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ROADSIDE GRADING GUIDANCE - PHASE I

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16. Abstract (Limit: 200 words)

Provisions for the design of roadside foreslopes are not readily available. As a result, engineering judgment is often employed. Unfortunately, this can lead to inconsistent designs, where, inevitably, some designs will be too costly and other designs will be too dangerous. Therefore guidance has been compiled to lend consistency to the design of these foreslopes while maintaining the most economical and safe design.

This guidance was prepared after conducting a benefit-cost analysis using the Roadside Safety Analysis Program (RSAP). A large test matrix was developed in an attempt to simulate the most possible scenarios, leaving interpolation to a minimum. However, before the analysis could be run, the severity indices associated with foreslopes needed to be updated to accurately reflect vehicle damage and injury levels caused during an encroachment occurring at an average impact speed. Current indices are overestimated because they were based on a survey given out to highway safety officials who were most likely biased toward high-speed accidents. More data is being collected and will be added to the results of this report in phase two.

To update the severity indices, accident data from the State of Ohio was analyzed using a program called Global Mapper, which allowed the user to measure topographical features, such as foreslopes, heights, and offsets. A method to account for underreported accidents on flat slopes is presented as well. Finally, equations for determining accident cost as a function of the traffic volume are given in conjunction with examples that demonstrate the use of these equations.

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1 INTRODUCTION

1.1 Problem Statement

Engineering judgment is used to design foreslopes. As a result, very little consistency exists amongst engineers. Because of this inconsistency, an engineer may call for a slope that is flatter than is required or call for a guardrail when one is not needed. To determine the best course of action, a benefit-cost analysis would be required. Tools to conduct benefit-cost analyses exist, such as the Roadside Safety Analysis Program (RSAP), but it can be cumbersome to apply to every possible highway scenario and difficult to implement amongst engineers statewide. With shrinking budgets, it has become expedient to develop a systematic approach to designing roadside geometries and safety appurtenances that economically create a safe environment.

A previous study was conducted that estimated the severity of crashes involving roadside embankments, but the accuracy of that study is questionable [1]. The Roadside Design Guide (RDG) associated these encroachments with a severity index. However, these severity indices appear to be overestimated since they were determined from engineering judgment alone and were primarily based on high-speed impacts [2, 3]. More accurate severity indices need to be incorporated into RSAP to establish correct accident costs associated with a crash that involves roadside slopes.

In addition, many run-off-road accident types are possible and include collisions with fixed objects, embankments, and ditches with a single vehicle of multiple vehicles. This research applies to single-vehicle run-off-road accidents only, which comprise approximately 5 percent of all run-off-road accidents types, according to accident data from 2008 [4]. This is demonstrated graphically in Figure 1. The remaining accident types were considered to be outside the scope of this project and should be analyzed using alternative methods. In addition, the run-off-road rate fluctuation was only considered in a general sense. If the run-off-road rate is significantly higher than expected, creating a "black spot," than alternative methods to those presented in this research should be considered.

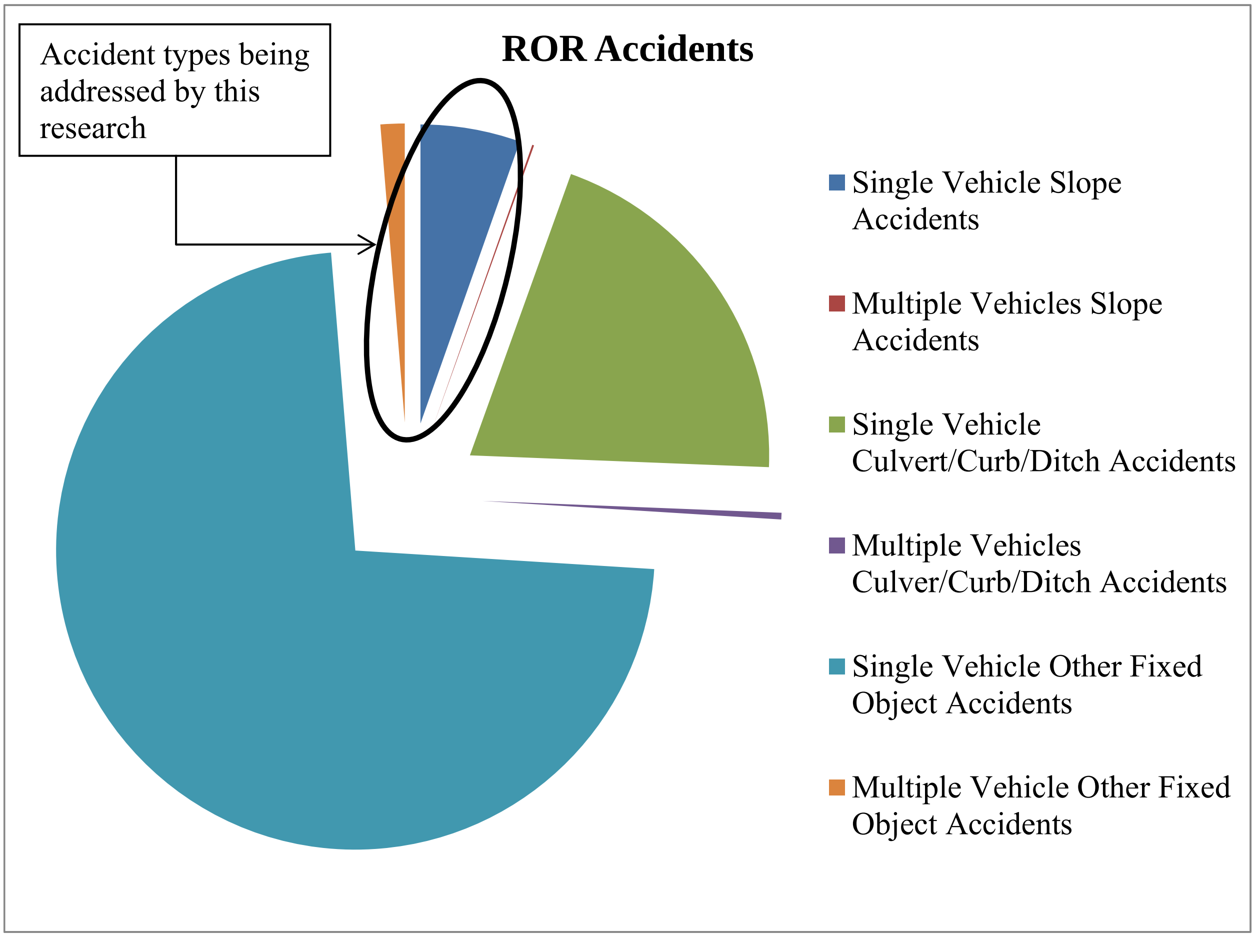

Figure 1. Run-Off-Road Accident Types [4]

1.2 Objective

The objectives of this research study were as follows: (1) estimate severity indices of foreslopes using real-world accident data; (2) develop a relationship between the accident cost and traffic volume for several roadside configurations; and (3) develop a deterministic program using Microsoft Excel to predict the accident costs and benefit-cost ratios associated with various design alternatives.

1.3 Scope

The research objectives were achieved through the completion of several tasks. First, the severity indices associated with roadside embankments were updated to accurately predict accident costs. Next, an extensive test matrix was constructed for use in RSAP by varying parameters that were most likely to influence accident costs. Next, the results from the RSAP analyses were used to create equations for any scenario that could predict the accident cost, which in turn could be used in a benefit-cost analysis. Finally, a Microsoft Excel program was created to facilitate a quick and simple way to calculate accident costs associated with a particular roadside slope crash scenario.

2 LITERATURE REVIEW

2.1 Highway Safety

Vehicular fatalities in the United States have historically remained relatively constant, despite an ever-growing number of vehicular miles traveled. However, in 2009, the number of fatalities was 30,797 which was nearly 7,000 less than in 2007, and more than 3,000 less than in 2008 [5]. This decrease marks the largest of its kind over the past 15 years. This decrease was the result of several factors including safer vehicle designs, safer roadside designs, and potentially fewer recreational motorists due to rising fuel prices. However, the total number of vehicle miles traveled increased by 5 billion, resulting in a decrease in the number of fatalities per 100 million vehicle miles traveled (1.26 in 2008 to 1.13 in 2009) [5]. Of the 30,797 fatalities in 2009, 18,745 involved a single vehicle, and 9,891 of those fatalities were off the roadway [6]. The number of fatal crashes in which the first harmful event was a collision on an embankment was 1,018 which was 3.3 percent of all fatalities, but the total number of crashes in which the first harmful event was a collision with an embankment was 52,000, which represented only 0.9 percent of all accidents [6]. From this data, embankments were shown to be disproportionately high for fatal accidents. However, the percent of fatalities has decreased slightly from 2008, which had a 3.4 percent fatality rate when a collision with an embankment was the first harmful event [4]. Although the general trend of fatal accidents from year to year is one of improvement, the number of fatalities is still too high, indicating a need for more embankment design guidance based on actual accident data.

2.2 Monte Carlo Simulation Technique

The Monte Carlo method generates data from known probability distributions of important parameters, like encroachment location, speed and angle, vehicle type, and vehicle orientation. This technique allows its user to generate as much data as is required without ever running physical tests. As a result, thousands of simulations can be run in only seconds, generating the average number of impacts, the average speed and angle of the impact, and ultimately, the average accident cost, as determined from the foreslope type and the severity of the impact. However, the actual number of simulations required to produce an indicative result is impossible to estimate beforehand. Instead, a block of simulations (for example 20,000 encroachments) is tested, and the accident cost is determined. Then another block is added, and the accident cost is checked for any changes from the first block. If that change is less than 1 percent (high convergence), the simulation ceases. Otherwise, the process is repeated until the convergence criterion is met. In addition to the end result (accident costs), the randomly generated parameters (encroachment location, speed and angle, vehicle type, and vehicle orientation) are checked for uniformity from one block to the next. This check ensures that the average accident costs are correct and that the simulation does not end too soon [3].

The Monte Carlo simulation technique was used because it is capable of simulating parameters that need to be combined. This combination creates an unpredictable probability distribution. However, the probability distribution of combined parameters is not needed in this technique. Only the distributions of the individual parameters are required. The Monte Carlo method is also very capable of simulating independent parameters. These parameters, vehicle type and vehicle orientation, were selected based on separate random processes. These parameters were considered independent because no conclusive data linked these parameters to other parameters. Dependent parameters must be combined into a common random number generation process. Speed and angle are connected by physical limitations while cornering. Similarly, the location of the encroachment depends on the segment in which the encroachment occurs, the location within the segment, the direction of travel, the lane in which the encroachment originates, and the direction of the encroachment [3].

Each parameter was scaled to be uniformly distributed (except encroachment location). Without this scaling, the probability of some of the severe impact conditions would likely eliminate some fatal or severe accidents from the scenario. Because these events have the largest effect on accident costs, they need to be included. Therefore, a scaling factor was applied to each cell that was assigned to a probability of occurrence for each parameter. Later, the average crash cost was divided by this scale factor to determine an average encroachment cost. This process had no effect on the actual average costs, but it dramatically reduced the effect of over- and under-sampling of the extreme events. The distribution for encroachment location was not scaled because the encroachment may occur at any location along a segment (continuous parameter). Hence, the probability of each location was zero, and the scale factor approached infinity. However, the probability distribution was still uniform since the segment was broken up into equal sub-segments, and each one had the same chance of producing an encroachment.

Random numbers were generated from a linear congruent generator and were used to create encroachment samples. A pseudo-code was created to generate numbers from a start point or seed number [7, 8]. If the same seed number was used, the same random numbers were generated. RSAP uses a dual generator, thus increasing the period of randomness; after which, the numbers were no longer random. Additionally, a shuffling process was used to increase the randomness of the output [9].

A drawback to this random process was that no two runs would be the same, in theory. Output was allowed to vary within the convergence criteria set by the user. Therefore, results cannot be viewed as deterministic. For example, if a benefit-cost (BC) ratio between alternatives

1 and 2, with 1 being the do-nothing alternative, was 2.01, the engineer cannot conclude that it was always better to select alternative 2. The next attempted analysis may yield a BC ratio of 1.99 without changing any parameters.

2.3 Accident Prediction

2.3.1 RSAP

RSAP uses two modules to predict accident events. First, the program must simulate an encroachment based on encroachment frequency data. Second, for each encroachment, RSAP determines if the vehicle will strike any fixed object or slope using the crash prediction module. Once a crash is predicted, it determines the severity of the impact using the crash severity module. From the severity, an average accident cost is determined, which in turn, is used to calculate the BC ratio in the BC analysis.

First, an encroachment must be simulated. A study done by Cooper in the late 1970s was the basis for the encroachment module used in RSAP [10]. However, limitations to this study have forced researchers to modify the results. First, encroachments of less than 13.1 ft (4.0 m) were undetectable due to paved shoulders. The results were reanalyzed after excluding encroachments that extended less than 13.1 ft (4.0 m) laterally. It was estimated that encroachments were underreported by a ratio of 2.466 and 1.878 on two-lane undivided and multi-lane divided highways respectively, and the encroachment frequencies were adjusted upward accordingly [3]. In addition, controlled and uncontrolled encroachments could not be distinguished. Examples of a controlled encroachment include implements of husbandry driving off the pavement or a vehicle pulled over to the side of the road to switch drivers. It was believed that these controlled encroachments were less in number than the uncontrolled encroachments. In fact, a study was done that examined the number of impacts on longitudinal barriers and the number of actual reported accidents. From that study, 60 percent of the accidents were reported to the police [11]. Therefore, the encroachment frequencies were again modified by multiplying the frequency by 0.60 [3]. The results of the Cooper data are shown in Figure 2. Additionally, adjustment factors were applied to the encroachment frequency for horizontal curvature, vertical grade, traffic growth, and any user-defined factor. For sharp curves, steep down grades, and larger traffic growths, the encroachment frequency was enlarged. However, the encroachment frequency was never reduced by any of these factors.

