259 684 382 1066 1 | 446 661 1599 2260 1504 1999 3503 826 1999 2825 0 | 447 313 964 1277 862 1205 2067 391 1205 1596 1 |
| 448 18 58 76 64 78 142 22 73 95 1 | 449 212 285 497 591 368 959 265 360 625 1 | 450 711 165 876 964 208 1172 889 207 1096 1 | 451 372 811 1183 755 1014 1769 465 1014 1479 1 |
| 452 749 227 976 1284 292 1576 936 286 1222 1 | 453 1231 1562 2793 1852 1952 3804 1539 1952 3491 0 | 454 602 745 1347 952 931 1883 752 931 1683 1 | 455 748 1243 1991 1685 1554 3239 935 1554 2489 0 |
| 456 476 209 685 735 264 999 595 262 857 1 | 457 748 450 1198 1284 569 1853 935 562 1497 1 | 458 490 936 1426 744 1170 1914 612 1170 1782 1 |
|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 502 | 772 | 273 | 1045 | 1112 | 347 | 1459 | 965 | 343 | 1308 | 1 |
| 503 | 216 | 78 | 294 | 524 | 100 | 624 | 270 | 98 | 368 | 1 |
| 504 | 420 | 954 | 1374 | 1161 | 1192 | 2353 | 525 | 1192 | 1717 | 1 |
| 505 | 945 | 411 | 1356 | 1683 | 522 | 2205 | 1181 | 514 | 1695 | 1 |
| 506 | 395 | 97 | 492 | 948 | 134 | 1082 | 494 | 123 | 617 | 1 |
| 507 | 228 | 90 | 318 | 918 | 130 | 1048 | 285 | 114 | 399 | 1 |
| 508 | 81 | 275 | 356 | 284 | 360 | 644 | 101 | 348 | 449 | 1 |
| 509 | 1555 | 1176 | 2731 | 2406 | 1470 | 3876 | 1944 | 1470 | 3414 | 0 |
| 510 | 963 | 213 | 1176 | 2351 | 288 | 2639 | 1204 | 272 | 1476 | 0 |
| 511 | 1514 | 1048 | 2562 | 2232 | 1310 | 3542 | 1892 | 1310 | 3202 | 0 |
| 512 | 879 | 189 | 1068 | 1469 | 246 | 1715 | 1099 | 238 | 1337 | 1 |
| 513 | 198 | 68 | 266 | 563 | 91 | 654 | 247 | 86 | 333 | 1 |
| 514 | 131 | 65 | 196 | 390 | 89 | 479 | 164 | 82 | 246 | 1 |
| 515 | 1195 | 1494 | 2689 | 1997 | 1867 | 3864 | 1494 | 1867 | 3361 | 0 |
| 516 | 1515 | 364 | 1879 | 2254 | 460 | 2714 | 1894 | 455 | 2349 | 0 |
| 517 | 491 | 157 | 648 | 732 | 198 | 930 | 614 | 197 | 811 | 1 |
| 518 | 726 | 1611 | 2337 | 1452 | 2014 | 3466 | 907 | 2014 | 2921 | 0 |
| 519 | 822 | 398 | 1220 | 1586 | 513 | 2099 | 1027 | 497 | 1524 | 1 |
| 520 | 213 | 110 | 323 | 512 | 142 | 654 | 266 | 138 | 404 | 1 |
| 521 | 488 | 1190 | 1678 | 909 | 1487 | 2396 | 610 | 1487 | 2097 | 1 |
| 522 | 345 | 133 | 478 | 969 | 184 | 1153 | 431 | 169 | 600 | 1 |
| 523 | 1053 | 1240 | 2293 | 1584 | 1550 | 3134 | 1316 | 1550 | 2866 | 0 |
| 524 | 174 | 103 | 277 | 589 | 143 | 732 | 217 | 131 | 348 | 1 |
| 525 | 883 | 183 | 1066 | 1516 | 241 | 1757 | 1104 | 231 | 1335 | 1 |
| 526 | 634 | 434 | 1068 | 1277 | 557 | 1834 | 792 | 542 | 1334 | 1 |
| 527 | 174 | 363 | 537 | 517 | 466 | 983 | 217 | 454 | 671 | 1 |
| 528 | 1697 | 386 | 2083 | 3836 | 499 | 4335 | 2121 | 482 | 2603 | 0 |
| 529 | 600 | 447 | 1047 | 1166 | 565 | 1731 | 750 | 559 | 1309 | 1 |
| 530 | 114 | 182 | 296 | 351 | 234 | 585 | 142 | 229 | 371 | 1 |
| 531 | 244 | 544 | 788 | 774 | 688 | 1462 | 305 | 680 | 985 | 1 |
| 532 | 1411 | 1070 | 2481 | 1951 | 1337 | 3288 | 1764 | 1337 | 3101 | 0 |
| 533 | 1100 | 1542 | 2642 | 2686 | 1927 | 4613 | 1375 | 1927 | 3302 | 0 |
| 534 | 160 | 43 | 203 | 357 | 55 | 412 | 200 | 54 | 254 | 1 |
| 535 | 376 | 742 | 1118 | 1119 | 927 | 2046 | 470 | 927 | 1397 | 1 |
| 536 | 1361 | 912 | 2273 | 2605 | 1140 | 3745 | 1701 | 1140 | 2841 | 0 |
| 537 | 110 | 330 | 440 | 327 | 422 | 749 | 137 | 412 | 549 | 1 |
| 538 | 41 | 119 | 160 | 175 | 170 | 345 | 51 | 152 | 203 | 1 |
| 539 | 352 | 1380 | 1732 | 1072 | 1725 | 2797 | 440 | 1725 | 2165 | 0 |
| 540 | 755 | 1003 | 1758 | 1578 | 1254 | 2832 | 944 | 1254 | 2198 | 1 |
| 541 | 895 | 1305 | 2200 | 1514 | 1631 | 3145 | 1119 | 1631 | 2750 | 0 |
| 542 | 50 | 28 | 78 | 204 | 41 | 245 | 62 | 36 | 98 | 1 |
| 543 | 501 | 892 | 1393 | 951 | 1115 | 2066 | 626 | 1115 | 1741 | 1 |
| 544 | 335 | 672 | 1007 | 814 | 848 | 1662 | 419 | 840 | 1259 | 1 |

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|   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|
| 545 | 448 | 265 | 713 | 765 | 337 | 1102 | 560 |
| 546 | 1313 | 351 | 1664 | 3114 | 465 | 3579 | 1641 |
| 547 | 1682 | 850 | 2532 | 4335 | 1062 | 5397 | 2102 |
| 548 | 1210 | 1508 | 2718 | 2261 | 1885 | 4146 | 1512 |
| 549 | 474 | 130 | 604 | 747 | 166 | 913 | 592 |
| 550 | 1679 | 628 | 2307 | 3775 | 798 | 4573 | 2099 |
| 551 | 207 | 72 | 279 | 439 | 92 | 531 | 259 |
| 552 | 1007 | 1427 | 2434 | 1687 | 1784 | 3471 | 1259 |
| 553 | 817 | 1110 | 1927 | 1557 | 1387 | 2944 | 1021 |
| 554 | 69 | 160 | 229 | 245 | 209 | 454 | 86 |
| 555 | 215 | 979 | 1194 | 633 | 1224 | 1857 | 269 |
| 556 | 813 | 441 | 1254 | 1466 | 558 | 2024 | 1016 |
| 557 | 1508 | 766 | 2274 | 2513 | 957 | 3470 | 1885 |
| 558 | 1238 | 223 | 1461 | 2201 | 290 | 2491 | 1547 |
| 559 | 399 | 912 | 1311 | 671 | 1140 | 1811 | 499 |
| 560 | 744 | 1673 | 2417 | 1860 | 2091 | 3951 | 930 |
| 561 | 521 | 281 | 802 | 1075 | 362 | 1437 | 651 |
| 562 | 335 | 66 | 401 | 792 | 91 | 883 | 419 |
| 563 | 1027 | 659 | 1686 | 2445 | 839 | 3284 | 2445 |
| 564 | 1646 | 712 | 2358 | 3319 | 890 | 4209 | 2057 |
| 565 | 596 | 488 | 1084 | 989 | 614 | 1603 | 745 |
| 566 | 616 | 1547 | 2163 | 1319 | 1934 | 3253 | 770 |
| 567 | 412 | 902 | 1314 | 696 | 1127 | 1823 | 515 |
| 568 | 603 | 240 | 843 | 1336 | 317 | 1653 | 754 |
| 569 | 959 | 1200 | 2159 | 1856 | 1500 | 3356 | 1199 |
| 570 | 127 | 22 | 149 | 365 | 29 | 394 | 159 |
| 571 | 1297 | 878 | 2175 | 1793 | 1097 | 2890 | 1621 |
| 572 | 1301 | 442 | 1743 | 2371 | 559 | 2930 | 1626 |
| 573 | 781 | 156 | 937 | 1051 | 197 | 1248 | 976 |
| 574 | 762 | 1370 | 2132 | 1461 | 1712 | 3173 | 952 |
| 575 | 266 | 607 | 873 | 962 | 772 | 1734 | 332 |
| 576 | 364 | 799 | 1163 | 980 | 999 | 1979 | 455 |
| 577 | 1562 | 1004 | 2566 | 2742 | 1255 | 3997 | 1952 |
| 578 | 151 | 184 | 335 | 452 | 243 | 695 | 189 |
| 579 | 1624 | 679 | 2303 | 2211 | 850 | 3061 | 2030 |
| 580 | 1777 | 1624 | 2801 | 1572 | 2030 | 3602 | 1471 |
| 581 | 679 | 1505 | 2184 | 1337 | 1881 | 3218 | 849 |
| 582 | 405 | 194 | 599 | 931 | 257 | 1188 | 506 |
| 583 | 533 | 1324 | 1857 | 907 | 1655 | 2562 | 666 |
| 584 | 226 | 1118 | 1344 | 530 | 1397 | 1927 | 282 |
| 585 | 440 | 1199 | 1639 | 1244 | 1499 | 2743 | 550 |
| 586 | 215 | 500 | 715 | 505 | 629 | 1134 | 269 |
| 587 | 381 | 1206 | 1587 | 742 | 1507 | 2249 | 476 |
|    |     |     |     |     |     |     |     |     |     |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 588| 431 | 269 | 700 | 901 | 354 | 1255| 539 | 341 | 880 |
| 589| 268 | 364 | 632 | 902 | 472 | 1374| 335 | 455 | 790 |
| 590| 368 | 858 | 1226| 1115| 1072| 2187| 460 | 1072| 1532 |
| 591| 40  | 219 | 259 | 128 | 279 | 407 | 50  | 275 | 325 |
| 592| 923 | 383 | 1306| 1743| 493 | 2236| 1154| 479 | 1633 |
| 593| 443 | 138 | 581 | 1091| 185 | 1276| 554 | 175 | 729 |
| 594| 152 | 205 | 357 | 435 | 266 | 701 | 190 | 259 | 449 |
| 595| 1392| 773 | 2165| 2862| 966 | 3828| 1740| 966 | 2706 |
| 596| 942 | 1302| 2244| 1385| 1627| 3012| 1177| 1627| 2804 |
| 597| 882 | 1515| 2397| 1591| 1894| 3485| 1102| 1894| 2996 |
| 598| 173 | 453 | 626 | 455 | 570 | 1025| 216 | 566 | 782 |
| 599| 733 | 1119| 1852| 1457| 1399| 2856| 916 | 1399| 2315 |
| 600| 1416| 554 | 1970| 2792| 704 | 3496| 1770| 692 | 2462 |
| 601| 631 | 473 | 1104| 1466| 601 | 2067| 789 | 591 | 1380 |
## Appendix E:

### Table 9: Results from HCS 7 Runs

| Scenario Number | LOS (no Climbing Lane) | LOS (Climbing Lane) | Guideline1 | Guideline2 | Guideline3 | Guidelines Satisfied (overall) | Acceptable Performance (No Climbing Lane) | Acceptable Performance (Climbing Lane) | Logical Clause 1 Valid | Logical Clause 2 Valid | Logical Clause 3 Valid | Logical Clause 4 Valid |
|-----------------|------------------------|---------------------|------------|------------|------------|-------------------------------|-------------------------------------------|-------------------------------------------|----------------------------|------------------------|------------------------|------------------------|
| 1               | D                      | B                   | 1          | 1          | 1          | 1                             | 0                                         | 1                                         | 0                          | 1                      | 0                      | 0                      |
| 2               | C                      | B                   | 0          | 0          | 1          | 0                             | 1                                         | 1                                         | 0                          | 0                      | 0                      | 1                      |
| 3               | B                      | B                   | 0          | 0          | 0          | 0                             | 1                                         | 1                                         | 0                          | 0                      | 0                      | 1                      |
| 5               | D                      | C                   | 1          | 1          | 1          | 1                             | 0                                         | 1                                         | 1                                         | 0                      | 1                      | 0                      |
| 7               | E                      | C                   | 1          | 1          | 1          | 1                             | 0                                         | 1                                         | 1                                         | 0                      | 1                      | 0                      |
| 8               | C                      | B                   | 1          | 0          | 1          | 0                             | 1                                         | 1                                         | 0                                         | 0                      | 0                      | 1                      |
| 12              | A                      | A                   | 0          | 0          | 0          | 0                             | 1                                         | 1                                         | 0                                         | 0                      | 0                      | 1                      |
| 15              | C                      | B                   | 1          | 1          | 1          | 1                             | 1                                         | 1                                         | 0                                         | 0                      | 1                      | 0                      |
| 17              | B                      | B                   | 0          | 0          | 0          | 0                             | 1                                         | 1                                         | 0                                         | 0                      | 0                      | 1                      |
| 18              | D                      | C                   | 1          | 1          | 1          | 1                             | 0                                         | 1                                         | 1                                         | 0                      | 1                      | 0                      |
| 19              | E                      | E                   | 1          | 0          | 1          | 0                             | 0                                         | 0                                         | 0                                         | 1                      | 0                      | 0                      |
| 21              | E                      | D                   | 1          | 1          | 1          | 1                             | 0                                         | 1                                         | 0                                         | 0                      | 0                      | 0                      |
| 22              | E                      | D                   | 1          | 1          | 1          | 1                             | 0                                         | 0                                         | 1                                         | 0                      | 0                      | 0                      |
| 24              | B                      | B                   | 0          | 0          | 0          | 0                             | 1                                         | 1                                         | 0                                         | 0                      | 0                      | 1                      |
| 25              | C                      | A                   | 0          | 0          | 0          | 0                             | 1                                         | 1                                         | 0                                         | 0                      | 0                      | 1                      |
| 28              | E                      | C                   | 1          | 1          | 1          | 1                             | 0                                         | 1                                         | 1                                         | 0                      | 1                      | 0                      |
| 29              | D                      | B                   | 1          | 1          | 1          | 1                             | 0                                         | 1                                         | 1                                         | 0                      | 1                      | 0                      |
| 31              | C                      | B                   | 1          | 0          | 1          | 0                             | 1                                         | 1                                         | 0                                         | 0                      | 0                      | 1                      |
| 32              | D                      | C                   | 1          | 0          | 1          | 0                             | 0                                         | 1                                         | 0                                         | 0                      | 0                      | 0                      |
| 33              | B                      | B                   | 0          | 0          | 0          | 0                             | 1                                         | 1                                         | 0                                         | 0                      | 0                      | 1                      |
| 34              | D                      | C                   | 1          | 1          | 1          | 1                             | 0                                         | 1                                         | 1                                         | 0                      | 1                      | 0                      |
| 36              | E                      | B                   | 1          | 1          | 1          | 1                             | 0                                         | 1                                         | 1                                         | 0                      | 1                      | 0                      |
| 37              | E                      | D                   | 1          | 1          | 1          | 1                             | 0                                         | 0                                         | 1                                         | 0                      | 0                      | 0                      |
| 38              | C                      | B                   | 1          | 1          | 1          | 1                             | 1                                         | 1                                         | 1                                         | 0                      | 0                      | 1                      |
| 39              | E                      | D                   | 1          | 1          | 1          | 1                             | 0                                         | 0                                         | 1                                         | 0                      | 0                      | 0                      |
| 41              | D                      | C                   | 1          | 1          | 1          | 1                             | 0                                         | 1                                         | 1                                         | 0                      | 1                      | 0                      |

121
|   | E | D | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 44|   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 45| D | C | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |   |   |
| 46| B | A | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |   |
| 47| D | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 48| D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 49| C | B | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 50| A | A | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 51| D | C | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |   |   |
| 52| D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 53| C | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 54| D | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 55| C | B | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 56| C | B | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 57| D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 58| D | A | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 59| E | D | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |   |   |
| 60| D | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 61| E | D | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |   |   |
| 62| D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 63| E | D | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |   |   |
| 64| D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 65| C | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 66| D | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 67| C | B | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 68| D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 69| B | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 70| C | B | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 71| E | D | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |   |   |
| 72| D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 73| B | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 74| D | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 75| C | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 76| D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 77| B | A | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 78| D | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 79| A | A | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 80| D | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 81| C | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 82| D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 83| B | A | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 84| B | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 85| E | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 86| B | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 87| D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 88| C | B | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 89| B | A | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 90| B | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 91| E | D | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 92| C | B | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 93| C | A | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 94| D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 95| C | B | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |
| 96| D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |   |
| 97| C | B | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |   |