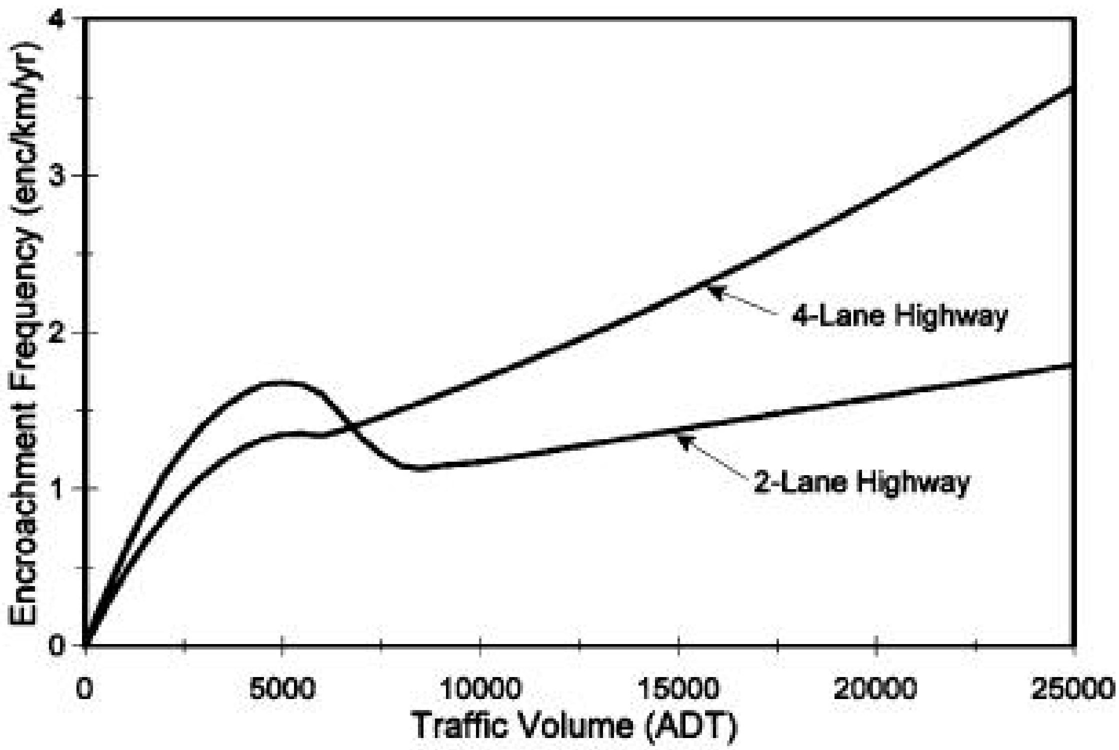

Figure 2. Cooper Encroachment Data [10]

After RSAP predicted an encroachment, it determined if a crash occurred. Not every encroachment resulted in a crash. By using the speed and angle of the encroachment and the hazard layout, the program determined if a hazard was struck, and if so, if the vehicle penetrated through the hazard and struck another hazard. Hazards programmed by the user were sorted by their longitudinal position relative to the beginning of the segment. They were placed on the correct side of the road or in the median and were moved laterally to the specified offset from the edge of the traveled way. Finally, the vehicle swath was determined. Based on the encroachment module, the vehicle speed, direction, and orientation were all simulated using the Monte Carlo method. If any object was in the vehicle swath, a crash was predicted. These objects were equipped with penetration data, such that, if the vehicle had enough energy, it could penetrate through the object and continue on, possibly striking another object. However, this study focused on foreslopes, where no penetration could occur. Therefore, a crash was predicted if the extent of lateral encroachment exceeded the offset to the top edge of the slope.

This module assumed the vehicle maintained a constant angle throughout the event (i.e., a straight line) and a constant orientation. In addition, the vehicle speed did not change as a result of braking. These three assumptions combined into one basic assumption, driver behavior was ignored. This means the driver's attempt to maneuver away from the foreslope or to slow down before reaching the bottom was not considered. In addition, RSAP currently does not modify severity indices based on vehicle orientation, but it would be possible to modify the program to change the severities once it is known how different orientations can affect the severity. In addition to using a straight-line encroachment, RSAP also does not attempt to predict a rollover on foreslopes. This is concerning because as much only 14 percent of all rollovers are caused by striking a fixed object [15]. Currently, RSAP generates a random number that selects the speed and angle of the encroachment, but that angle remains constant throughout the simulation. Under the National Cooperative Highway Research Program (NCHRP) Project 22-27, RSAP is being updated using Visual Basic and Excel [16]. In this updated version, curvi-linear encroachments will be included by randomly selecting one possible encroachment path.

2.3.2 Additional Encroachment Models

Other competing encroachment models exist. First, Hutchinson and Kennedy conducted a study on a stretch of an interstate in Illinois in the 1960s [12]. Their data indicated the same approximate relationship between the traffic volume and the encroachment frequency as Cooper's results. However, new statistical tools had been developed and used by Davis to show that the Hutchinson and Kennedy results were influenced by the weather and by the sampling technique more than the traffic volume [13]. Because the Cooper data and the Hutchinson and Kennedy data show a similar trend, the statistical analysis that Davis used should be applied to Cooper's data as well to see if the encroachment frequency held a dependence on weather or sampling techniques. Miaou proposed another method of predicting encroachment frequencies from accident data taken from single-vehicle, run-off-road (SVROR) accidents in Alabama, Michigan, and Washington [14]. From those accidents, the probability of a SVROR accident occurring for a given roadside could be estimated. By multiplying that probability by the traffic volume, the expected number of accidents for that roadside configuration could be estimated. From this accident model, and by using the traffic volume and length of the roadway segment, the encroachment frequency model was created. These results indicated a monotonic relationship between traffic volume and the encroachment frequency per year per mile, as opposed to the results presented by both Cooper and Hutchinson and Kennedy.

2.3.3 Other Accident Prediction Methods

Zegeer approached accident prediction in a different way by determining a percent reduction in the number of crashes for several roadside features [17]. Of particular note, the effect of sideslopes on single-vehicle accidents and on rollovers was investigated. He concluded that steeper slopes had higher accident rates and that slopes steeper than 1 Vertical: 4 Horizontal (1V:4H), had significantly higher rollover rates than slopes that were 1V:5H or flatter. Even more importantly, slopes that were 1V:3H or steeper had significantly higher single-vehicle accident rates than foreslopes that were 1V:4H or flatter. This trend was also shown in the results outlined in the research contained herein.

Using the same data that Miaou used (Alabama, Michigan, and Washington), Zegeer analyzed 595 accidents and developed an equation that accounted for the steepness of the slope, the lane width, the roadside recovery distance, the traffic volume, and the shoulder width. Using this equation, he developed a table of percent reductions in the number of single-vehicle accidents. These reductions were used to reduce the number of known accidents on one slope to the number of expected accidents on another slope. Zegeer's work was later modified slightly to create crash modification factors (CMF). These factors were first published in the NCHRP Report No. 617 and again in the Highway Safety Manual [18, 19]. Instead of reducing the number of known accidents by 10 percent, the number of known accidents was multiplied by 0.90. The tabulated CMFs that were determined from Zegeer's work and applied to single-vehicle accidents are shown in Table 1.

Table 1. CMFs as Appeared in the Highway Safety Manual [19]

Table 13-19. Potential Crash Effects on Single Vehicle Crashes of Flattening Sideslopes

Treatment	(Road Type)	Traffic Volume	Crash Type (Severity)	CMF				
				Sideslope in Before Condition	Sideslope in After Condition			
					1V:4H	1V:5H	1V:6H	1V:7H
Flatten Sideslopes	Rural (Two-lane road)	Unspecified	Single Vehicle (Unspecified)	1V:2H	0.9	0.85	0.79	0.73
				1V:3H	0.92	0.86	0.81	0.74
				1V:4H		0.94	0.88	0.81
				1V:5H			0.94	0.86
				1V:6H				0.92

Base Condition: Existing sideslope in *before* condition.

2.4 Severity Indices

Glennon and Tamburri may have been among the first researchers to begin studying what would become known as severity indices. Glennon defined a severity index (SI) as "a numerical weighing scheme that ranks roadside obstacles by degree of accident consequence" [20]. Glennon and Tamburri developed an equation for determining the severity of an embankment based on the number of fatal accidents, injury accidents, and property damage only (PDO) accidents [21]. It used a weighted average that placed a large emphasis on fatal accidents and a smaller emphasis on injury accidents, as shown in Equation 1. Other than being included in the equation, no additional emphasis was placed on the PDO accidents.

$$SI = \frac{25\times(fatal\ accidents)+6\times(injury\ accidents)+(PDO\ accidents)}{(total\ accidents)} \tag{1}$$

The results of that study estimated SI values that would be regarded as high in today's transportation safety community since the number of fatal accidents was inflated due to the close proximity of fixed objects and slopes to the edge of the roadway. Since the inception of that study, roadside geometries have been made safer by the implementation of better-performing safety features and the concept of a clear roadside. In addition, these SI values were not in a form commonly used today, which is a scale of 1 to 10, with 10 being fatal. Instead, Glennon's results could exceed 10 if the percentage of fatalities and severe injuries was high.

Weaver, Post, and French began work on severity index estimation in 1975 [1]. Their approach would define severity indices on a set scale from 0 to 10, with 10 representing a 100 percent fatality rate. They also recommended a definition for each severity on the scale that included the percent of PDO accidents, injury accidents, and fatal accidents. These definitions were based primarily on survey response in which participants were asked to rank objects by their severity. This allowed them to estimate severity indices by examining accident reports for various roadside features. They estimated the severity index to be 3.0 on a roadside slope that was, as they described, built up of "sod." No distinction was made between slope steepnesses.

Zegeer and Parker worked to estimate the severity of utility poles [22]. Their work was significant in that it looked at fatal and injury accidents to indicate the severity of the object. In addition to this adjusted approach, they were able to conclude the variability in the number of these extreme accidents was high from state to state.

McFarland and Rollins wanted to validate the definitions set forth by Weaver et al. [23]. To do so, they examined 136,000 accidents between 1978 and 1979 in Texas. From their results, Weaver's recommendations were too high in most cases. However, for trees in particular, Weaver's recommendation was too low. Either way, it was shown that relying on survey responses is not a suitable way to determine accurate and reliable severity indices.

Brogan and Hall conducted a study on fixed objects in New Mexico from 1980 to 1982 [24]. Their primary observation was that the magnitude of the severity index alone was not enough to describe the consequence of striking the object. The exposure of that object was also required. This would allow the researcher to estimate average annual accident costs by multiplying the cost of one accident, according to the severity scale and the associated severity costs, by the accident frequency for any given year.

In 1985, Mak began estimating the relative severity of object impacts based on the percent of fatal (K) and incapacitating injury (A) accidents ((K+A) accidents) [25]. The SI value was relative because the percent of (K+A) accidents at the target site was divided by the percent of (K+A) accidents at all sites. For the purposes of embankments, accident data taken from the National Accident Sampling System (NASS) was used, but no distinction between slope steepness was made.

The 1996 RDG makes use of a set of SI values for many slope and height combinations, as well as for several design speeds [26]. Subsequent editions of the RDG did not publish all severity indices but rather referred to the 1996 edition. Those values were believed to be inaccurate in part because they were based on the design speed and not the impact speed. Because design speed was used, it was possible to get a positive value for an SI when the speed was zero, which is erroneous for any foreslope with a definable slope. RSAP utilizes these severity indices, but the values were modified by passing a line through the origin and the SI values at each speed [3]. The square of the distance between that line and the SI values was minimized, resulting in a linear relationship between impact speed and the severity index. This impact speed was randomly chosen from a speed distribution associated with the functional class; therefore, the engineer does not need to know the impact speed.

The first step in determining new severity indices based on real-world accident data would be to analyze accident reports filed by police officers. Police reports use a 5-level rating scale to describe accidents. This rating system is known as the KABCO scale, and its description is as follows:

- K – Fatal injury
- A – Severe or incapacitating injury
- B – Moderate or non-incapacitating injury
- C – Minor or possible injury, and
- O – Property Damage Only (PDO)

This 5-level scale was used to determine a severity index for any struck object. These indices can range from 0 (no damages) to 10 (100 percent fatality rate). All indices in between were comprised of some percentage of the 5-level scale used in accident reports; however, the injury levels (by percent) were determined by engineering judgment. The resulting breakdown of each severity index is shown in Table 2 and was taken from the 1996 RDG [26].

Table 2. Injury Level Percentages for Each Severity Index [2].

Severity Index (SI)	Injury Level (%)						
	None	PDO1	PDO2	Minor Injury - C	Moderate Injury - B	Severe Injury - A	Fatal - K
0	100.0	-	-	-	-	-	-
0.5	-	100.0	-	-	-	-	-
1	-	66.7	23.7	7.3	2.3	-	-
2	-	-	71.0	22.0	7.0	-	-
3	-	-	43.0	34.0	21.0	1.0	1.0
4	-	-	30.0	30.0	32.0	5.0	3.0
5	-	-	15.0	22.0	45.0	10.0	8.0
6	-	-	7.0	16.0	39.0	20.0	18.0
7	-	-	2.0	10.0	28.0	30.0	30.0
8	-	-	-	4.0	19.0	27.0	50.0
9	-	-	-	-	7.0	18.0	75.0
10	-	-	-	-	-	-	100.0

Wolford and Sicking were able to establish a relationship between impact speed and SI values for varying steepnesses as well [27]. Their work examined approximately 13,700 accidents on embankments alone in the State of Michigan and even more in Utah between the years 1985 and 1992. They established representative foreslopes for rural interstates, rural arterials, and rural collectors, which had foreslopes of 1V:4H, 1V:3.5H, and 1V:2.5H, respectively. In addition, the average depth of these foreslopes was 6.6 ft (2.0 m). Using the percentage of each accident type on the KABCO scale, an average severity was calculated for each foreslope. From the results, additional severity relationships were extrapolated from the three known slope severities for depths of 6.6 ft (2.0 m).

The default version of RSAP (version 2003.04.01) used the severity indices contained in the 1996 RDG, but those values were modified [3]. The modification was imposed to derive the severity index as a function of impact speed. The values listed in the RDG were based on the design speed. To adjust the SI values, a line was passed through the origin and through the SI values at each speed. The square of the distance between the line and each of the points was minimized. The result was a linear relationship between the impact speed and the SI, where an impact speed of zero would produce an SI of zero.

Unfortunately, the validity of the severity indices determined using Table 2 were questionable because they were also determined by survey responses. Recall, McFarland and Rollins showed that Weaver's results were incorrect, and Weaver's results used an injury percentage table very similar to that shown in Table 2. A possible reason for potential errors in these values was most of the accidents included in the survey were biased toward higher speeds. As a result, the average severity indices tend to be overestimated. This means that average accident costs will be over-estimated as well. For use in RSAP, the severity index for each feature is defined as a linear line between 0 and 60 mph (96.6 km/h). This gives a unit of increase in the SI per unit of increase in impact speed. The values below are the values used in

RSAP version released with the 1996 RDG. They were taken from the RSAP User's Manual [28].

Type No.	Description	SI at 0 mph	Rate of Slope	SI at 60 mph
Category 1 = Foreslopes				
7	1V:6H, H >=0.3 m (1 ft)	0.0	0.0286	1.72
9	1V:4H, H 0.3 m (1 ft)	0.0	0.0378	2.27
10	1V:4H, H >=2.0 m (7 ft)	0.0	0.0430	2.58
12	1V:3H, H 0.3 m (1 ft)	0.0	0.0458	2.75
13	1V:3H, H 2.0 m (7 ft)	0.0	0.0578	3.47
14	1V:3H, H 4.0 m (13 ft)	0.0	0.0597	3.58
19	1V:2H, H 0.3 m (1 ft)	0.0	0.0562	3.37
20	1V:2H, H 2.0 m (7 ft)	0.0	0.0778	4.67
21	1V:2H, H 4.0 m (13 ft)	0.0	0.0841	5.05

2.5 RSAP Input Values

Three categories of foreslopes have been defined by the American Association of State Highway Transportation Officials (AASHTO) in the 2006 RDG [2]. They are recoverable, non-recoverable, and critical. A recoverable slope was as a 1V:4H slope or flatter. A motorist can safely and easily traverse a recoverable slope by slowing down or coming to a stop.