122
|   | C | B | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 295|   |   |   |   |   |   |   |   |   |   |   |   |
| 303| B | A | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 305| E | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 306| B | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 309| E | D | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 310| D | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 311| A | A | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 312| E | D | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 313| D | B | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 314| E | D | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 315| C | B | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 316| D | B | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| 317| B | A | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 319| B | B | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 |
| 320| E | D | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 321| C | A | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 |
| 323| B | A | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 324| C | B | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 325| E | D | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 327| D | C | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 328| E | D | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 329| E | D | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 330| E | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 331| E | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 332| C | A | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 334| E | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 339| C | B | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 340| D | A | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 342| E | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 344| C | B | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 347| D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 348| E | D | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 349| B | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 350| C | B | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 351| E | C | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 352| B | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 353| C | B | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 354| E | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 356| D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 357| D | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 358| B | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 359| D | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 360| E | D | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
|   |   | B | B | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 422|   | D | A | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 423|   | D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |   |
| 424|   | B | A | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |
| 425|   | B | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |   |
| 426|   | D | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 427|   | D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 428|   | B | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 429|   | B | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 430|   | D | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 431|   | D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 432|   | E | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 433|   | D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 434|   | D | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 435|   | D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 436|   | B | A | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 437|   | C | B | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 438|   | E | B | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 439|   | D | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 440|   | D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 441|   | E | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 442|   | D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 443|   | D | B | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 444|   | E | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 445|   | D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 446|   | D | C | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 447|   | D | C | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 448|   | E | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 449|   | D | C | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 450|   | D | C | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 451|   | D | A | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 452|   | A | A | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 453|   | C | B | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 454|   | C | C | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 455|   | D | C | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 456|   | D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 457|   | C | A | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 458|   | B | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 459|   | E | D | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 460|   | B | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 461|   | D | C | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 462|   | B | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 463|   | D | C | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 464|   | D | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 465|   | C | B | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 466|   | B | A | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 467|   | E | D | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 468|   | E | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
|   |   |   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 485 | B | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 487 | D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 488 | C | A | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 |
| 489 | D | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 491 | D | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 492 | C | B | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 493 | C | B | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 494 | D | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 495 | E | E | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 497 | D | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 498 | B | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 499 | A | A | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 501 | C | A | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 502 | E | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 503 | C | B | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 504 | E | D | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 505 | E | D | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 506 | D | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 507 | C | A | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 |
| 508 | C | B | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 512 | E | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 513 | C | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 514 | C | A | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 517 | D | A | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 519 | E | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 520 | C | B | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 521 | E | D | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 522 | D | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 524 | B | B | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 525 | E | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 526 | D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 527 | C | B | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 529 | E | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 530 | B | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 531 | C | B | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 |
| 534 | C | A | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 535 | D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 537 | B | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 538 | B | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 540 | E | D | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 542 | B | B | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 543 | D | C | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 544 | D | B | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
|   | D  | B  | 1  | 0  | 1  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  |
|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 545| D  | B  | 1  | 0  | 1  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  |
| 549| D  | B  | 1  | 0  | 1  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  |
| 551| C  | A  | 1  | 0  | 0  | 0  | 1  | 1  | 0  | 0  | 0  | 0  | 1  |   |
| 553| E  | E  | 1  | 1  | 1  | 1  | 0  | 0  | 1  | 0  | 0  | 0  |   |   |
| 554| B  | B  | 0  | 0  | 0  | 0  | 1  | 1  | 0  | 0  | 0  | 0  | 1  |   |
| 555| D  | C  | 1  | 1  | 1  | 1  | 0  | 1  | 1  | 0  | 1  | 0  |   |   |
| 556| E  | C  | 1  | 1  | 1  | 1  | 0  | 1  | 1  | 0  | 1  | 0  |   |   |
| 559| D  | C  | 1  | 0  | 1  | 0  | 0  | 1  | 0  | 0  | 0  | 0  |   |   |
| 561| D  | B  | 1  | 1  | 1  | 1  | 0  | 1  | 1  | 0  | 1  | 0  |   |   |
| 562| D  | A  | 1  | 1  | 1  | 1  | 0  | 1  | 1  | 0  | 1  | 0  |   |   |
| 565| E  | B  | 1  | 1  | 1  | 1  | 0  | 1  | 1  | 0  | 1  | 0  |   |   |
| 567| D  | C  | 1  | 0  | 1  | 0  | 0  | 1  | 0  | 0  | 0  | 0  |   |   |
| 568| E  | C  | 1  | 1  | 1  | 1  | 0  | 1  | 1  | 0  | 1  | 0  |   |   |
| 570| C  | A  | 0  | 0  | 0  | 0  | 1  | 1  | 0  | 0  | 0  | 0  | 1  |   |
| 573| E  | B  | 1  | 0  | 1  | 0  | 0  | 1  | 0  | 0  | 0  | 0  |   |   |
| 575| D  | C  | 1  | 1  | 1  | 1  | 0  | 1  | 1  | 0  | 1  | 0  |   |   |
| 576| D  | C  | 1  | 1  | 1  | 1  | 0  | 1  | 1  | 0  | 1  | 0  |   |   |
| 578| B  | B  | 0  | 0  | 0  | 0  | 1  | 1  | 0  | 0  | 0  | 0  | 1  |   |
| 582| D  | B  | 1  | 1  | 1  | 1  | 0  | 1  | 1  | 0  | 1  | 0  |   |   |
| 583| E  | D  | 1  | 1  | 1  | 1  | 0  | 1  | 0  | 0  | 0  | 0  |   |   |
| 584| D  | C  | 1  | 0  | 1  | 0  | 0  | 1  | 0  | 0  | 0  | 0  |   |   |
| 585| E  | D  | 1  | 1  | 1  | 1  | 0  | 0  | 1  | 0  | 0  | 0  |   |   |
| 586| C  | B  | 1  | 0  | 1  | 0  | 1  | 1  | 0  | 0  | 0  | 1  |   |   |
| 587| E  | C  | 1  | 1  | 1  | 1  | 0  | 1  | 1  | 0  | 1  | 0  |   |   |
| 588| D  | B  | 1  | 1  | 1  | 1  | 0  | 1  | 1  | 0  | 1  | 0  |   |   |
| 589| C  | B  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0  | 0  | 1  |   |   |
| 590| D  | C  | 1  | 1  | 1  | 1  | 0  | 1  | 1  | 0  | 1  | 0  |   |   |
| 591| B  | B  | 0  | 0  | 0  | 0  | 1  | 1  | 0  | 0  | 0  | 1  |   |   |
| 593| D  | B  | 1  | 1  | 1  | 1  | 0  | 1  | 1  | 0  | 1  | 0  |   |   |
| 594| C  | B  | 0  | 0  | 1  | 0  | 1  | 1  | 0  | 0  | 0  | 1  |   |   |
| 596| E  | E  | 1  | 1  | 1  | 1  | 0  | 0  | 1  | 0  | 0  | 0  |   |   |
| 598| C  | B  | 0  | 0  | 1  | 0  | 1  | 1  | 0  | 0  | 0  | 1  |   |   |
| 599| E  | D  | 1  | 1  | 1  | 1  | 0  | 0  | 1  | 0  | 0  | 0  |   |   |
| 601| E  | C  | 1  | 1  | 1  | 1  | 0  | 1  | 1  | 0  | 1  | 0  |   |   |
Appendix F:

**Table 10: Classification and Error Rates**

| Scenario Number | Proper Classification | Proper Classification Count | Proper Classification Rate | Type I Classification Error | Type I Error Count | Type I Error Rate | Type II Classification Error | Type II Error Count | Type II Error Rate |
|-----------------|-----------------------|-----------------------------|---------------------------|----------------------------|-------------------|-------------------|-------------------------------|-------------------|-------------------|
| 1               | 1                     | 1                           | 1.00                      | 0                          | 0                 | 0.00              | 0                             | 0                 | 0.00              |
| 2               | 0                     | 1                           | 0.50                      | 0                          | 0                 | 0.00              | 1                             | 1                 | 0.50              |
| 3               | 0                     | 1                           | 0.33                      | 0                          | 0                 | 0.00              | 1                             | 2                 | 0.67              |
| 5               | 1                     | 2                           | 0.50                      | 0                          | 0                 | 0.00              | 0                             | 2                 | 0.50              |
| 7               | 1                     | 3                           | 0.60                      | 0                          | 0                 | 0.00              | 0                             | 2                 | 0.40              |
| 8               | 0                     | 3                           | 0.50                      | 0                          | 0                 | 0.00              | 1                             | 3                 | 0.50              |
| 12              | 0                     | 3                           | 0.43                      | 0                          | 0                 | 0.00              | 1                             | 4                 | 0.57              |
| 15              | 0                     | 3                           | 0.38                      | 1                          | 1                 | 0.13              | 0                             | 4                 | 0.50              |
| 17              | 0                     | 3                           | 0.33                      | 0                          | 1                 | 0.11              | 1                             | 5                 | 0.56              |
| 18              | 1                     | 4                           | 0.40                      | 0                          | 1                 | 0.10              | 0                             | 5                 | 0.50              |
| 19              | 0                     | 4                           | 0.36                      | 0                          | 1                 | 0.09              | 1                             | 6                 | 0.55              |
| 21              | 0                     | 4                           | 0.33                      | 1                          | 2                 | 0.17              | 0                             | 6                 | 0.50              |
| 22              | 0                     | 4                           | 0.31                      | 1                          | 3                 | 0.23              | 0                             | 6                 | 0.46              |
| 24              | 0                     | 4                           | 0.29                      | 0                          | 3                 | 0.21              | 1                             | 7                 | 0.50              |
| 25              | 0                     | 4                           | 0.27                      | 0                          | 3                 | 0.20              | 1                             | 8                 | 0.53              |
| 28              | 1                     | 5                           | 0.31                      | 0                          | 3                 | 0.19              | 0                             | 8                 | 0.50              |
| 29              | 1                     | 6                           | 0.35                      | 0                          | 3                 | 0.18              | 0                             | 8                 | 0.47              |
| 31              | 0                     | 6                           | 0.33                      | 0                          | 3                 | 0.17              | 1                             | 9                 | 0.50              |
| 32              | 0                     | 6                           | 0.32                      | 0                          | 3                 | 0.16              | 1                             | 10                | 0.53              |
| 33              | 0                     | 6                           | 0.30                      | 0                          | 3                 | 0.15              | 1                             | 11                | 0.55              |
| 34              | 1                     | 7                           | 0.33                      | 0                          | 3                 | 0.14              | 0                             | 11                | 0.52              |
| 36              | 1                     | 8                           | 0.36                      | 0                          | 3                 | 0.14              | 0                             | 11                | 0.50              |
| 37              | 0                     | 8                           | 0.35                      | 1                          | 4                 | 0.17              | 0                             | 11                | 0.48              |
| 38              | 0                     | 8                           | 0.33                      | 1                          | 5                 | 0.21              | 0                             | 11                | 0.46              |
| 39              | 0                     | 8                           | 0.32                      | 1                          | 6                 | 0.24              | 0                             | 11                | 0.44              |
| 41              | 1                     | 9                           | 0.35                      | 0                          | 6                 | 0.23              | 0                             | 11                | 0.42              |
| 44              | 0                     | 9                           | 0.33                      | 1                          | 7                 | 0.26              | 0                             | 11                | 0.41              |
|   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|
| 45 | 0 | 9 | 0.32 | 0 | 7 | 0.25 |
| 46 | 0 | 9 | 0.31 | 0 | 7 | 0.24 |
| 47 | 1 | 10 | 0.33 | 0 | 7 | 0.23 |
| 48 | 1 | 11 | 0.35 | 0 | 7 | 0.23 |
| 49 | 0 | 11 | 0.34 | 0 | 7 | 0.22 |
| 50 | 0 | 11 | 0.33 | 0 | 7 | 0.21 |
| 51 | 0 | 11 | 0.32 | 0 | 7 | 0.21 |
| 52 | 1 | 12 | 0.34 | 0 | 7 | 0.21 |
| 53 | 0 | 12 | 0.33 | 1 | 8 | 0.22 |
| 54 | 1 | 12 | 0.35 | 0 | 8 | 0.22 |
| 55 | 0 | 13 | 0.34 | 0 | 8 | 0.21 |
| 56 | 0 | 13 | 0.33 | 0 | 8 | 0.21 |
| 57 | 1 | 14 | 0.35 | 0 | 8 | 0.20 |
| 58 | 1 | 15 | 0.37 | 0 | 8 | 0.20 |
| 59 | 0 | 15 | 0.36 | 1 | 9 | 0.21 |
| 60 | 1 | 16 | 0.37 | 0 | 9 | 0.21 |
| 61 | 0 | 16 | 0.36 | 1 | 10 | 0.23 |
| 62 | 1 | 17 | 0.38 | 0 | 10 | 0.22 |
| 63 | 0 | 17 | 0.37 | 1 | 11 | 0.24 |
| 64 | 0 | 17 | 0.36 | 0 | 11 | 0.23 |
| 65 | 0 | 17 | 0.35 | 0 | 11 | 0.23 |
| 66 | 0 | 17 | 0.34 | 1 | 12 | 0.24 |
| 67 | 1 | 18 | 0.35 | 0 | 12 | 0.24 |
| 68 | 0 | 18 | 0.34 | 0 | 12 | 0.23 |
| 69 | 1 | 19 | 0.35 | 0 | 12 | 0.22 |
| 70 | 0 | 19 | 0.35 | 0 | 12 | 0.22 |
| 71 | 1 | 20 | 0.36 | 0 | 12 | 0.21 |
| 72 | 0 | 20 | 0.35 | 0 | 12 | 0.21 |
| 73 | 1 | 21 | 0.36 | 0 | 12 | 0.21 |
| 74 | 0 | 21 | 0.35 | 0 | 12 | 0.21 |
| 75 | 1 | 22 | 0.36 | 0 | 12 | 0.20 |
| 76 | 0 | 22 | 0.35 | 0 | 12 | 0.20 |
| 77 | 1 | 23 | 0.34 | 0 | 12 | 0.20 |
| 78 | 0 | 23 | 0.34 | 0 | 12 | 0.20 |
| 79 | 1 | 24 | 0.33 | 0 | 13 | 0.19 |
| 80 | 0 | 24 | 0.33 | 0 | 13 | 0.19 |
| 81 | 1 | 25 | 0.33 | 0 | 13 | 0.19 |
| 82 | 0 | 25 | 0.33 | 0 | 13 | 0.19 |
| 83 | 1 | 26 | 0.34 | 0 | 13 | 0.19 |
| 84 | 0 | 26 | 0.34 | 0 | 13 | 0.19 |
| 85 | 1 | 27 | 0.34 | 0 | 13 | 0.19 |
| 86 | 0 | 27 | 0.34 | 0 | 13 | 0.19 |
| 87 | 1 | 28 | 0.33 | 0 | 13 | 0.19 |
| 88 | 0 | 28 | 0.33 | 0 | 13 | 0.19 |
| 89 | 1 | 29 | 0.33 | 0 | 13 | 0.19 |
| 90 | 0 | 29 | 0.33 | 0 | 13 | 0.19 |
| 91 | 1 | 30 | 0.34 | 0 | 13 | 0.19 |
| 92 | 0 | 30 | 0.34 | 0 | 13 | 0.19 |
| 93 | 1 | 31 | 0.33 | 0 | 13 | 0.19 |
| 94 | 0 | 31 | 0.33 | 0 | 13 | 0.19 |
| 95 | 1 | 32 | 0.33 | 0 | 13 | 0.19 |
| 96 | 0 | 32 | 0.33 | 0 | 13 | 0.19 |
| 97 | 1 | 33 | 0.33 | 0 | 13 | 0.19 |
| 98 | 0 | 33 | 0.33 | 0 | 13 | 0.19 |
| 99 | 1 | 34 | 0.33 | 0 | 13 | 0.19 |
|   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|
| 101| 0  | 23 | 0.32 | 0  | 13 | 0.18 | 1  | 35 | 0.49|
| 102| 0  | 23 | 0.32 | 0  | 13 | 0.18 | 1  | 36 | 0.50|
| 103| 0  | 23 | 0.32 | 1  | 14 | 0.19 | 0  | 36 | 0.49|
| 105| 1  | 24 | 0.32 | 0  | 14 | 0.19 | 0  | 36 | 0.49|
| 106| 1  | 25 | 0.33 | 0  | 14 | 0.19 | 0  | 36 | 0.48|
| 107| 1  | 26 | 0.34 | 0  | 14 | 0.18 | 0  | 36 | 0.47|
| 108| 0  | 26 | 0.34 | 1  | 15 | 0.19 | 0  | 36 | 0.47|
| 109| 0  | 26 | 0.33 | 0  | 15 | 0.19 | 1  | 37 | 0.47|
| 110| 0  | 26 | 0.33 | 0  | 15 | 0.19 | 1  | 38 | 0.48|
| 111| 1  | 27 | 0.34 | 0  | 15 | 0.19 | 0  | 38 | 0.48|
| 113| 1  | 28 | 0.35 | 0  | 15 | 0.19 | 0  | 38 | 0.47|
| 118| 1  | 29 | 0.35 | 0  | 15 | 0.18 | 0  | 38 | 0.46|
| 119| 1  | 30 | 0.36 | 0  | 15 | 0.18 | 0  | 38 | 0.46|
| 122| 0  | 30 | 0.36 | 0  | 15 | 0.18 | 1  | 39 | 0.46|
| 123| 1  | 31 | 0.36 | 0  | 15 | 0.18 | 0  | 39 | 0.46|
| 125| 0  | 31 | 0.36 | 1  | 16 | 0.18 | 0  | 39 | 0.45|
| 128| 1  | 32 | 0.37 | 0  | 16 | 0.18 | 0  | 39 | 0.45|
| 130| 0  | 32 | 0.36 | 1  | 17 | 0.19 | 0  | 39 | 0.44|
| 131| 0  | 32 | 0.36 | 0  | 17 | 0.19 | 1  | 40 | 0.45|
| 132| 1  | 33 | 0.37 | 0  | 17 | 0.19 | 0  | 40 | 0.44|
| 133| 1  | 34 | 0.37 | 0  | 17 | 0.19 | 0  | 40 | 0.44|
| 134| 0  | 34 | 0.37 | 0  | 17 | 0.18 | 1  | 41 | 0.45|
| 135| 1  | 35 | 0.38 | 0  | 17 | 0.18 | 0  | 41 | 0.44|
| 136| 0  | 35 | 0.37 | 0  | 17 | 0.18 | 1  | 42 | 0.45|
| 137| 0  | 35 | 0.37 | 0  | 17 | 0.18 | 1  | 43 | 0.45|
| 138| 0  | 35 | 0.36 | 1  | 18 | 0.19 | 0  | 43 | 0.45|
| 140| 0  | 35 | 0.36 | 0  | 18 | 0.19 | 1  | 44 | 0.45|
| 143| 0  | 35 | 0.36 | 1  | 19 | 0.19 | 0  | 44 | 0.45|
| 145| 1  | 36 | 0.36 | 0  | 19 | 0.19 | 0  | 44 | 0.44|
| 149| 0  | 36 | 0.36 | 0  | 19 | 0.19 | 1  | 45 | 0.45|
| 150| 1  | 37 | 0.37 | 0  | 19 | 0.19 | 0  | 45 | 0.45|
| 151| 0  | 37 | 0.36 | 0  | 19 | 0.19 | 1  | 46 | 0.45|
| 154| 0  | 37 | 0.36 | 0  | 19 | 0.18 | 1  | 47 | 0.46|
| 156| 0  | 37 | 0.36 | 0  | 19 | 0.18 | 1  | 48 | 0.46|