A non-recoverable slope can be traversed. When vehicles encroach on non-recoverable slopes, the vehicle will most likely reach the toe of the slope and extend beyond that point. When a barn roof configuration is used, and the non-traversable slope is within the extent of lateral encroachment, clear zone widths must extend beyond the toe of the non-recoverable slope far enough to provide the driver with room to come to a safe stop. The RDG defines slopes between

1V:3H and 1V:4H as non-recoverable [2]. A flat run-out area would be required at the base of non-recoverable slopes even if a barn-roof cross-section was not used.

Critical slopes are likely to cause rollover, which is extremely hazardous even if seatbelts are used. Both the 2006 RDG and the Green Book define this category as 1V:3H or steeper. When vehicles encroach on this slope, they are redirected more laterally, and as a result, they encroach much further beyond the edge of the travelway. To reduce the amount of lateral encroachment and save space in the clear zone width, a barrier is often warranted, provided the traffic volume is large enough to consider treatment. Figure 3 was created to determine when barriers are warranted, given slope conditions and average daily traffic (ADT) [2]. As with non-recoverable slopes, a flat run-out area must be provided beyond the toe of the foreslope for this category.

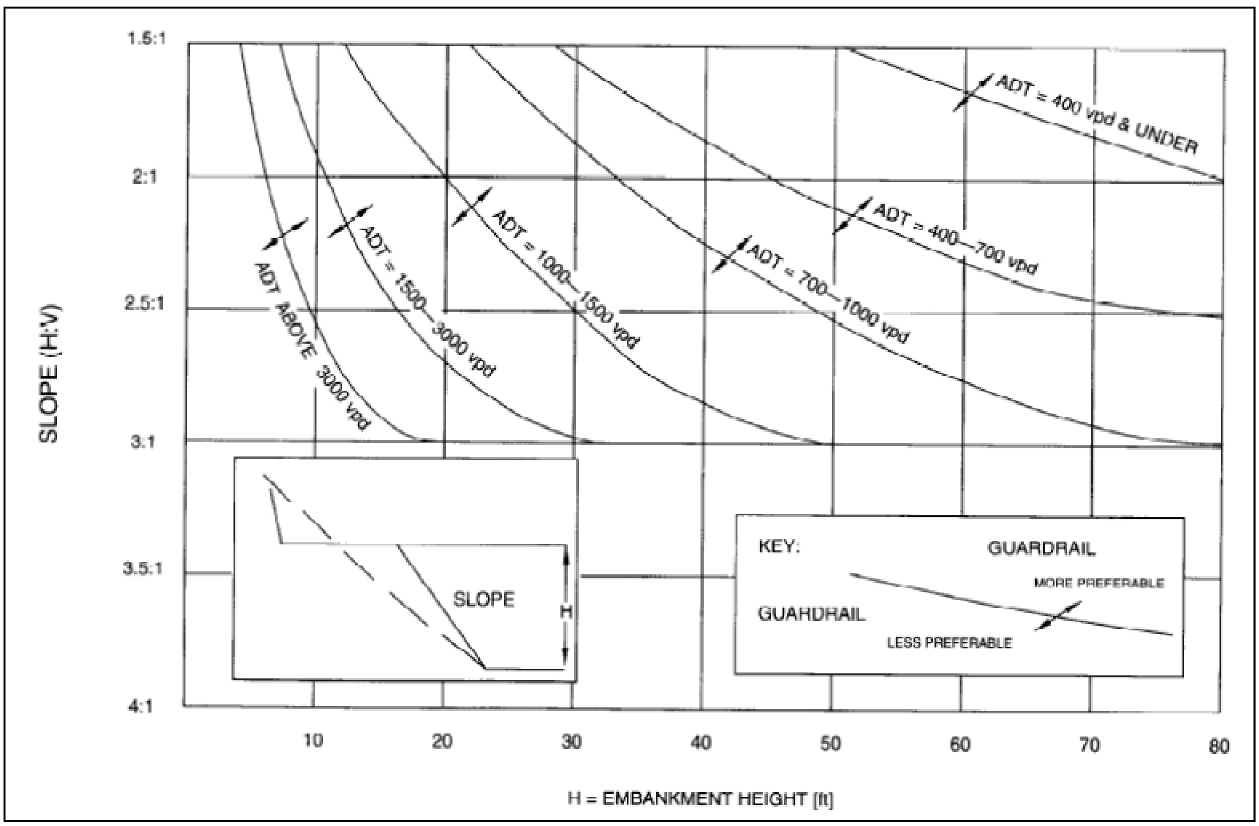

Figure 3. Design Chart for Embankment Warrants Based on Fill Height, Slope, and ADT [2]

Foreslopes are typically given in the form of 1V:4H or 1V:3H, but these values actually represent a range of slopes. In this report, the boundary for a slope was represented by the middle value between adjacent slopes. For example, a 1V:3H slope represents all slopes between 1V:2.5H and 1V:3.5H. Additionally, because a 1V:5H slope was not used, a 1V:4H slope represented slopes between 1V:3.5H and 1V:5H because the next flattest slope was a 1V:6H slope.

In addition to foreslopes, a guardrail system was examined. Two prevailing methods for determining the length-of-need of a guardrail system exist. The first, presented in the 2006 RDG, was based on an encroachment frequency study conducted by Hutchinson and Kennedy [12]. However, this study was likely affected by the unfamiliarity of the motorists to the interstate because the study began when the interstate was just opened. This was supported by the fact that the number of low-angle encroachments was much larger in the study than in similar studies, which indicated the willingness of the motorist to pull over and would be classified as a controlled encroachment, and not relevant to encroachment frequencies used in BC analyses. The large number of the low-angle encroachments erroneously increased the travel length of the vehicle, which in turn erroneously increased the required length-of-need of the guardrail. In addition to the low-angle, controlled encroachments, evidence has recently been presented that shows Hutchinson's and Kennedy's data was affected by time trends and seasonal weather conditions [13]. Instead of a direct link between encroachment frequency and only ADT, the authors of the new study concluded that encroachment frequency was also a function of the weather conditions, with a higher frequency expected in the winter months.

The second method is presented in the NCHRP Report No. 638: Guidelines for Guardrail Implementation [30]. Like the 2006 RDG method, this method relies on encroachment frequency data to conduct a BC analysis. Unlike the 2006 RDG method, this method uses the Cooper encroachment frequency study [10]. This data indicated the same trend in the traffic volume as the Hutchinson and Kennedy data; however, this study was not influenced by driver unfamiliarity. The length of low-angle encroachments was not as long as the corresponding length in the Hutchinson and Kennedy data. Because this length was shorter, the required runout length was shorter, as confirmed in studies conducted by Sicking, Wolford, and Coon [31, 32].

In addition to providing an alternative method for calculating the length-of-need of a guardrail system, NCHRP Report No. 638 can be helpful in determining values for other parameters, such as minimum slopes, maximum degrees of curvature, and maximum grades [30]. In addition, offsets were determined from the minimum shoulder widths, assuming the worst-case scenario would place the slope at minimum distances from the edge of the shoulder. NCHRP Report No. 638 surveyed four states (Iowa, Louisiana, New York, and Oregon) to determine minimum design standards for different functional classes. The results of that survey are shown in Table 3.

Table 3. Minimum Design Standards [30]

Characteristics	Rural Local/ Collector	Rural Arterial	Urban Local/ Collector	Urban Arterial	Freeway
Min. Shoulder Width, ft (m)	2 - 8 (0.6 – 2.4)	4 – 8 (1.2 – 2.4)	6 – 8 (1.8 – 2.4)	6 – 10 (1.8 – 3.0)	8 – 12 (2.4 – 3.7)
Min. Clear Zone, ft (m)	7 – 17 (2.1 – 5.2)	6 – 26 (1.8 – 7.9)	8 – 26 (2.4 – 7.9)	9 – 38 (2.7 – 11.6)	10 – 38 (3.0 – 11.6)
Max. Side Slope	2:1 – 6:1	3:1 – 6:1	3:1 – 4:1	3:1 – 6:1	3:1 – 6:1
Max. Horizontal Curvature (degrees)	5 – 8	3 – 6	7 – 37.5	5 – 10	2 – 3
Max. Grade (percent)	4 – 10	3 – 6	7 – 12	5 – 9	3 – 5

3 RESEARCH APPROACH

An accident report database from the State of Ohio in the year 2000 was used in an attempt to understand the correlation between roadside geometries and accident severities. From this data, a more accurate subset of severity indices was created and integrated into RSAP. A test matrix was constructed to adequately cover possible roadway configurations, and these configurations were analyzed by RSAP. The results from this analysis were used to determine the coefficients of linear equations that could be used to calculate the accident cost as a function of the ADT. The first step was to determine accurate severity indices for foreslopes. A severity index is a number from zero to ten used to estimate the societal cost in the form of property damages, injuries, and fatalities or a combination of the three.

Current severity indices are overestimated because the surveys that were used to determine them were representative of high-speed impacts [3]. As a result, the benefit of improved safety features would be underestimated. This benefit would be observed in the form of reduced societal costs. Therefore, the severity indices must be updated to accurately reflect damages associated with impacts with roadside slopes. This was completed using data taken from the Highway Safety Information System (HSIS) for Ohio. This data included accident locations, highway names and classifications (such as State Route, U.S. Route, or Interstate), county name, number of vehicles involved in the accident, accident location (on or off the road), number of passengers, accident severities (on a 1-5 scale, with 1 being fatal), first harmful event, and most harmful event. From this database, the accidents were sorted to include SVROR accidents where no fixed objects were struck, and the most harmful event was an impact with a slope or embankment. To do so, the HSIS Guidebook for the Ohio State Data Files was used [37].

In addition to the accident data provided in the HSIS files, cross-sectional measures were taken using the Ohio Geographically Referenced Information Program (OGRIP) and a topographical tool called Global Mapper [38]. The State of Ohio provided data pertaining to the location of highways and county lines in the form of graphical layers. The OGRIP included Light Detection and Ranging (LiDAR) files for 25,000 square foot (2,322.6 square-meter) tiles. These tiles and the state layers for highways and county lines could be read by Global Mapper and were used to locate and measure three-dimensional features, such as the slope and height of the embankment. These measurements were recorded to the nearest tenth (e.g., 1V:3.4H). This was done because Global Mapper records the slope as a percentage to the nearest tenth. For example, the measurement may read 29.4 percent. By dividing 100 by this measurement, the run-to-rise ratio becomes 100:29.4, or 1V:3.4H. The results of these measurements were combined with the HSIS database of accidents to establish a link between accident severities and the roadside geometries.

Slopes can be classified by their steepness. They are described in terms of the ratio of the vertical distance to the horizontal distance. Flat slopes typically have one unit of vertical distance to every six units of horizontal distance (1V:6H), whereas steep slopes are typically steeper than 1V:3H. The results of a preliminary analysis indicated that the severity of the flatter slopes was the same as the severity of the steeper slopes; however, intuition would suggest otherwise. This can be explained by the fact that less severe accidents (which occur mostly on flatter slopes) were not reported. If they had been, the average severity of the flatter slopes would have been reduced. To account for the missing accidents, the number of severe or fatal accidents in each slope category was used to adjust the severity calculations in RSAP by assuming a linear relationship between the number of these extreme accidents and the mileage of each slope category. These slope categories were ranges of slopes derived from the slope classifications of recoverable, nonrecoverable, and critical, as defined in the 2006 RDG [2].

Using trial-and-error, the severity index modification factor used by RSAP was modified until the number of severe or fatal accidents predicted by RSAP matched the accident data found in the HSIS files. Once the severity indices were corrected, roadside configurations were developed and programmed into RSAP. A test matrix was established representing a wide spectrum of possible scenarios. RSAP was allowed to run continuously until all the scenarios were simulated. The results were tabulated and used to develop models that could be used to predict the accident cost directly from the applicable ADT value. The coefficients for these equations are presented in this report. In addition, a Microsoft Excel program was created that automatically calculates an accident cost for any ADT and scenario. This calculation included linear interpolation between two known accident costs at known parameter inputs and linear extrapolation beyond the range of known values.

4 SEVERITY INDICES FOR FORESLOPES

4.1 Problem

Attempts to estimate severity indices (SIs) have been made for many different roadside features, including foreslopes. One prevailing method used to estimate these indices was to survey highway safety officials about accidents in which those officials were asked to rank the severity of accidents on a scale of 1 to 10. Those responses are believed to have been biased towards high-speed accidents, and as a result, the average severity indices were overestimated [3]. In order to conduct an accurate BC analysis on the effect of flattening slopes, these SI values needed to be updated because they have the single largest influence on the accident cost of a given scenario. For example, a severity-index change from 2.52 to 3.23 (a 28.2 percent increase) resulted in an accident-cost change from $38,644.50 to $84,383.90 (a 118.4 percent increase). This problem gave rise to a set of objectives that were partially separate from the original objectives of the research.

4.2 Objectives

First, new SI values were developed based on actual accident data, as opposed to the opinions of safety officials. This objective would not only be necessary for the completion of this research, but it may also be useful in other BC analyses involving roadside foreslopes.

Second, the new SI values were implemented into the BC analysis tool, RSAP, to produce more accurate accident costs, which can be used to determine the cost-effectiveness of flattening a slope.

4.3 Accident Data Description and Analysis

4.3.1 Data Description and Preliminary Analysis

Accident data collected by law enforcement officials in the State of Ohio in the year 2000, recorded in the HSIS, was used to estimate new severity indices for foreslopes. The original data population included 17,948 accidents. These accidents were then filtered to include only SVROR accidents where no fixed object was struck and an embankment or ditch impact was included in at least one impact event, reducing the number of accidents to 1,294. Each accident was assigned a severity value on a scale of 1 to 5 with 1 being fatal and 5 being a PDO accident. The location of the accident was also included in the HSIS and was used to find the site on Global Mapper, at which point, the slopes and heights at each accident location were measured and recorded.

When combining the results of the accident data severities and the cross-sectional measurements, the number of (K+A) accidents per mile per slope-height category could be estimated. To do this, each accident was sorted into one of nine categories. Those categories were developed by combining the slope with the height. Four slopes were chosen to be consistent with RSAP: (1) 1V:2H for critical slopes; (2) 1V:3H for non-recoverable slopes; (3) 1V:4H for recoverable slopes; and (4) 1V:6H, also for recoverable slopes. Three height categories were chosen as well. Short heights were considered less than 4 ft (1.2 m) tall. Medium heights were considered greater than or equal to 4 ft (1.2 m) but less than 10 ft (3.0 m) tall, and tall slopes were considered greater than or equal to 10 ft (3.0 m) tall. The 1V:2H and 1V:3H slopes utilized all three height categories, creating six combinations. The medium and tall heights were combined into one category and used with the short height category for the 1V:4H slope, creating two combinations. Finally, all three height combinations were combined into one category and used with the 1V:6H slope to create the ninth and final combination. These slope-height combinations were chosen to be consistent with the slope-height combinations currently available in RSAP and are illustrated in Table 4.