| 157| 0  | 37 | 0.35 | 1  | 20 | 0.19 | 0  | 48 | 0.46|
| 160| 1  | 38 | 0.36 | 0  | 20 | 0.19 | 0  | 48 | 0.45|
| 161| 0  | 38 | 0.36 | 0  | 20 | 0.19 | 1  | 49 | 0.46|
| 162| 0  | 38 | 0.35 | 0  | 20 | 0.19 | 1  | 50 | 0.46|
| 166| 1  | 39 | 0.36 | 0  | 20 | 0.18 | 0  | 50 | 0.46|
| 167| 1  | 40 | 0.36 | 0  | 20 | 0.18 | 0  | 50 | 0.45|
| 168| 0  | 40 | 0.36 | 0  | 20 | 0.18 | 1  | 51 | 0.46|
| 169| 1  | 41 | 0.37 | 0  | 20 | 0.18 | 0  | 51 | 0.46|
| 170| 1  | 42 | 0.37 | 0  | 20 | 0.18 | 0  | 51 | 0.45|
| 171 | 0  | 42  | 0.37 | 1  | 21  | 0.18 | 0  | 51  | 0.45 |
|-----|----|-----|------|----|-----|------|----|-----|------|
| 172 | 1  | 43  | 0.37 | 0  | 21  | 0.18 | 0  | 51  | 0.44 |
| 174 | 0  | 43  | 0.37 | 1  | 22  | 0.19 | 0  | 51  | 0.44 |
| 176 | 0  | 43  | 0.37 | 0  | 22  | 0.19 | 1  | 52  | 0.44 |
| 177 | 1  | 44  | 0.37 | 0  | 22  | 0.19 | 0  | 52  | 0.44 |
| 179 | 0  | 44  | 0.37 | 0  | 22  | 0.18 | 1  | 53  | 0.45 |
| 181 | 0  | 44  | 0.37 | 0  | 22  | 0.18 | 1  | 54  | 0.45 |
| 183 | 0  | 44  | 0.36 | 0  | 22  | 0.18 | 1  | 55  | 0.45 |
| 184 | 0  | 44  | 0.36 | 0  | 22  | 0.18 | 1  | 56  | 0.46 |
| 185 | 0  | 44  | 0.36 | 0  | 22  | 0.18 | 1  | 57  | 0.46 |
| 186 | 0  | 44  | 0.35 | 1  | 23  | 0.19 | 0  | 57  | 0.46 |
| 189 | 1  | 45  | 0.36 | 0  | 23  | 0.18 | 0  | 57  | 0.46 |
| 190 | 1  | 46  | 0.37 | 0  | 23  | 0.18 | 0  | 57  | 0.45 |
| 191 | 1  | 47  | 0.37 | 0  | 23  | 0.18 | 0  | 57  | 0.45 |
| 192 | 0  | 47  | 0.37 | 0  | 23  | 0.18 | 1  | 58  | 0.45 |
| 193 | 1  | 48  | 0.37 | 0  | 23  | 0.18 | 0  | 58  | 0.45 |
| 194 | 1  | 49  | 0.38 | 0  | 23  | 0.18 | 0  | 58  | 0.45 |
| 197 | 0  | 49  | 0.37 | 0  | 23  | 0.18 | 1  | 59  | 0.45 |
| 199 | 0  | 49  | 0.37 | 0  | 23  | 0.17 | 1  | 60  | 0.45 |
| 200 | 1  | 50  | 0.38 | 0  | 23  | 0.17 | 0  | 60  | 0.45 |
| 203 | 1  | 51  | 0.38 | 0  | 23  | 0.17 | 0  | 60  | 0.45 |
| 204 | 0  | 51  | 0.38 | 0  | 23  | 0.17 | 1  | 61  | 0.45 |
| 205 | 0  | 51  | 0.38 | 1  | 24  | 0.18 | 0  | 61  | 0.45 |
| 206 | 0  | 51  | 0.37 | 1  | 25  | 0.18 | 0  | 61  | 0.45 |
| 207 | 1  | 52  | 0.38 | 0  | 25  | 0.18 | 0  | 61  | 0.44 |
| 208 | 0  | 52  | 0.37 | 1  | 26  | 0.19 | 0  | 61  | 0.44 |
| 210 | 1  | 53  | 0.38 | 0  | 26  | 0.19 | 0  | 61  | 0.44 |
| 211 | 0  | 53  | 0.38 | 0  | 26  | 0.18 | 1  | 62  | 0.44 |
| 212 | 1  | 54  | 0.38 | 0  | 26  | 0.18 | 0  | 62  | 0.44 |
| 213 | 0  | 54  | 0.38 | 0  | 26  | 0.18 | 1  | 63  | 0.44 |
| 214 | 1  | 55  | 0.38 | 0  | 26  | 0.18 | 0  | 63  | 0.44 |
| 215 | 0  | 55  | 0.38 | 0  | 26  | 0.18 | 1  | 64  | 0.44 |
| 218 | 1  | 56  | 0.38 | 0  | 26  | 0.18 | 0  | 64  | 0.44 |
| 220 | 1  | 57  | 0.39 | 0  | 26  | 0.18 | 0  | 64  | 0.44 |
| 221 | 1  | 58  | 0.39 | 0  | 26  | 0.18 | 0  | 64  | 0.43 |
| 222 | 1  | 59  | 0.40 | 0  | 26  | 0.17 | 0  | 64  | 0.43 |
| 224 | 1  | 60  | 0.40 | 0  | 26  | 0.17 | 0  | 64  | 0.43 |
| 225 | 1  | 61  | 0.40 | 0  | 26  | 0.17 | 0  | 64  | 0.42 |
| 229 | 1  | 62  | 0.41 | 0  | 26  | 0.17 | 0  | 64  | 0.42 |
| 231 | 0  | 62  | 0.41 | 0  | 26  | 0.17 | 1  | 65  | 0.42 |
| 232 | 0  | 62  | 0.40 | 0  | 26  | 0.17 | 1  | 66  | 0.43 |
| 234 | 0  | 62  | 0.40 | 0  | 26  | 0.17 | 1  | 67  | 0.43 |
| 235 | 1  | 63  | 0.40 | 0  | 26  | 0.17 | 0  | 67  | 0.43 |
|   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|
| 236 | 0 | 63 | 0.40 | 0 | 26 | 0.17 | 1 | 68 | 0.43 |
| 237 | 1 | 64 | 0.41 | 0 | 26 | 0.16 | 0 | 68 | 0.43 |
| 240 | 0 | 64 | 0.40 | 0 | 26 | 0.16 | 1 | 69 | 0.43 |
| 241 | 0 | 64 | 0.40 | 0 | 26 | 0.16 | 1 | 70 | 0.44 |
| 242 | 0 | 64 | 0.40 | 0 | 26 | 0.16 | 1 | 71 | 0.44 |
| 243 | 0 | 64 | 0.40 | 0 | 26 | 0.16 | 1 | 72 | 0.44 |
| 244 | 1 | 65 | 0.40 | 0 | 26 | 0.16 | 0 | 72 | 0.44 |
| 245 | 1 | 66 | 0.40 | 0 | 26 | 0.16 | 0 | 72 | 0.44 |
| 246 | 1 | 67 | 0.41 | 0 | 26 | 0.16 | 0 | 72 | 0.44 |
| 247 | 0 | 67 | 0.40 | 0 | 26 | 0.16 | 1 | 73 | 0.44 |
| 249 | 0 | 67 | 0.40 | 0 | 26 | 0.16 | 1 | 74 | 0.44 |
| 250 | 0 | 67 | 0.40 | 0 | 26 | 0.15 | 1 | 75 | 0.45 |
| 251 | 0 | 67 | 0.40 | 0 | 26 | 0.15 | 1 | 76 | 0.45 |
| 253 | 0 | 67 | 0.39 | 0 | 26 | 0.15 | 1 | 77 | 0.45 |
| 254 | 1 | 68 | 0.40 | 0 | 26 | 0.15 | 0 | 77 | 0.45 |
| 255 | 0 | 68 | 0.40 | 1 | 27 | 0.16 | 0 | 77 | 0.45 |
| 256 | 0 | 68 | 0.39 | 1 | 28 | 0.16 | 0 | 77 | 0.45 |
| 257 | 0 | 68 | 0.39 | 1 | 29 | 0.17 | 0 | 77 | 0.44 |
| 259 | 0 | 68 | 0.39 | 0 | 29 | 0.17 | 1 | 78 | 0.45 |
| 261 | 0 | 68 | 0.39 | 0 | 29 | 0.16 | 1 | 79 | 0.45 |
| 262 | 1 | 69 | 0.39 | 0 | 29 | 0.16 | 0 | 79 | 0.45 |
| 266 | 0 | 69 | 0.39 | 0 | 29 | 0.16 | 1 | 80 | 0.45 |
| 267 | 1 | 70 | 0.39 | 0 | 29 | 0.16 | 0 | 80 | 0.45 |
| 268 | 0 | 70 | 0.39 | 0 | 29 | 0.16 | 1 | 81 | 0.45 |
| 271 | 1 | 71 | 0.39 | 0 | 29 | 0.16 | 0 | 81 | 0.45 |
| 272 | 0 | 71 | 0.39 | 0 | 29 | 0.16 | 1 | 82 | 0.45 |
| 273 | 1 | 72 | 0.39 | 0 | 29 | 0.16 | 0 | 82 | 0.45 |
| 274 | 0 | 72 | 0.39 | 0 | 29 | 0.16 | 1 | 83 | 0.45 |
| 275 | 0 | 72 | 0.39 | 0 | 29 | 0.16 | 1 | 84 | 0.45 |
| 276 | 0 | 72 | 0.39 | 0 | 29 | 0.16 | 1 | 85 | 0.46 |
| 277 | 0 | 72 | 0.39 | 1 | 30 | 0.16 | 0 | 85 | 0.45 |
| 280 | 0 | 72 | 0.38 | 0 | 30 | 0.16 | 1 | 86 | 0.46 |
| 281 | 1 | 73 | 0.39 | 0 | 30 | 0.16 | 0 | 86 | 0.46 |
| 283 | 1 | 74 | 0.39 | 0 | 30 | 0.16 | 0 | 86 | 0.45 |
| 284 | 0 | 74 | 0.39 | 0 | 30 | 0.16 | 1 | 87 | 0.46 |
| 286 | 0 | 74 | 0.39 | 0 | 30 | 0.16 | 1 | 88 | 0.46 |
| 288 | 0 | 74 | 0.38 | 0 | 30 | 0.16 | 1 | 89 | 0.46 |
| 289 | 0 | 74 | 0.38 | 0 | 30 | 0.15 | 1 | 90 | 0.46 |
| 291 | 0 | 74 | 0.38 | 0 | 30 | 0.15 | 1 | 91 | 0.47 |
| 292 | 0 | 74 | 0.38 | 0 | 30 | 0.15 | 1 | 92 | 0.47 |
| 293 | 0 | 74 | 0.38 | 1 | 31 | 0.16 | 0 | 92 | 0.47 |
| 294 | 0 | 74 | 0.37 | 0 | 31 | 0.16 | 1 | 93 | 0.47 |