Table 4. Slope-Height Combinations

Slope \ Height, ft (m)	h < 4 (1.2)	4 (1.2) ≤ h < 10 (3.0)	h ≥ 10 (3.0)
1V:2H	I	II	III
1V:3H	IV	V	VI
1V:4H	VII	VIII	
1V:6H	IX		

The preliminary results suggested that the severity of a non-recoverable slope was approximately the same as the severity of a recoverable slope. Obviously, as the slope steepness increases, the severity should also increase. The discrepancy in this logic can be explained by unreported accidents. Impacts or encroachments on slopes can result in one of four outcomes: (1) the vehicle may return to the roadway without incident; (2) the vehicle may come to a controlled stop; (3) the vehicle may strike some fixed object on or beyond the slope; or (4) the vehicle may rollover [27]. The third possibility was eliminated in this study by filtering out all accidents in which a fixed object was struck. The remaining three were left to influence the severity of the slope; however, the first two possibilities often result in little or no damage. After one of these accidents, the motorist was unlikely to report the accident to authorities. These unreported accidents would have occurred more often on flatter slopes. If they had been reported, the increased number of low-severity accidents would have increased the overall mileage of accidents for each slope category, effectively reducing the number of (K+A) accidents per mile on the recoverable slopes. Instead, the number of (K+A) accidents for recoverable and non-recoverable slopes was within 22 percent of each other whereas the difference between a critical and non-recoverable slope was 41 percent. These results are shown in Table 5. The lengths used in this table were the lengths provided in the accident data. Each accident was given a segment length over which the accident occurred. For filtering purposes, the critical slope range was defined as slopes steeper than 1V:2.5H, and the recoverable slope range was defined as slopes flatter than 1V:3.5H. All slopes between these limits were classified as non-recoverable.

Table 5. Severity Calculations Based Only on Accident Data

Slope Category	Slope Range	#(K+A)	Length, miles (km)	#(K+A)/mile ((#K+A)/km)
Critical	< 2.5H	19	865.0 (1,392.0)	0.02197 (0.01365)
Nonrecoverable	2.5H to 3.5H	7	449.9 (724.1)	0.01556 (0.00097)
Recoverable	> 3.5H	27	2110.6 (3,396.7)	0.01279 (0.00795)

It was believed that the number of miles per slope category was under-represented for recoverable slopes and possibly non-recoverable slopes due to unreported accidents with relatively low severity levels. This length was intended to be a total length for the entire highway system in the State, but due to the limited sample size, many locations throughout the state were not represented in the accident data. In order to more accurately assess the number of (K+A) accidents per mile per slope type, the number of miles of each slope type had to be estimated across the State of Ohio.

4.3.2 Mileage of Slope-Height Combinations

To determine a more representative mileage for each slope category, the entire highway network in Ohio should be examined. The State of Ohio has 12,776 miles (20,561 km) of rural, two-lane highways [37]. In order to determine how those miles are divided up into the slope categories, discretized segments were measured using LiDAR tiles and Global Mapper. This was necessary to determine the slopes and heights of every segment along the highways. These segments would have to be small enough that significant changes in the slope would not be prevalent in one segment. For this research, 100-ft (30.5-m) long segments were used. This would require approximately 677,128 measurements to determine exactly how many miles of each slope type there are on rural, two-lane highways. By assuming optimistically that each measurement takes one minute, it should be obvious that the time demand would be too enormous to consider this approach. Instead, highway segments were taken at random and were assumed to represent the total highway network. From these random samples, the percentage of each slope type could be determined and applied to the total highway length to estimate the mileage for each slope type in Ohio.

In order to model the statewide highway network, 150 segments of rural highways were randomly selected. This was accomplished by using roadway description inventory reports, such as the one shown in Appendix A. These tables were imported into Microsoft Excel, where filters were applied to the data to eliminate urban segments. In addition, interstate highways were filtered out, leaving behind U.S. and State Routes. These highway types were considered because they are similar to typical rural, two-lane highways, which make up the vast majority of the total mileage in Ohio. Once the data was filtered, the total length was 11,393 miles (18,335 km). The difference in this value and the total number of rural, two-lane highway miles was due to the overlapping of some highways. The longer length included some stretches of highways twice because they had two names. The filtered data eliminated repeated data, leaving behind the total number of actual miles. However, some of the highways began and ended within city limits; therefore, these small highways were not filtered out. In addition, no distinction is made between divided and undivided highways. As a result, 150 locations were randomly selected and examined using Google Maps to determine if the highway was acceptable (undivided, rural, two-lane). Of those 150 locations, 130 were acceptable.

Once the filtered data was prepared, the highways were placed end-on-end by summing a cumulative length from the first highway segment to the last. Then a random number was generated between 0 and 11,393. This number was used to select a highway. This process allowed the longer highways to be selected at a greater probability, which allowed the random samples to more accurately model the actual highway distribution. This was imperative because accidents were more likely to occur on long highways than short highways due to the increased exposure, provided the only difference between those highways was their length. Each data entry from the inventory report broke the highway into segments, using landmarks or some other distinguishing features to describe each of those segments. The previously generated random number was also used to select a segment within the highway. However, once the segment was chosen, a new random number had to be generated to determine the starting point for measurements in Global Mapper. As previously mentioned, 100-ft (30.5-m) sub-segments were used for each segment. Those segments measured just over 1 mile (1.61 km) in length or 5,300 ft (1615 m). As a result, a random number was generated between the beginning milepost of the segment and 1 mile (1.61 km) less than the ending milepost for that segment to determine a starting milepost. This ensured that the entire 1-mile (1.61-km) segment would be located in the selected highway. Once those 150 segments were chosen, they were investigated using Google Maps to see if they were in fact rural, two-lane highways. If they did not meet these criteria, they were ignored. Of the 150 segments, 127 were used. This ratio was close to the ratio determined previously (130:150); therefore, the sampling process was considered consistent and representative of undivided, rural, two-lane highways. The used segments were measured the same way the accident data were measured.

Using Global Mapper and the OGRIP database, slope and height measurements were taken along both sides of the highway. This was done because the location of the accidents was unknown. The side of the road the accident occurred on was given in the accident database, but the relative direction of the vehicle prior to the accident was not given. As a result, the encroached side of the roadway could not be ascertained. The side of the road with the steepest slope was associated with the accident. By doing this, the fatal and severe accidents were associated with the steepest slope, which was congruent with the assumption that steeper slopes are more severe than flatter slopes.

To determine if the samples were an adequate model for the entire highway system, the ratio of State to U.S. Routes was compared for the 11,393 miles (18,335 km) and for the 127 miles (204 km). The two ratios were considered approximately equal if the difference was less than 10 percent. Those ratios were 3.34 and 3.10, respectively. This constituted a difference of only 8 percent, and as a result, the samples were considered to be an adequate model.

In addition to determining mileage for each slope category, the mileage for each height category had to be determined. As previously mentioned, each slope category was broken into height categories. The critical and non-recoverable slopes used three heights: short or less than 4 ft (1.2 m), medium or greater than or equal to 4 ft (1.2 m) but less than 10 ft (3.0 m), and tall or greater than or equal to 10 ft (3.0 m). The recoverable slopes were broken into two slope categories: 1V:4H and 1V:6H. For the 1V:4H slope, two heights were used because the medium and tall heights were combined. For 1V:6H slope, all height categories were combined. Finally, to determine the number of miles in each of these nine combinations, the number of miles for the slope-height combination was divided by 254 (the total miles of the sample). This fraction was applied to the total mileage, 11,393 miles (18,335 km), to determine the number of expected miles in each slope-height combination. The results of the estimated mileage are shown in Table 6. To contrast the difference from the previous severity calculations as summarized in Table 5, the recoverable miles increased by 340 percent.

Table 6. Severity Calculations Based on Estimated Mileage

Slope Category	Slope Range	#(K+A)	Length, miles (km)	#(K+A)/mile ((#K+A)/km)
Critical	< 2.5H	19	815.4 (1,312.3)	0.0233 (0.01448)
Nonrecoverable	2.5H to 3.5H	7	1096.5 (1,764.6)	0.00638 (0.00397)
Recoverable	> 3.5H	27	9264.0 (14,909.0)	0.00291 (0.00181)

The recoverable slope was treated differently than the other two slope categories, because it was represented by two slopes. As a result, the total mileage for those two slopes had to be estimated. From the accident data, 38.6 percent of the accidents on recoverable slopes occurred on slopes steeper than 1V:5H, or halfway between 1V:4H and 1V:6H. Once the miles of recoverable slopes was multiplied by the percent of the accidents on recoverable slopes (38.6 percent or 0.386), it was then broken further into the height categories to give the mileage for the 1V:4H slope. The 1V:6H slope mileage was simply 61.4 percent of the total recoverable slope mileage. Using the number of (K+A) accidents determined from the accident data, the number of (K+A) accidents per mile could be estimated for each slope-height combination. These results are shown in Table 7 in US units and Table 8 in SI units.

Table 7. #(K+A) per Mile for Each Slope-Height Combination

<table>
<tr><th rowspan="3">Height</th><th colspan="12">Slope</th></tr>
<tr><th colspan="3">1V:6H</th><th colspan="3">1V:4H</th><th colspan="3">1V:3H</th><th colspan="3">1V:2H</th></tr>
<tr><th>Length (miles)</th><th>#of K+A</th><th>#K+A/ mile</th><th>Length (miles)</th><th>#of K+A</th><th>#K+A/ mile</th><th>Length (miles)</th><th>#of K+A</th><th>#K+A/ mile</th><th>Length (miles)</th><th>#of K+A</th><th>#K+A/ mile</th></tr>
<tr><td>Short</td><td rowspan="3">5688</td><td rowspan="3">18</td><td rowspan="3">0.0032</td><td>2521</td><td>2</td><td>0.0008</td><td>260.1</td><td>0</td><td>0.0000</td><td>235.5</td><td>6</td><td>0.0255</td></tr>
<tr><td>Medium</td><td rowspan="2">1055</td><td rowspan="2">7</td><td rowspan="2">0.0066</td><td>606.9</td><td>2</td><td>0.0033</td><td>175.5</td><td>6</td><td>0.0342</td></tr>
<tr><td>Tall</td><td>229.5</td><td>5</td><td>0.0218</td><td>404.4</td><td>7</td><td>0.0173</td></tr>
</table>

Table 8. #(K+A) per Kilometer for Each Slope-Height Combination

<table>
<tr><th rowspan="3">Height</th><th colspan="12">Slope</th></tr>
<tr><th colspan="3">1V:6H</th><th colspan="3">1V:4H</th><th colspan="3">1V:3H</th><th colspan="3">1V:2H</th></tr>
<tr><th>Length (km)</th><th>#of K+A</th><th>#K+A/ km</th><th>Length (km)</th><th>#of K+A</th><th>#K+A/ km</th><th>Length (km)</th><th>#of K+A</th><th>#K+A/ km</th><th>Length (km)</th><th>#of K+A</th><th>#K+A/ km</th></tr>
<tr><td>Short</td><td rowspan="3">9154</td><td rowspan="3">18</td><td rowspan="3">0.0020</td><td>4057</td><td>2</td><td>0.0005</td><td>418.6</td><td>0</td><td>0.0000</td><td>379</td><td>6</td><td>0.0158</td></tr>
<tr><td>Medium</td><td rowspan="2">1698</td><td rowspan="2">7</td><td rowspan="2">0.0041</td><td>976.8</td><td>2</td><td>0.0020</td><td>282.5</td><td>6</td><td>0.0212</td></tr>
<tr><td>Tall</td><td>369.4</td><td>5</td><td>0.0135</td><td>650.8</td><td>7</td><td>0.0108</td></tr>
</table>

4.3.3 Calculation of New Severity Indices

4.3.3.1 Approach

RSAP utilizes a linear relationship between impact speed and severity. This relationship was used in this research to determine new SI values for foreslopes based solely on the number of (K+A) accidents per mile. The results from taking measurements with Global Mapper and combining the measurements with the accident data were presented in the previous section; however, those results were inconsistent at times owing to the small sample size. As a result, the results had to be modified to produce useable accident rates per mile per slope-height combination. Once that was accomplished, the RSAP SI modification factor was modified by trial-and-error until the simulated number of (K+A) accidents closely matched the modified accident data results. Once those values matched, a new average SI was calculated by RSAP. It should be noted that additional research is ongoing which will increase the sample population size of the accident data.

4.3.3.2 Results

The results of the determination of the number of (K+A) accidents per mile was shown in Table 7, but it had to be modified to account for unexpected discrepancies in the data. For example, the number of (K+A) accidents per mile decreased for the 1V:2H slope from the medium height to the tall height. It is common knowledge that as the height increases, the severity increases as well. The discrepancy was caused by the small sample size. It is expected that as the number of accidents in the database increases by including additional years of data, the number of (K+A) accidents for tall heights would increase relative to the medium heights. An example of the problem of tall heights is shown in Figure 4.

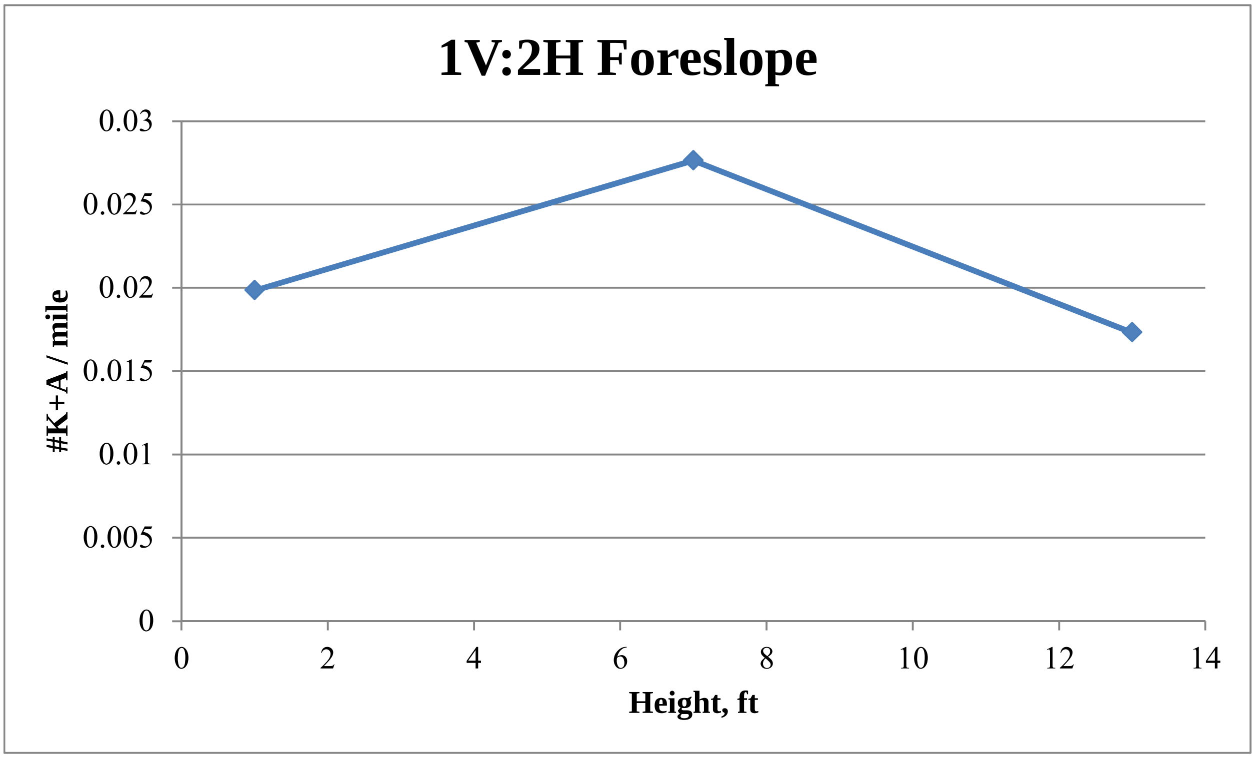

Figure 4. Accident Rate for 1V:2H Slope, Demonstrating Unreliability of Tall Heights

In addition to the height complication, the number of (K+A) accidents decreased from recoverable slopes to non-recoverable slopes. This was because non-recoverable slopes represent a significantly smaller sample of the total mileage of slope steepness. The recoverable slopes flatter than 1V:6H were by far the most common slope type, and because of the increased exposure, were sure to have more accidents of all types. As a result, a monotonically increasing “best-fit” line was passed through the plots of the number of (K+A) accidents verses the slope steepness. This was accomplished by using a logarithmic function as shown in Figure 5. This procedure was applied to short and medium heights but was neglected for tall heights due to the trend shown in Figure 4.