| 295 | 0 | 74 | 0.37 | 0 | 31 | 0.16 | 1 | 94 | 0.47 |
|   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|
| 303 | 0 | 74 | 0.37 | 0 | 31 | 0.16 |
| 305 | 1 | 75 | 0.37 | 0 | 31 | 0.15 |
| 306 | 0 | 75 | 0.37 | 0 | 31 | 0.15 |
| 309 | 0 | 75 | 0.37 | 1 | 32 | 0.16 |
| 310 | 1 | 76 | 0.37 | 0 | 32 | 0.16 |
| 311 | 0 | 76 | 0.37 | 0 | 32 | 0.16 |
| 312 | 0 | 76 | 0.37 | 1 | 33 | 0.16 |
| 313 | 0 | 76 | 0.37 | 0 | 33 | 0.16 |
| 314 | 0 | 76 | 0.37 | 1 | 34 | 0.16 |
| 315 | 0 | 76 | 0.36 | 0 | 34 | 0.16 |
| 316 | 1 | 77 | 0.37 | 0 | 34 | 0.16 |
| 317 | 0 | 77 | 0.36 | 0 | 34 | 0.16 |
| 319 | 0 | 77 | 0.36 | 1 | 35 | 0.17 |
| 320 | 0 | 77 | 0.36 | 1 | 36 | 0.17 |
| 321 | 0 | 77 | 0.36 | 1 | 37 | 0.17 |
| 323 | 0 | 77 | 0.36 | 0 | 37 | 0.17 |
| 324 | 0 | 77 | 0.36 | 1 | 38 | 0.18 |
| 325 | 0 | 77 | 0.35 | 1 | 39 | 0.18 |
| 327 | 0 | 77 | 0.35 | 0 | 39 | 0.18 |
| 328 | 0 | 77 | 0.35 | 0 | 39 | 0.18 |
| 329 | 0 | 77 | 0.35 | 1 | 40 | 0.18 |
| 330 | 1 | 78 | 0.35 | 0 | 40 | 0.18 |
| 331 | 1 | 79 | 0.36 | 0 | 40 | 0.18 |
| 332 | 0 | 79 | 0.35 | 0 | 40 | 0.18 |
| 334 | 1 | 80 | 0.36 | 0 | 40 | 0.18 |
| 339 | 0 | 80 | 0.36 | 0 | 40 | 0.18 |
| 340 | 1 | 81 | 0.36 | 0 | 40 | 0.18 |
| 342 | 1 | 82 | 0.36 | 0 | 40 | 0.18 |
| 344 | 0 | 82 | 0.36 | 0 | 40 | 0.18 |
| 347 | 1 | 83 | 0.36 | 0 | 40 | 0.18 |
| 348 | 0 | 83 | 0.36 | 1 | 41 | 0.18 |
| 349 | 0 | 83 | 0.36 | 0 | 41 | 0.18 |
| 350 | 0 | 83 | 0.36 | 0 | 41 | 0.18 |
| 351 | 0 | 83 | 0.36 | 0 | 41 | 0.18 |
| 352 | 0 | 83 | 0.35 | 0 | 41 | 0.18 |
| 353 | 0 | 83 | 0.35 | 0 | 41 | 0.17 |
| 354 | 1 | 84 | 0.36 | 0 | 41 | 0.17 |
| 356 | 1 | 85 | 0.36 | 0 | 41 | 0.17 |
| 357 | 1 | 86 | 0.36 | 0 | 41 | 0.17 |
| 358 | 0 | 86 | 0.36 | 0 | 41 | 0.17 |
| 359 | 1 | 87 | 0.36 | 0 | 41 | 0.17 |
| 360 | 0 | 87 | 0.36 | 1 | 42 | 0.17 |
| 362 | 1 | 88 | 0.36 | 0 | 42 | 0.17 |
|   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|
| 363 | 1 | 89 | 0.37 | 0 | 42 | 0.17 | 0 |
| 366 | 1 | 90 | 0.37 | 0 | 42 | 0.17 | 0 |
| 367 | 0 | 90 | 0.37 | 0 | 42 | 0.17 | 1 |
| 368 | 0 | 90 | 0.37 | 0 | 42 | 0.17 | 1 |
| 369 | 0 | 90 | 0.36 | 1 | 43 | 0.17 | 0 |
| 371 | 0 | 90 | 0.36 | 0 | 43 | 0.17 | 1 |
| 372 | 0 | 90 | 0.36 | 1 | 44 | 0.18 | 0 |
| 373 | 0 | 90 | 0.36 | 0 | 44 | 0.18 | 1 |
| 374 | 1 | 91 | 0.36 | 0 | 44 | 0.18 | 1 |
| 375 | 0 | 91 | 0.36 | 1 | 45 | 0.18 | 0 |
| 377 | 0 | 91 | 0.36 | 1 | 46 | 0.18 | 0 |
| 378 | 0 | 91 | 0.36 | 0 | 46 | 0.18 | 1 |
| 379 | 0 | 91 | 0.36 | 0 | 46 | 0.18 | 1 |
| 381 | 0 | 91 | 0.36 | 0 | 46 | 0.18 | 1 |
| 383 | 1 | 92 | 0.36 | 0 | 46 | 0.18 | 0 |
| 384 | 0 | 92 | 0.36 | 0 | 46 | 0.18 | 1 |
| 385 | 1 | 93 | 0.36 | 0 | 46 | 0.18 | 0 |
| 386 | 1 | 94 | 0.36 | 0 | 46 | 0.18 | 0 |
| 387 | 0 | 94 | 0.36 | 0 | 46 | 0.18 | 1 |
| 388 | 0 | 94 | 0.36 | 0 | 46 | 0.18 | 1 |
| 389 | 0 | 94 | 0.36 | 0 | 46 | 0.17 | 1 |
| 391 | 0 | 94 | 0.36 | 0 | 46 | 0.17 | 1 |
| 394 | 0 | 94 | 0.35 | 0 | 46 | 0.17 | 1 |
| 395 | 0 | 94 | 0.35 | 0 | 46 | 0.17 | 1 |
| 396 | 0 | 94 | 0.35 | 0 | 46 | 0.17 | 1 |
| 398 | 0 | 94 | 0.35 | 0 | 46 | 0.17 | 1 |
| 400 | 1 | 95 | 0.35 | 0 | 46 | 0.17 | 0 |
| 401 | 0 | 95 | 0.35 | 0 | 46 | 0.17 | 1 |
| 403 | 0 | 95 | 0.35 | 1 | 47 | 0.17 | 0 |
| 404 | 0 | 95 | 0.35 | 0 | 47 | 0.17 | 1 |
| 405 | 0 | 95 | 0.35 | 0 | 47 | 0.17 | 1 |
| 407 | 1 | 96 | 0.35 | 0 | 47 | 0.17 | 0 |
| 408 | 1 | 97 | 0.35 | 0 | 47 | 0.17 | 0 |
| 410 | 0 | 97 | 0.35 | 0 | 47 | 0.17 | 1 |
| 411 | 1 | 98 | 0.35 | 0 | 47 | 0.17 | 0 |
| 413 | 1 | 99 | 0.36 | 0 | 47 | 0.17 | 0 |
| 414 | 0 | 99 | 0.35 | 0 | 47 | 0.17 | 1 |
| 416 | 0 | 99 | 0.35 | 0 | 47 | 0.17 | 1 |
| 418 | 1 | 100 | 0.36 | 0 | 47 | 0.17 | 0 |
| 419 | 0 | 100 | 0.35 | 0 | 47 | 0.17 | 1 |
| 420 | 0 | 100 | 0.35 | 0 | 47 | 0.17 | 1 |
| 421 | 0 | 100 | 0.35 | 1 | 48 | 0.17 | 0 |
| 422 | 0 | 100 | 0.35 | 0 | 48 | 0.17 | 1 |
|   |   |   |   |   |   |   |
|---|---|---|---|---|---|
| 423 | 0 | 100 | 0.35 | 0 | 48 | 0.17 |
| 424 | 1 | 101 | 0.35 | 0 | 48 | 0.17 |
| 425 | 0 | 101 | 0.35 | 0 | 48 | 0.17 |
| 426 | 0 | 101 | 0.35 | 0 | 48 | 0.17 |
| 429 | 1 | 102 | 0.35 | 0 | 48 | 0.17 |
| 432 | 1 | 103 | 0.35 | 0 | 48 | 0.16 |
| 435 | 0 | 103 | 0.35 | 0 | 48 | 0.16 |
| 437 | 0 | 103 | 0.35 | 0 | 48 | 0.16 |
| 438 | 0 | 103 | 0.35 | 0 | 48 | 0.16 |
| 439 | 0 | 103 | 0.35 | 0 | 48 | 0.16 |
| 440 | 1 | 104 | 0.35 | 0 | 48 | 0.16 |
| 443 | 1 | 105 | 0.35 | 0 | 48 | 0.16 |
| 444 | 1 | 106 | 0.36 | 0 | 48 | 0.16 |
| 445 | 1 | 107 | 0.36 | 0 | 48 | 0.16 |
| 447 | 1 | 108 | 0.36 | 0 | 48 | 0.16 |
| 448 | 0 | 108 | 0.36 | 0 | 48 | 0.16 |
| 449 | 0 | 108 | 0.36 | 1 | 49 | 0.16 |
| 450 | 0 | 108 | 0.36 | 0 | 49 | 0.16 |
| 451 | 1 | 109 | 0.36 | 0 | 49 | 0.16 |
| 452 | 1 | 110 | 0.36 | 0 | 49 | 0.16 |
| 454 | 1 | 111 | 0.36 | 0 | 49 | 0.16 |
| 456 | 0 | 111 | 0.36 | 0 | 49 | 0.16 |
| 457 | 1 | 112 | 0.36 | 0 | 49 | 0.16 |
| 458 | 0 | 112 | 0.36 | 0 | 49 | 0.16 |
| 461 | 1 | 113 | 0.36 | 0 | 49 | 0.16 |
| 462 | 0 | 113 | 0.36 | 0 | 49 | 0.16 |
| 463 | 0 | 113 | 0.36 | 1 | 50 | 0.16 |
| 464 | 0 | 113 | 0.36 | 0 | 50 | 0.16 |
| 465 | 0 | 113 | 0.36 | 0 | 50 | 0.16 |
| 466 | 1 | 114 | 0.36 | 0 | 50 | 0.16 |
| 467 | 1 | 115 | 0.36 | 0 | 50 | 0.16 |
| 469 | 1 | 116 | 0.37 | 0 | 50 | 0.16 |
| 472 | 0 | 116 | 0.36 | 0 | 50 | 0.16 |
| 474 | 0 | 116 | 0.36 | 0 | 50 | 0.16 |
| 475 | 0 | 116 | 0.36 | 1 | 51 | 0.16 |
| 476 | 0 | 116 | 0.36 | 0 | 51 | 0.16 |
| 477 | 0 | 116 | 0.36 | 0 | 51 | 0.16 |
| 479 | 1 | 117 | 0.36 | 0 | 51 | 0.16 |
| 480 | 0 | 117 | 0.36 | 0 | 51 | 0.16 |
| 482 | 0 | 117 | 0.36 | 0 | 51 | 0.16 |
| 483 | 0 | 117 | 0.36 | 1 | 52 | 0.16 |
| 484 | 1 | 118 | 0.36 | 0 | 52 | 0.16 |
| 485 | 0 | 118 | 0.36 | 0 | 52 | 0.16 |