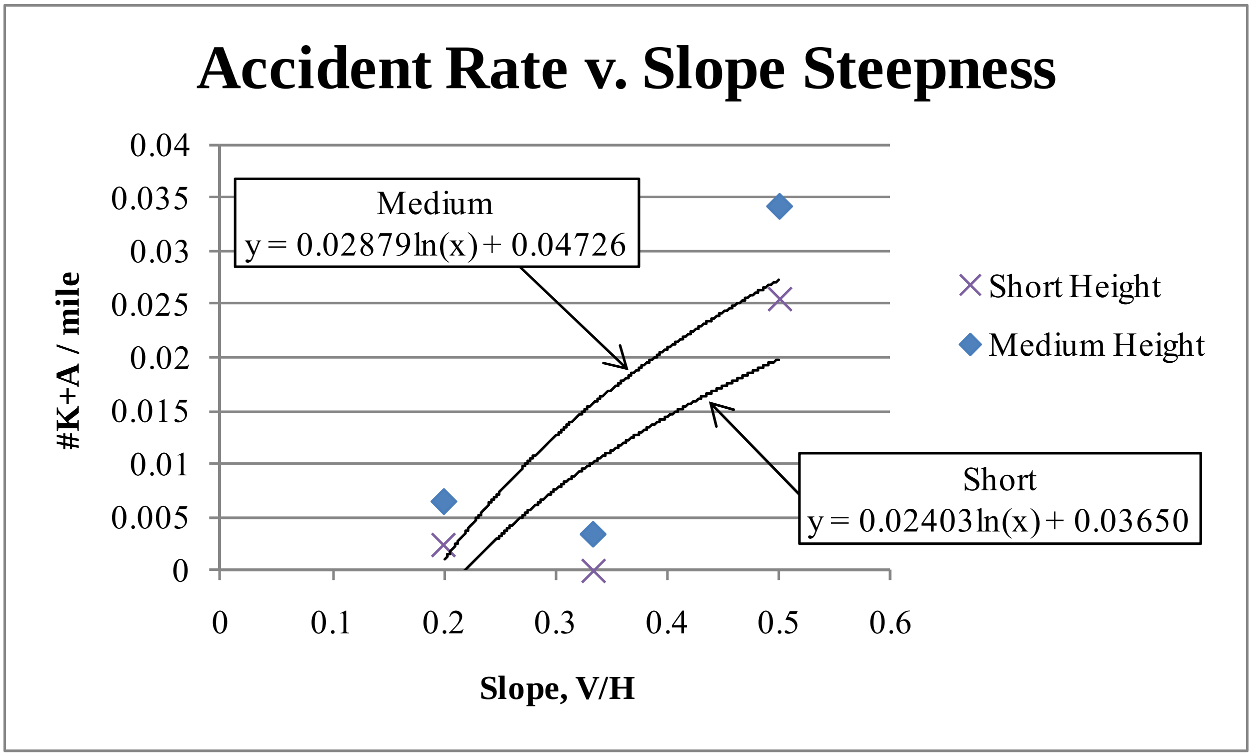

Figure 5. Accident Rate vs. Slope Steepness for Short and Medium Heights

From the logarithmic functions, linear equations were developed by solving for the number of (K+A) accidents for each slope for both the short and medium heights. It was assumed that the short height was 1 ft (0.3 m) and the medium height was 7 ft (2.1 m). This gave two points for each slope, which were then used to construct the slope-intercept equations shown in Equations 2 through 4. These equations were used to determine the number of (K+A) accidents per mile for each slope and height combination, including the tall heights.

$$\varphi_2 = 0.00130h + .01854 \tag{2}$$

$$\varphi_3 = 0.00098h + .00912 \tag{3}$$

$$\varphi_4 = 0.00021h - .00021 \tag{4}$$

Where φ_2, φ_3, and φ_4 are the number of (K+A) accidents per mile for the 1V:2H, 1V:3H, and 1V:4H slopes respectively, and h is the height of the foreslope in feet.

The expected number of (K+A) accidents per mile for the 1V:6H slope was reduced to zero since there were no accidents on heights less than 13 ft (4.0 m). It should be noted that at 1 ft (0.3 m) the number of (K+A) accidents on a 1V:4H slope goes to zero. The reductions on the recoverable slopes may be overestimated, but this overestimation would be conservative because it would reduce the severity of flat slopes in comparison to steeper slopes or guardrail applications, making the flat slopes better alternatives than if default SI values were used. If more data becomes available, the results for the 1V:4H and 1V:6H slope should be revisited. The graphical results of Equations 2 through 4 are shown in Figure 6.

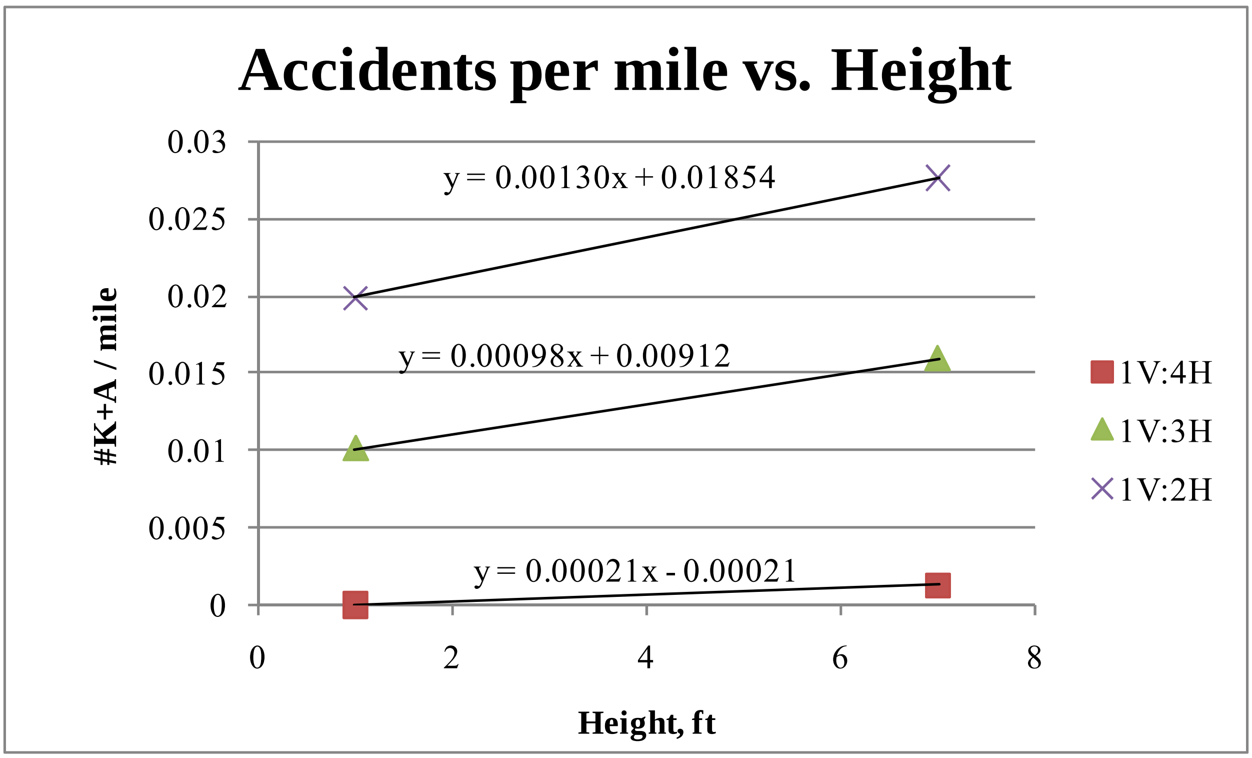

Figure 6. Accident Rates for Foreslopes

Once the expected number of fatal or severe accidents was known, the trial-and-error process began to alter the simulated number of (K+A) accidents. As a stochastic program, RSAP looks to outside data files for some of its input. One of those files contains information for only foreslopes. In that file, a severity index modification factor was set to one by default. By reducing this value, the number of simulated (K+A) accidents would also be reduced, which was required based on the default simulation results and the accident data results. Because of the inexact nature of the Monte Carlo technique, the precision of this factor was carried out to two decimal places. When two adjacent factors (say 0.62 and 0.63) straddled the expected number of (K+A) accidents, the value that yielded the closest result was chosen. This process was repeated for each of the slope-height combinations. The results of this process, including the new SI values, are shown in Table 9, assuming the traffic volume was 10,000 vehicles per day (vpd) on a rural principal arterial, undivided highway with a speed limit of 55 mph (88.5 km/h).

Table 9. SI Values and Modification Factors with #(K+A) Results

Slope	Height (ft)	Default RSAP SI	Default RSAP #K+A per mile	SI Modification Factor	New RSAP SI	DATA #K+A per mile	New RSAP #K+A per mile
1V:6H	Any	1.65	0.00469	0.60	0.98	0.0000	0.0000
1V:4H	1	2.18	0.01597	0.46	1.00	0.0000	0.0000
	7 & 13	2.47	0.02548	0.53	1.31	0.0013	0.0013
1V:3H	1	2.64	0.03458	0.75	1.97	0.0101	0.0102
	7	3.34	0.08077	0.65	2.17	0.0160	0.0157
	13	3.45	0.08987	0.69	2.37	0.0219	0.0218
1V:2H	1	3.24	0.07234	0.71	2.30	0.0198	0.0197
	7	4.48	0.17235	0.56	2.51	0.0276	0.0268
	13	4.84	0.19787	0.55	2.66	0.0354	0.0355

Comparatively speaking, these results were less than the results presented by Wolford and Sicking and the default values of RSAP. This was expected, considering the RSAP results were possibly biased toward higher-speed accidents. For an illustrative comparison of the three sources of SI values, see Figures 7 and 8. These plots were created assuming the embankment height was 7 ft (2.1 m).

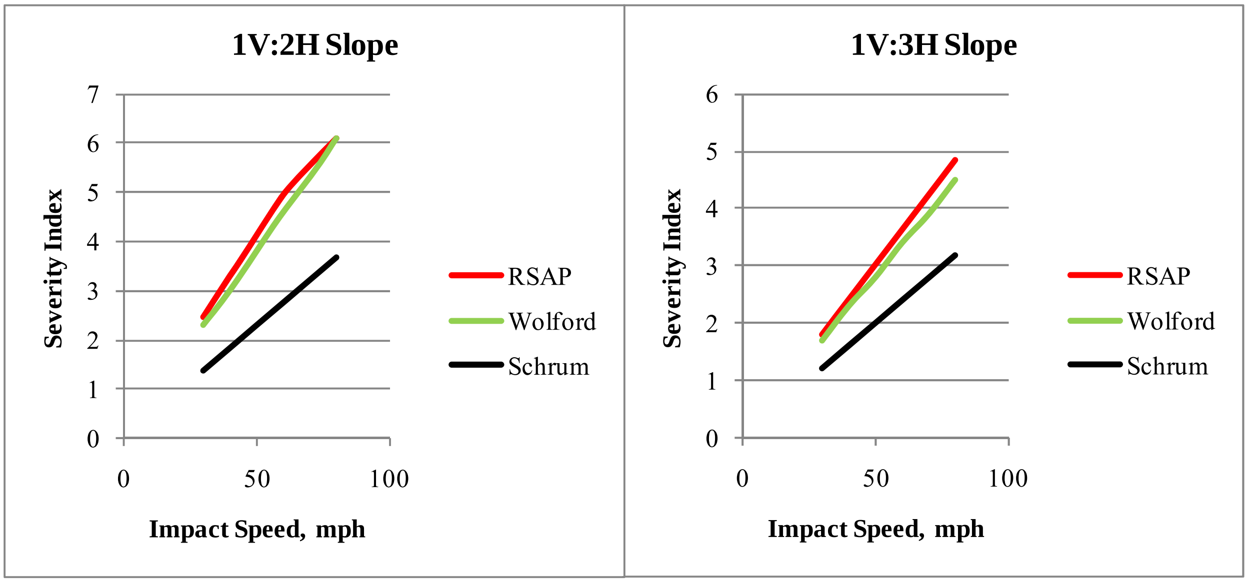

Figure 7. Severity Indices - 1V:2H and 1V:3H Foreslopes

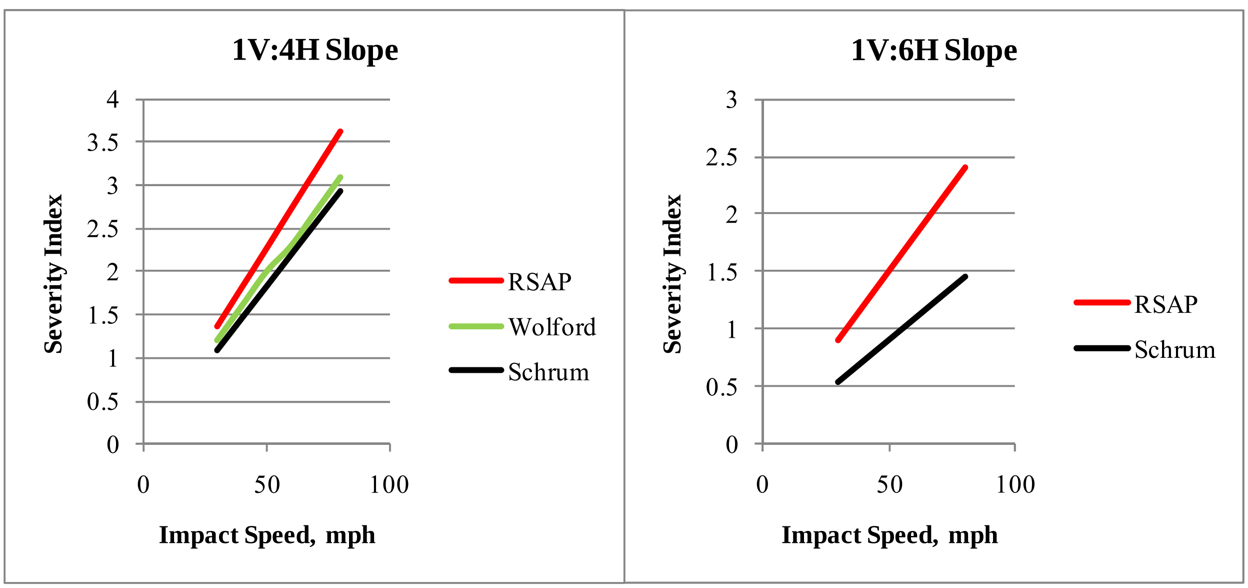

Figure 8. Severity Indices - 1V:4H and 1V:6H Foreslopes

5 SENSITIVITY ANALYSIS

5.1 Analyzed Parameters

Eighteen parameters were evaluated against the baseline condition (shown in Figure 9) to observe the impact of each parameter. The impact of each parameter was converted into a sensitivity index and was used to establish a more refined pool of parameters to vary in the detailed study.

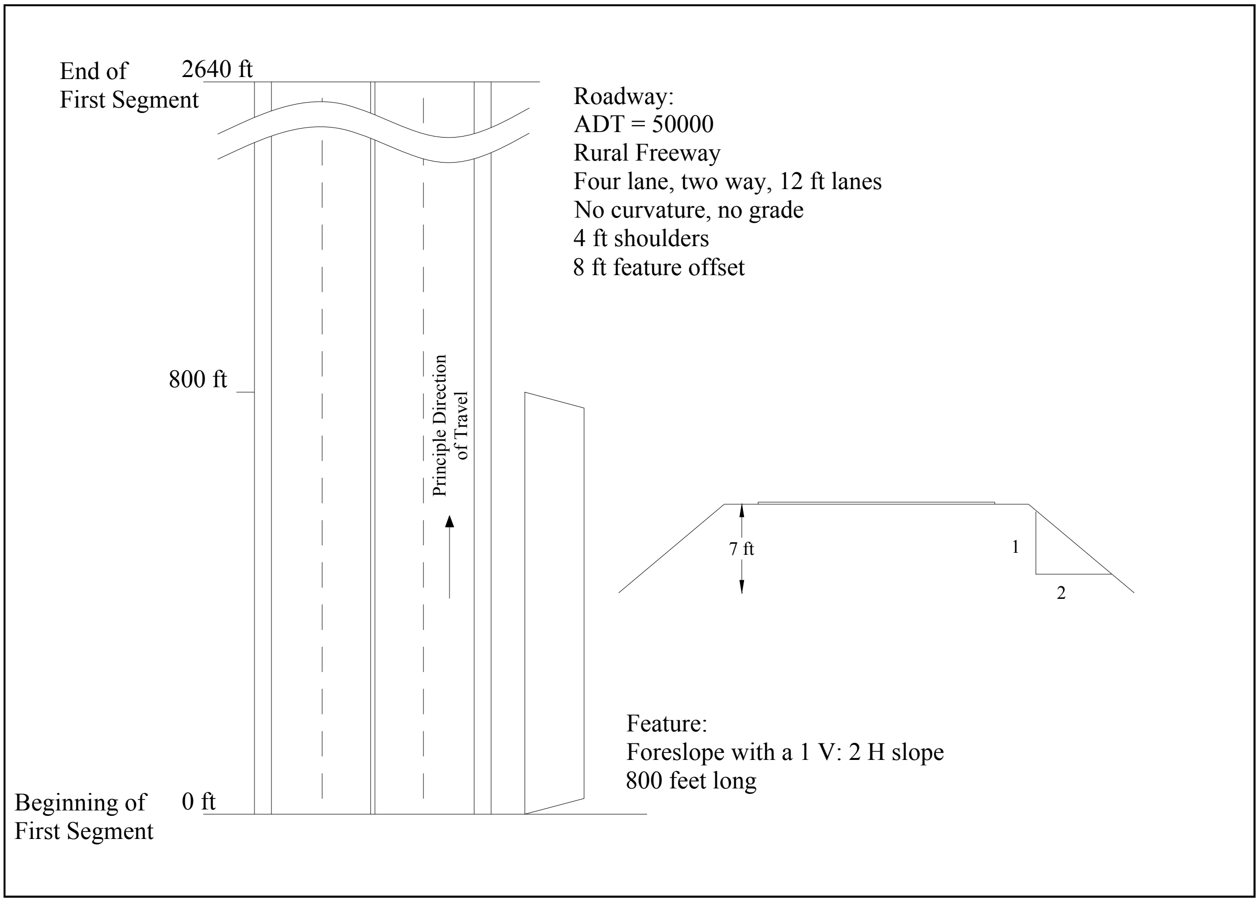

Figure 9. Base Condition for Sensitivity Analysis

The median width was chosen from the barrier warrant diagram given in the 2006 RDG [2]. An average width of 40 ft (12.2 m), or midway between 30 ft (9.1 m) and 50 ft (15.2 m), was chosen. Because this research considered the use of a longitudinal barrier, this barrier warrant was justified. The number of lanes was tested to cover a range of 2 to 6 lanes, which is adequate when dealing with rural local and arterial highways as well as rural freeways. The volume of traffic was varied from 10,000 to 90,000, which, with the exception of local highways, reflects most highway conditions. The degree of curvature was of particular concern, and as a result, the analysis was conducted on an extreme range of possible curvatures. Similarly, the grade of the highway was adjusted to show the impact of both downgrades and upgrades.

All functional classes were analyzed, and it was determined that each had particular impacts on the study. Likewise, the area type (rural or urban) was shown to influence the accident costs, but on a smaller scale. The functional classes and area types were combined in RSAP and were treated as one parameter in the detailed study.

The level of service of a highway represents operating conditions at or near the highway's capacity and are described on an alphabetical scale from "A" to "F," with the latter representing a complete breakdown in flow [39]. The level of service traffic volumes were used to select standard lane and shoulder widths. Typically, lanes are 12 ft (3.7 m) wide. Reducing that width reduces the highway's service volume for an "E" level of service by 13 percent for a width of 10 ft (3.0 m) and 24 percent for a width of 9 ft (2.7 m) [40]. As a result, the parameter study only accounted for a reduced width of 10 ft (3.0 m). To analyze larger widths with the same degree of change, the upper range was represented by a 14-ft (4.3-m) width. Shoulder width was included in this analysis but had little impact and, ultimately, was dropped from consideration. Shoulder widths larger than 6 ft (1.8 m) had no added benefit to service volume, while 2-ft (0.6-m) widths only reduced the capacity service volume by 7 percent at an "E" level of service and a 12-ft (3.7-m) lane width [40].

The traffic growth rate and percent of trucks were estimated by the Wisconsin Department of Transportation (WSDOT) to be approximately 2 percent and 16 percent, respectively [35]. To verify that these parameters could be held as constants, they were analyzed as part of the sensitivity analysis and were found to be inconsequential.

The distance from the edge of the travel way to the obstruction, or offset, was also analyzed. Values for this parameter were small by comparison to the 2006 RDG recommendations for clear zone distances, which can approach 28 ft (8.5 m) on foreslopes [2]. However, in urban areas, no actual requirements are given. A study by the Iowa State University presented results from a survey that indicated a desirable offset of 12 ft (3.7 m) was common in many states [41]. As a result, a 12-ft (3.7-m) offset was chosen as the maximum offset, with 4-ft (1.2-m) increments, making 8 ft (2.4 m) the baseline offset.

For the sake of completeness, the different alternatives and heights were considered in the sensitivity study. The heights were chosen to represent a range of severities. At 1 ft (0.3 m), the severity of a 1V:2H foreslope at 62 mph (100 km/h) was 3.1 on smooth and firm conditions, according to the 1996 RDG. Under the same scenario, the severity indices at 7 ft (2.1 m) and 13 ft (4.0 m) were 4.3 and 4.6, respectively. The change between 1 and 7 ft (0.3 and 2.1 m) was 39 percent while the change between 7 and 13 ft (2.1 and 4.0 m) was only 7 percent. Therefore, these three values represented a vastly changing section of the severity-height plot from 1 ft (0.3 m) to 7 ft (2.1 m) and a vastly unchanging section from 7 ft (2.1 m) to 13 ft (4.0 m). As with the functional class and area type, RSAP combines the alternative and height into one parameter. As expected, the resulting accident costs were significantly different from the baseline accident costs. The parameters examined in the parametric study are outlined in Table 10.

Table 10. Baseline and Parameter Values

Parameter	Baseline	Variations	
Number of Lanes	4	2	6
ADT	50,000	10,000	90,000
Degree of Curvature	0	8 L	8 R
Grade	0	- 6%	+ 6%
Lane Width	12 ft	10 ft	14 ft
Traffic Growth Rate	2.0%	1.5%	2.5%
Percent Trucks	16%	5%	40%
Length of Feature	800 ft	100 ft	1500 ft
Offset	8 ft	4 ft	12 ft
Shoulder Width	4 ft	2 ft	6 ft
Height	7 ft	1 ft	13 ft

5.2 Baseline Accident Cost Determination

The speed limit was set to 55 mph (88.5 km/h) for all conditions. This was the maximum speed that RSAP can use because the speed distributions were based on a study done when the national speed limit was still set at 55 mph (88.5 km/h) [3, 33]. In addition, the average impact speed on interstate highways was approximately 45 mph (72.4 km/h), according to a study completed in 2009 [34]. The higher speed was chosen to represent a larger percentage of possible impacts than the average impact speed. Since 55 mph (88.5 km/h) was the highest allowable speed, it was used. The encroachment rate adjustment factor was set to 1 for all analyses because it is only used in specific situations when the Cooper encroachment data can be substituted with more accurate data. The segment length was set at 2,640 ft (804.7 m) simply to allow for enough space such that the number of encroachments could be accurately modeled. If the length is too small, Monte Carlo simulation may predict zero accidents on that segment, even if the encroachment frequency is not zero. The distance from the beginning of the first segment to the feature was set to 0 arbitrarily. This value was not significant because RSAP automatically places a segment in front of the specified segment in order to predict impacts away from the roadway, even at the beginning of the segment. The width was determined by the height and the slope. For example, on a 1V:3H slope and a height of 7 ft (2.1 m), the width would be 3 x 7 = 21 ft (6.4 m). After inputting the remaining variables given in Table 10 into RSAP and running the program with a high level of convergence, a baseline accident cost report was produced. By rerunning the analysis 200 times with identical input values, as suggested in the RSAP Engineer's Manual, an average cost was determined to be $21,199.67 for all cases, as shown in Table 11.

Table 11. Accident Costs and Percent Differences for Each Parameter

Parameter	Baseline Accident Cost	Variation Accident Cost		Average Percent Difference
Degree of Curvature	$21,199.67	$ 50,245.39	$ 32,193.86	94%
Length of Feature	$21,199.67	$ 3,820.44	$ 39,353.44	84%
ADT	$21,199.67	$ 7,937.52	$ 31,568.47	56%
Grade	$21,199.67	$ 31,779.03	$ 32,129.55	51%
Height	$21,199.67	$ 7,390.78	$ 26,186.20	44%
Offset	$21,199.67	$ 27,441.54	$ 16,063.66	27%
Number of Lanes	$21,199.67	$ 17,206.76	$ 22,883.78	13%
Lane Width	$21,199.67	$ 22,965.74	$ 19,836.64	7%
Traffic Growth Rate	$21,199.67	$ 20,079.64	$ 22,387.09	5%
Shoulder Width	$21,199.67	$ 20,506.61	$ 20,547.96	3%
Percent Trucks	$21,199.67	$ 21,088.98	$ 21,385.30	1%

5.3 Parametric Analysis

Only one parameter from Table 10 was changed at a time, which demonstrated each parameter's impact on the accident cost. Each parameter was analyzed once using RSAP to determine its accident cost. In order to refine the parameter pool, engineering judgment was used to determine which variables were sensitive to change. The sensitivity analysis was conducted to reduce the number of the variables outlined in Table 10 such that the total number of required simulated scenarios could be reduced.

To calculate the effect of changing a parameter, the baseline accident cost was first calculated, as noted in Section 5.2. Then, the accident costs were determined individually for each parameter as it was changed. Finally, the percent difference was calculated for each parameter, effectively measuring the influence of that parameter on the accident cost. Most parameters had two variations to the baseline. As a result, there were two new accident costs and two new percent differences for those parameters. In order to gage the parameter as a whole, the percent differences were averaged together for each parameter, where applicable. These average percent differences are shown in Table 11.

Using engineering judgment, the bottom five parameters shown in Table 11 were excluded. This cutoff point included offset in the analysis but excluded the number of lanes. This was partially due to the fact that as the number of lanes was allowed to increase, the percent difference in accident cost was almost negligible. In addition, some functional classes simply don't use four or more lanes, such as a rural local highway. The percent differences for the remaining parameters indicate a percent difference in accident cost of no more than 7 percent, making them insensitive to change relative to the offset or any highlighted parameter in Table 11.

5.4 Detailed Study Recommendation

The safety treatment alternative and the presence of a median were determined by the functional class independent of the results of the parameter study. The results indicate that those two parameters were in fact sensitive to change; however, they were not subject to the same changes for every functional class. The same alternatives were considered for most highways. The use of these alternative slopes is explained in more detail in Chapter 7. The presence of a median in the highway was dependent on the functional class. Freeways were divided only (median included), and local highways were undivided only (no median). Arterials included both divided and undivided classifications. Therefore, the parameters left to be altered and used to create an RSAP simulation matrix were the length of the feature, height of the embankment, traffic volume, degree of curvature, percent grade, and offset. These parameters are highlighted in Table 11.

6 RSAP ALTERNATIVES

Three safety treatments were considered for this study. They were: (1) do-nothing; (2) slope flattening; and (3) guardrail installation. Each one of these treatments were modeled using RSAP and are described in the following sections.

6.1 "Do Nothing" Condition

Alternatives are compared to a baseline condition known as the "do nothing" condition. The do nothing option consists of applying no safety treatment to the roadside slope. This was done if the direct costs of flattening the slope were too expensive or if the severity of striking a guardrail outweighed the severity of striking the existing slope. For all highways, a minimum slope of 1V:2H was used. However, NCHRP Report No. 638 recommends a minimum slope of 1V:3H on all functional classes except the rural local class [30]. This report used 1V:2H slopes on all functional classes in the event that an existing design incorporated that cross-section.

6.2 Slope Flattening

Soil must be transported to the site and compacted in place. The slope of the roadside is defined by a rise-over-run designation, with the rise always equal to 1 unit. For example, a slope with a rise of 1 unit and a run of 2 units would be designated as 1V:2H. The cost of soil transportation would depend on the distance between the source of the soil and its destination. In some cases, there may be an excavation project nearby, and the cost of fill material would be almost nothing. In contrast, if soil must be transported over a great distance, the cost would have a large negative effect on this alternative's viability. The contractor must compact the soil to meet the specifications set forth by the engineer. This means that the volume of fill to be transported must be larger than the volume of fill required. This volume difference must be accounted for when determining the cost of the material.