|   |    |    |    |    |    |    |    |    |    |
|---|---|---|---|---|---|---|---|---|---|
| 487| 1 | 119 | 0.36 | 0 | 52 | 0.16 | 0 | 158 | 0.48 |
| 488| 0 | 119 | 0.36 | 1 | 53 | 0.16 | 0 | 158 | 0.48 |
| 489| 1 | 120 | 0.36 | 0 | 53 | 0.16 | 0 | 158 | 0.48 |
| 491| 1 | 121 | 0.36 | 0 | 53 | 0.16 | 0 | 158 | 0.48 |
| 492| 0 | 121 | 0.36 | 0 | 53 | 0.16 | 1 | 159 | 0.48 |
| 493| 0 | 121 | 0.36 | 0 | 53 | 0.16 | 1 | 160 | 0.48 |
| 494| 1 | 122 | 0.36 | 0 | 53 | 0.16 | 0 | 160 | 0.48 |
| 495| 0 | 122 | 0.36 | 1 | 54 | 0.16 | 0 | 160 | 0.48 |
| 497| 1 | 123 | 0.36 | 0 | 54 | 0.16 | 0 | 160 | 0.47 |
| 498| 0 | 123 | 0.36 | 0 | 54 | 0.16 | 1 | 161 | 0.48 |
| 499| 0 | 123 | 0.36 | 0 | 54 | 0.16 | 1 | 162 | 0.48 |
| 501| 0 | 123 | 0.36 | 0 | 54 | 0.16 | 1 | 163 | 0.48 |
| 502| 1 | 124 | 0.36 | 0 | 54 | 0.16 | 0 | 163 | 0.48 |
| 503| 0 | 124 | 0.36 | 0 | 54 | 0.16 | 1 | 164 | 0.48 |
| 504| 0 | 124 | 0.36 | 1 | 55 | 0.16 | 0 | 164 | 0.48 |
| 505| 0 | 124 | 0.36 | 1 | 56 | 0.16 | 0 | 164 | 0.48 |
| 506| 1 | 125 | 0.36 | 0 | 56 | 0.16 | 0 | 164 | 0.48 |
| 507| 0 | 125 | 0.36 | 1 | 57 | 0.16 | 0 | 164 | 0.47 |
| 508| 0 | 125 | 0.36 | 0 | 57 | 0.16 | 1 | 165 | 0.48 |
| 512| 1 | 126 | 0.36 | 0 | 57 | 0.16 | 0 | 165 | 0.47 |
| 513| 0 | 126 | 0.36 | 0 | 57 | 0.16 | 1 | 166 | 0.48 |
| 514| 0 | 126 | 0.36 | 0 | 57 | 0.16 | 1 | 167 | 0.48 |
| 517| 0 | 126 | 0.36 | 0 | 57 | 0.16 | 1 | 168 | 0.48 |
| 519| 1 | 127 | 0.36 | 0 | 57 | 0.16 | 0 | 168 | 0.48 |
| 520| 0 | 127 | 0.36 | 0 | 57 | 0.16 | 1 | 169 | 0.48 |
| 521| 0 | 127 | 0.36 | 1 | 58 | 0.16 | 0 | 169 | 0.48 |
| 522| 1 | 128 | 0.36 | 0 | 58 | 0.16 | 0 | 169 | 0.48 |
| 524| 0 | 128 | 0.36 | 0 | 58 | 0.16 | 1 | 170 | 0.48 |
| 525| 1 | 129 | 0.36 | 0 | 58 | 0.16 | 0 | 170 | 0.48 |
| 526| 1 | 130 | 0.36 | 0 | 58 | 0.16 | 0 | 170 | 0.47 |
| 527| 0 | 130 | 0.36 | 0 | 58 | 0.16 | 1 | 171 | 0.48 |
| 529| 1 | 131 | 0.36 | 0 | 58 | 0.16 | 0 | 171 | 0.48 |
| 530| 0 | 131 | 0.36 | 0 | 58 | 0.16 | 1 | 172 | 0.48 |
| 531| 0 | 131 | 0.36 | 1 | 59 | 0.16 | 0 | 172 | 0.48 |
| 534| 0 | 131 | 0.36 | 0 | 59 | 0.16 | 1 | 173 | 0.48 |
| 535| 1 | 132 | 0.36 | 0 | 59 | 0.16 | 0 | 173 | 0.48 |
| 537| 0 | 132 | 0.36 | 0 | 59 | 0.16 | 1 | 174 | 0.48 |
| 538| 0 | 132 | 0.36 | 0 | 59 | 0.16 | 1 | 175 | 0.48 |
| 540| 0 | 132 | 0.36 | 1 | 60 | 0.16 | 0 | 175 | 0.48 |
| 542| 0 | 132 | 0.36 | 0 | 60 | 0.16 | 1 | 176 | 0.48 |
| 543| 1 | 133 | 0.36 | 0 | 60 | 0.16 | 0 | 176 | 0.48 |
| 544| 1 | 134 | 0.36 | 0 | 60 | 0.16 | 0 | 176 | 0.48 |
| 545| 0 | 134 | 0.36 | 0 | 60 | 0.16 | 1 | 177 | 0.48 |
|   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|
| 549 | 0 | 134 | 0.36 | 0 | 60 | 0.16 | 1 | 178 | 0.48 |
| 551 | 0 | 134 | 0.36 | 0 | 60 | 0.16 | 1 | 179 | 0.48 |
| 553 | 0 | 134 | 0.36 | 1 | 61 | 0.16 | 0 | 179 | 0.48 |
| 554 | 0 | 134 | 0.36 | 0 | 61 | 0.16 | 1 | 180 | 0.48 |
| 555 | 1 | 135 | 0.36 | 0 | 61 | 0.16 | 0 | 180 | 0.48 |
| 556 | 1 | 136 | 0.36 | 0 | 61 | 0.16 | 0 | 180 | 0.48 |
| 559 | 0 | 136 | 0.36 | 0 | 61 | 0.16 | 1 | 181 | 0.48 |
| 561 | 1 | 137 | 0.36 | 0 | 61 | 0.16 | 0 | 181 | 0.48 |
| 562 | 1 | 138 | 0.36 | 0 | 61 | 0.16 | 0 | 181 | 0.48 |
| 565 | 1 | 139 | 0.36 | 0 | 61 | 0.16 | 0 | 181 | 0.48 |
| 567 | 0 | 139 | 0.36 | 0 | 61 | 0.16 | 1 | 182 | 0.48 |
| 568 | 1 | 140 | 0.37 | 0 | 61 | 0.16 | 0 | 182 | 0.48 |
| 570 | 0 | 140 | 0.36 | 0 | 61 | 0.16 | 1 | 183 | 0.48 |
| 573 | 0 | 140 | 0.36 | 0 | 61 | 0.16 | 1 | 184 | 0.48 |
| 575 | 1 | 141 | 0.37 | 0 | 61 | 0.16 | 0 | 184 | 0.48 |
| 576 | 1 | 142 | 0.37 | 0 | 61 | 0.16 | 0 | 184 | 0.48 |
| 578 | 0 | 142 | 0.37 | 0 | 61 | 0.16 | 1 | 185 | 0.48 |
| 582 | 1 | 143 | 0.37 | 0 | 61 | 0.16 | 0 | 185 | 0.48 |
| 583 | 0 | 143 | 0.37 | 1 | 62 | 0.16 | 0 | 185 | 0.47 |
| 584 | 0 | 143 | 0.37 | 0 | 62 | 0.16 | 1 | 186 | 0.48 |
| 585 | 0 | 143 | 0.36 | 1 | 63 | 0.16 | 0 | 186 | 0.47 |
| 586 | 0 | 143 | 0.36 | 0 | 63 | 0.16 | 1 | 187 | 0.48 |
| 587 | 1 | 144 | 0.37 | 0 | 63 | 0.16 | 0 | 187 | 0.47 |
| 588 | 1 | 145 | 0.37 | 0 | 63 | 0.16 | 0 | 187 | 0.47 |
| 589 | 0 | 145 | 0.37 | 1 | 64 | 0.16 | 0 | 187 | 0.47 |
| 590 | 1 | 146 | 0.37 | 0 | 64 | 0.16 | 0 | 187 | 0.47 |
| 591 | 0 | 146 | 0.37 | 0 | 64 | 0.16 | 1 | 188 | 0.47 |
| 593 | 1 | 147 | 0.37 | 0 | 64 | 0.16 | 0 | 188 | 0.47 |
| 594 | 0 | 147 | 0.37 | 0 | 64 | 0.16 | 1 | 189 | 0.47 |
| 596 | 0 | 147 | 0.37 | 1 | 65 | 0.16 | 0 | 189 | 0.47 |
| 598 | 0 | 147 | 0.37 | 0 | 65 | 0.16 | 1 | 190 | 0.47 |
| 599 | 0 | 147 | 0.36 | 1 | 66 | 0.16 | 0 | 190 | 0.47 |
| 601 | 1 | 148 | 0.37 | 0 | 66 | 0.16 | 0 | 190 | 0.47 |
Appendix G: Permission Letter from American Association of State Highway and Transportation Officials

May 25, 2018

Luisa Schülke
14 Penobscot Trail
Narragansett, RI 02882

Dear Ms. Schülke,

This is in response to your recent email requesting permission to reproduce Figures 3-28 and 3-30 from the 2011 edition of the AASHTO publication *A Policy on Geometric Design of Highways and Streets* and include both of those figures in your master's thesis at the University of Rhode Island.

You have AASHTO's permission to use both of the aforementioned excerpts. Please note that this authorization applies only to your master's thesis. In addition, please insert the following language or something similar with each excerpt:

*From A Policy on Geometric Design of Highways and Streets, 2011, by the American Association of State Highway and Transportation Officials, Washington, D.C. Used with permission.*

If you have any questions about this letter, please do not hesitate to contact me at bcullen@aashto.org or 202-624-8918.

Sincerely,

Robert Cullen
Information Resource Manager
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