In addition to the cost of the fill, the cost to purchase the land immediately adjacent to the roadway must be ascertained. Once again, this cost may fluctuate significantly. Perhaps the state already owns the land, and the cost of the right-of-way (ROW) would be zero; or maybe the adjacent area includes buildings, cultural importance, or environment concerns, which could be a significant or impossible purchase. If the time required to obtain the ROW is the main concern, a cost associated with that time could be added to the total direct costs for used in a benefit-cost anaylsis. Because of the high uncertainty of the costs of this alternative, BC ratios could not be estimated. Instead, only the numerator of the BC ratio could be determined. What is certain is as the slope gets flatter, its safety performance increases.

As a vehicle goes over an embankment, its center of gravity acts through a point outside of the geometric center of the vehicle. Steeper slopes cause the center of gravity to move farther out relative to the vehicle than on flatter slopes. Therefore, as the slope gets steeper, the likelihood of a rollover increases because the lateral component of the weight of the vehicle is larger. For an illustration of this concept, Figure 10 is given. In this figure, a 1V:2H slope and 1V:6H slope are compared. Visually, the lateral component of the weight of the 1V:2H slope is significantly larger than the 1V:6H counterpart. Flatter slopes reduce the severity of each accident because the frequency of a rollover is reduced. As a result, the cost per accident decreases. However, rollover propensity on slopes was not used by RSAP. Instead, severity indices were adjusted for slopes when RSAP was created to account for the possibility of a rollover [3]. For this study, only the slopes that have been pre-programmed into RSAP were used. Those slopes were 1V:2H, 1V:3H, 1V:4H, and 1V:6H.

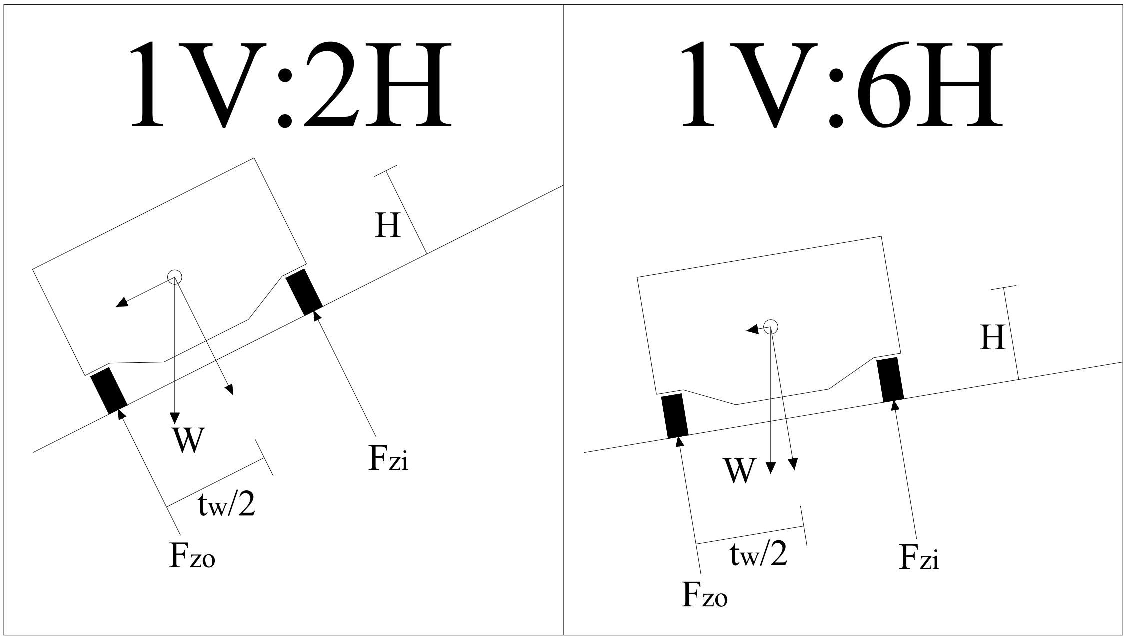

Figure 10. Effect of Slope on Lateral Component of Weight Vector

6.3 Guardrails and Terminals

If slope flattening is not a feasible or economical option, the next alternative design to consider is to shield the existing slope with a guardrail system. This is considered a secondary option because impacts with the guardrail may be more dangerous than simply leaving the slope unprotected. As a vehicle strikes the guardrail, there is a propensity for vehicular instability, which could cause the vehicle to rollover. The vehicle may also vault over the guardrail and traverse the steep slope anyway. It could also be redirected into traffic or snag on rigid posts. Occupant risk may increase in the form of ridedown accelerations or occupant impact velocities. These systems are located closer to the roadway than the edge of the slope. Previous research demonstrated that guardrails can be adequately implemented on slopes as steep as 1V:2H [42]. Despite the ability to place the guardrail system immediately adjacent to the slope, the face of the guardrail is still closer to the roadway. Being closer, the impact probability would increase, as would the accident costs.

The 2006 RDG method for determining the length-of-need was chosen for this research for two reasons. First, it results in conservatively long lengths of guardrail. Second, it is most likely the more common of the two methods. All guardrails and terminals were designed at Test Level 3 (TL-3) in order to safely redirect vehicles at speeds greater than 45 mph (72.4 km/h). The amount of guardrail required to shield the foreslope was determined based on the length of the slope adjacent to the roadway and the offset of this slope from the edge of the roadway. A more detailed description of how the length-of-need was calculated is presented in Section 8.2.

End terminals are required on the ends of most guardrail applications, especially on the end facing the primary direction of travel. In situations where a guardrail is used on the roadside of a divided highway, a terminal may not be required on the downstream end (facing opposing traffic), but in this study, it was included as part of the conservative design. These terminals were entered as TL-3 and were assumed to be 37.5 ft (11.4 m) long by 1.5 ft (0.5 m) wide, based on suggestions in the 2006 RDG [2].

If a different methodology was used to determine the length-of-need of a guardrail, an independent benefit-cost analysis for that alternative would need to be conducted.

6.4 Decision Tree

Usually, striking any obstacle is more hazardous than missing it. Therefore, if flattening a slope is warranted, it should be used. However, if flattening a slope is too expensive to implement, then the use of a longitudinal barrier should be examined. This decision tree is illustrated in Figure 11.

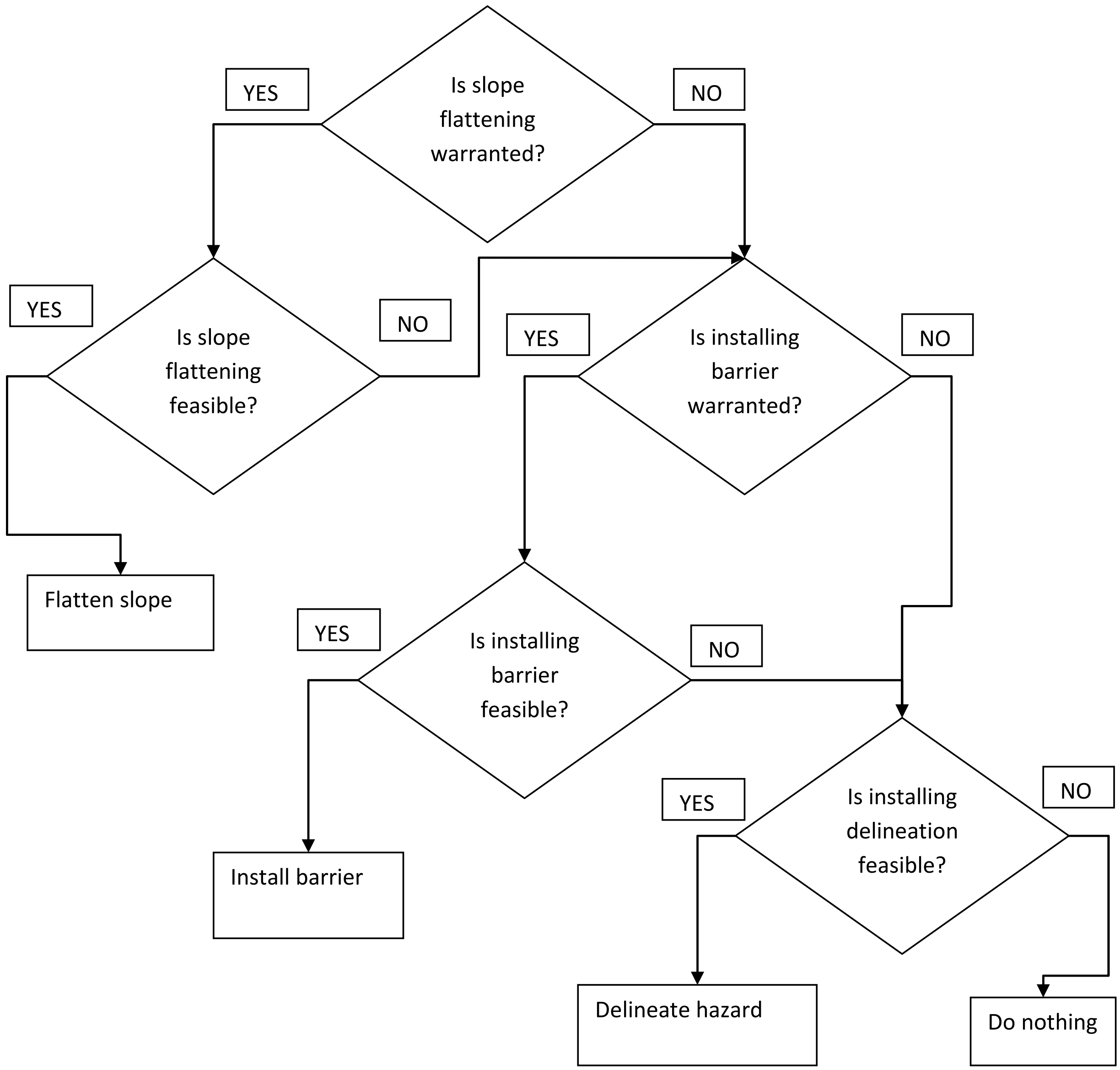

Figure 11. Alternative Decision Tree

7 RSAP INPUT VALUES

7.1 Land Usage

Functional classes are defined differently depending on the land usage (urban or rural) of the highway of interest. Urban areas are located within city limits where the population exceeds 5,000 people [29]. These limits or boundaries are determined by the State or by local officials. Rural areas are locations found outside of urban boundaries.

7.2 Functional Class

This research utilized the following three functional classes: (1) Local, (2) Principal Arterial, and (3) Freeway. Freeways are arterials with full control access. Typically, they support efficient flow of traffic and high traffic volumes (up to 100,000 vpd in this research). Freeways were considered as rural highways with volumes greater than 30,000 vpd, but the speed and angle distribution used by RSAP is identical for rural and urban settings. As a result, the conclusions made with regard to Freeways can be used in both land usages.

Arterials provide high-speed travel between major points, such as cities. This functional class typically makes up the largest portion of a State's highway infrastructure. As a result, many different types of highways, including freeways, can be included in this class. For this research, freeways were considered separately. For notational purposes, principal arterial highways were designated as arterial highways. Volumes on arterials up to 30,000 vpd were used. Principal and minor arterials are also assigned the same speed and angle distributions; therefore, conclusions made with regard to arterials apply to both principal and minor arterial highways. However, the urban arterials and rural arterials utilize differing speed and angle distributions and were considered separately.

Local highways are all roads that are not considered to be freeways, arterials, or collector highways. They support traffic over relatively short distances and serve land adjacent to collector networks. In RSAP, the speed and angle distributions differ for a rural and urban local highway. As a result, they were considered separately. Also, local highways tend to have small traffic volumes. For this research, rural local highways had volumes up to 1,000 vpd, and urban local highways had volumes up to 5,000 vpd.

Collector highways fall between arterial and local highways. Their modeling parameters, such as ADT, are not as clear as the other functional classes. As a result, the engineer is encouraged to classify the collector highway as an arterial or a local highway, based on the traffic volume.

For a more detailed description of this functional classes and land usages, including volume descriptions, the reader should consult with the AASHTO *Geometric Design of Highways and Streets* [29].

7.3 Roadway Geometry Parameters

Parameters characterized by a low sensitivity were assigned a constant value throughout all analyses. The area type was grouped with the functional class (e.g., Rural Freeway) and was treated with the moderately sensitive parameters. Four lanes were used on freeways and divided arterials, but two lanes were used on undivided arterials and local roads. A shoulder width of 8 ft (2.4 m) was also used on all highway types except the freeway. This width was chosen to give law enforcement enough room to pull over to the side of the road, to give maintenance workers enough space, and to provide enough room for motorists to avoid accidents [43]. The shoulder width on a freeway was increased to 12 ft (3.7 m) to account for the increased traffic volume [44]. The location of the slope or guardrail system under examination was assumed to be on the right side of the roadway. Default values of 25 years and 4 percent were used for the design life and discount rate, respectively. The traffic growth rate was estimated to be 2 percent between the years 2010 and 2020 in the State of Wisconsin, and the percent of trucks was set at a constant 16 percent [35].

Features and values used in a detailed study are summarized in Table 12. Offset values were chosen to represent a range of values capable of modeling actual offsets. Similarly, the height of the embankment and the length of the feature were chosen to represent a range of practical values. The grades, degrees of curvature, and slopes were chosen from NCHRP Report No. 638, and they varied depending on the functional class of the highway [30]. This report gave minimum design standards and are shown in Table 3. This table was applicable to the horizontal curvature, and the percent grade.

Table 12. RSAP Input Values

	Rural Local	Urban Local	Rural Arterial	Urban Arterial	Freeway
Degree of Curvature (°)	0, 4, 8L	0, 3, 6L	0, 3, 6L	0, 4, 8L	0, 2, 3L
Grade (%)	0, -4, -8	0, -6, -12	0, -3, -6	0, -3, -6	0, -2, -3
Length of Feature, ft (m)	200 (61.0) 800 (243.8) 1400 (426.7)				
Height, ft (m)	1 (0.3) 7 (2.1) 13 (4.0)				
Offset, ft (m)	2 (0.6) 7 (2.1) 12 (3.7)				

From this information, representative values were chosen that would adequately describe the parameter while reducing the number of required RSAP runs. Three values were chosen for horizontal curvature and percent grade. Those three values were modified per functional class to describe the range shown in Table 3. When possible, the increments between each value were kept equal. For example, the degrees of curvature for a rural local highway were 0, 4, and 8 degrees to the left (L), with the latter representing the absolute maximum value given in NCHRP

Report No. 638. Left curves and downgrades were selected over their counterparts because they represented the worst case for those parameters. By using only the worst case, the results were conservative, and the number of RSAP runs was reduced. The horizontal curvatures and percent grades are summarized in Table 12.

The final three parameters described in Table 12 were constant for each functional class and alternative. Again, three values were used to provide enough data to interpolate at any value while limiting the number of RSAP simulations that were required. Each of the parameters had equal increments between their values. In general, and when extreme values are avoided, the values of these parameters are arbitrary because the results will be used in linear interpolation to determine accident costs at any length, height, or offset. As the length of the feature increased, the accident frequency would increase linearly as well. As a result, the actual values used in RSAP were only significant in the interpolation of the results of the study. The height selection was discussed in the parametric study, and the same values were used in the detailed study. Recall that the 7-ft (2.1-m) height was close to an inflection point in the SI-height plot. The lower height was representative of a high-slope portion of that plot, while the upper height was representative of the low-slope portion of that plot. For the final parameter, offset, values were chosen at relatively close proximity to the roadway. As the offset increases, the accident frequency decreases. In order to capture the effect of a more turbulent region of encroachments, offsets of diminished magnitude were selected.

Backslopes were not considered in this report. Intuitively speaking, at low foreslope heights and high backslope heights, the effect of the backslope may be more pronounced. In this scenario, separate consideration should be given to the dangers associated with the backslope. For reference, the RDG gives preferred cross-sections in a V-ditch. This reference has been available since the 1970's, but very little is known about the safety performance of V-ditches via crash testing. The RDG suggests using slopes on either side of the V-ditch that are flatter than 1V:3H at all times. In fact, if one the two slopes is a 1V:3H slope, the other must be flat. As an illustration, a V-ditch with equal slopes of 1V:4H would not be preferred.

8 DIRECT COSTS

8.1 Required Fill Material for Slope Flattening

Contractors bid on fill obligations by unit of volume, usually cubic yards. The volume of fill required to flatten a slope can be determined for each alternative. The total required volume can be estimated using a cross section similar to the one shown in Figure 12, assuming the existing slope is a 1V:2H.

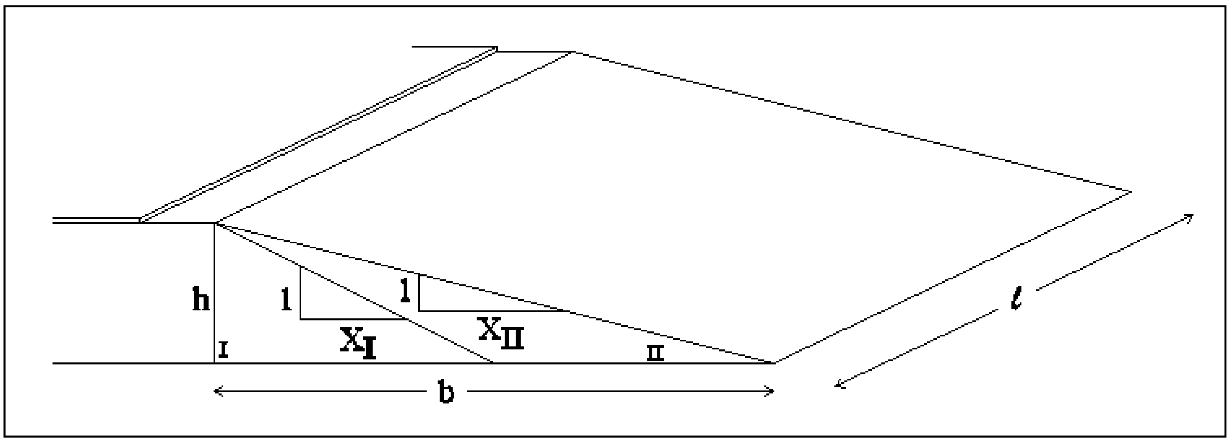

Figure 12. Cross-Sectional Area Required to Flatten Slope on Rural Local Highway

First, the cross-sectional area of the new slope can be determined assuming a right triangle was made and the face of the slope acted as the hypotenuse, as shown in Figure 12. The area of the triangle labeled with a Roman Numeral I can be determined assuming a constant slope of 1V:2H for rural local highways and 1V:3H for all other highway types. This area, A_I, was subtracted from the total area, A, thus determining the required cross sectional area, A_{II}, which can be used to determine the volume needed to flatten a slope. The volume was derived by Equations 5 through 16.

$$A_X = \frac{1}{2} b_2 h \quad (5)$$

$$b_2 = hX_{II} \quad (6)$$

By substituting Equation 6 into Equation 5, the total cross-sectional area of the flattened slope could be determined. This result is shown as Equation 7.

$$A_X = \frac{1}{2} X_{II} h^2 \tag{7}$$

Next, the cross-sectional area of the original slope was calculated. In terms of height and width, this area was given by Equation 8.

$$A_I = \frac{1}{2} b_1 h \tag{8}$$

$$b_1 = h X_I \tag{9}$$

By substituting Equation 9 into Equation 8, the cross-sectional area of the original slope could be determined in terms of the height of the slope. This cross-sectional area of the original slope is shown in Equation 10.

$$A_I = \frac{1}{2} X_I h^2 \tag{10}$$

Next, the cross-sectional area of the fill material needed to create the desired slope was determined in terms of the height and the flattened slope (1V:XH). This general equation is shown in Equation 11.

$$A_{II} = A_X - A_I \tag{11}$$

By substituting Equations 7 and 10 into Equation 11, the final required cross-sectional area in terms of the height and the difference of the two slopes is shown in Equation 12.

$$A_{II} = \frac{1}{2} h^2 (X_{II} - X_I) \tag{12}$$

The volume required to flatten the original slope to the desired slope is calculated by multiplying the length of the slope parallel to the roadway by the area calculated from Equation 12. This fill volume calculation is shown in Equation 13 in terms of the cross-sectional area and in Equation 14 in terms of the height and slope differences of the two slopes.

$$V_{fill} = A_{II} \times l \tag{13}$$

$$V_{fill} = \frac{1}{2} h^2 l (X_{II} - X_I) \tag{14}$$

The volume may need to be adjusted for bulking or shrinking. The shrinkage factor ($\Delta V/V_f$) of soil is a function of the unit weight of the fill material and the cut material.

$$\frac{\Delta V}{V_f} = \left[\frac{(\bar{\gamma}_d)_f}{(\bar{\gamma}_d)_c} - 1\right] \tag{15}$$

Where $(\bar{\gamma}_d)_f$ is the average dry unit weight of fill, and $(\bar{\gamma}_d)_c$ is the average dry unit weight of borrow. The volume of borrow required to satisfy the V_{fill} demand is always at least as much as the V_{fill} and is often more. The equation to calculate the total volume required from a borrow site is shown in Equation 16.

$$V_{borrow} = V_{fill}\left(1 + \frac{\Delta V}{V_f}\right) \tag{16}$$

In addition to the cost of materials, the cost of the right of way may need to be included. In some areas, this may be extremely expensive and force the engineer to abandon the idea of a flatter slope.

8.2 Required Material for a Guardrail System

The variables required to determine the guardrail length-of-need are shown in Figure 13. The tangent length of the barrier immediately upstream of the slope (L_1) was assumed to be 25 ft (7.6 m). This assumption was based on sample designs found in the 2006 RDG [2]. The shy line was defined as the point from the edge of the travel way at which the motorist would not be inclined to reduce the speed or direction of the vehicle. For 55 mph (88.5 km/h), the shyline is located 7.2 ft (2.2 m) from the edge of the travel way [2]. Flared guardrail was used to limit the reaction of a motorist to the guardrail by starting it further away from the road than the straight segment of guardrail. In addition, the use of flared guardrail sections reduces the total length-of-need for the guardrail installation. For scenarios with a guardrail offset of 2 and 7 ft (0.6 and 2.1 m) along the straight segment (inside the shy line), a flare rate of 24:1 was used. Outside the shy line, a flare rate of 16:1 was used. These flare rate recommendations were given in the 2006 RDG [2]. This was represented in Figure 13 as the section of guardrail not parallel to the roadway. To determine the total length of guardrail to be used in RSAP when the length of the terminal is 37.5 ft (11.4 m), which was assumed for all scenarios despite the fact that end terminals vary in length, and to determine the annual cost of installation, the following equations were used:

$$L = 2 \cdot (x - L_1 - 37.5) + l \tag{17}$$

$$x = \frac{(h \cdot S) + (L_1 \cdot F)}{F + \left(\frac{H \cdot S + L_2}{L_R}\right)} \tag{18}$$

Where

$$\text{h} = \text{Height (ft) of the foreslope}$$

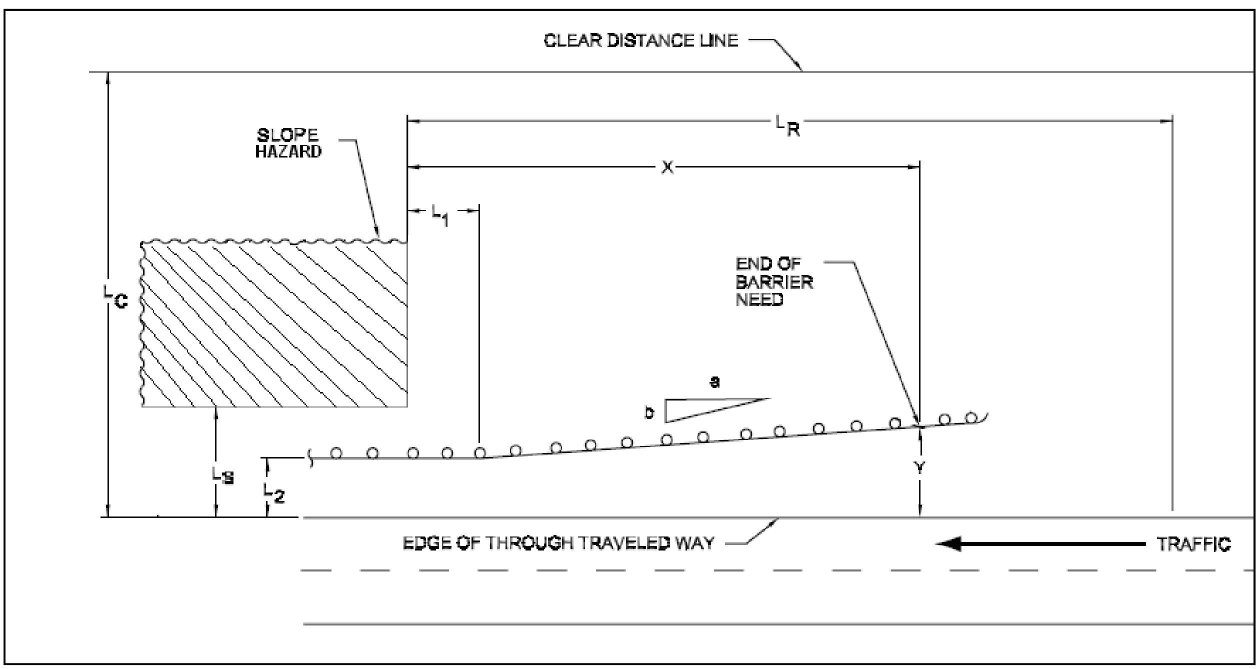

Figure 13. Guardrail Layout Variables

The runout length, L_R, is the distance for a vehicle to come to a stop once it has left the roadway. From the 2006 RDG, it was determined to be 280 ft (85.3 m) for traffic volumes less than 800 vpd, 315 ft (96.0 m) for traffic volumes between 800 and 2,000 vpd, 345 ft (105.2 m) for traffic volumes between 2,000 and 6,000 vpd, and 360 ft (109.7 m) for traffic volumes greater than 6,000 vpd [2]. The run-out length was correlated to the traffic volume because the Hutchinson and Kennedy encroachment data was used to simulate encroachment events, and, in that study, the encroachment frequency was dependent on the traffic volume [12]. Based on the height and slope of the foreslope, the width of the base of the slope was calculated. Given these parameters, basic geometry derived from the plan view was used to determine the lateral offset from the edge of the travel way of each point of interest along the system. This included the beginning of the terminal, the beginning of the guardrail, the end of the first flared section of guardrail, the end of the straight segment of guardrail, and the beginning of the second terminal. These lateral offsets were entered into RSAP.

Terminals were placed at both ends of the guardrail. For a TL-3 condition, many terminals are 37.5 ft (11.4 m) long and 1.5 ft (0.5 m) wide, as suggested by the 2006 RDG [2].

8.3 Annualized Direct Costs

The cost to install a new system or upgrade an existing one needs to be annualized for each alternative. The total cost per year takes into account the design life of the system as well as an interest rate. Equation 19 was used to determine the direct cost of each alternative, which can be used to determine the denominator of the BC ratio.

$$DC = P \cdot \left[\frac{i(1+i)^n}{(1+i)^n - 1}\right] \tag{19}$$

Where

$DC =$ Annualized direct cost to install the system

$P =$ Total cost of material, labor, and right-of-way

$i =$ Interest rate as a decimal

$n =$ Design life (years)

9 ACCIDENT COSTS

9.1 Societal Costs

Once the severity of an accident is determined, the cost of that accident can be calculated. The RSAP simulation determines the probability of an accident resulting in a certain injury level such as death or severe injury. For each level of injury, there is an associated cost.

Accident cost figures can be found from multiple sources including the RDG and the FHWA. The FHWA gives a data set that includes a person's willingness to pay to avoid injury or fatality. Therefore, it is strongly recommended that the FHWA's comprehensive accident cost values be used. However, their values are based on the value of the U.S. dollar in 1994. Those costs were then increased using the Gross Domestic Product (GDP) implicit price deflator for the year 2010. Therefore, those values were adjusted for the year 2010 using Equation 20. These values are given in Table 13.

$$AccCost = P\left[\frac{GDP_{2010}}{GDP_{1994}}\right] \quad (20)$$

Where

$AccCost =$ Accident cost in 2010

$P =$ Societal cost given by the FHWA in 1994

$GDP_i =$ GDP implicit price deflator for the year, i

The GDP implicit price deflator for 1994 and 2010 were 80.507 and 111.141, respectively [45]. To determine the accident costs in years other than 2010, the GDP_{2010} would be replaced by the deflator value for the desired year.

Table 13. FHWA Comprehensive Accident Costs

Accident Type	Accident Costs ($) for 1994	Accident Costs ($) for 2010
Fatal	$ 2,600,000	$ 3,589,335
Severe Injury	$ 180,000	$ 248,492
Moderate Injury	$ 36,000	$ 49,698
Minor Injury	$ 19,000	$ 26,230
Property Damage Only	$ 2,000	$ 2,761

The accident types and associated costs given in Table 13 needed to be converted to an SI range from 0 to 10, with 10 being an absolutely fatal event. This was completed by using the injury level percents shown in Table 2 and the costs given in Table 13. A weighted average method was used. For demonstration, the cost of a severity index 5 is calculated below. The results of this method for all SI's are given in Table 14. For severities between whole numbers, the accident cost can be linearly interpolated from the table.

$$AccCost_{SI=5} = (0.0 \times 2{,}761) + (0.15 \times 2{,}761) + (0.22 \times 26{,}230) +$$
$$(0.45 \times 49{,}698) + (0.10 \times 248{,}492) + (0.08 \times 3{,}589{,}335) = \$340{,}545$$

Table 14. Cost of each SI

Severity Index (SI)	Accident Cost
0	$ 0
0.5	$ 2,761
1	$ 5,554
2	$ 11,210
3	$ 58,920
4	$ 144,705
5	$ 340,545
6	$ 719,551
7	$ 1,167,942
8	$ 1,872,252
9	$ 2,740,209
10	$ 3,589,335

So far, only the unadjusted accident cost has been determined for any SI. The actual accident cost was determined using adjustment factors for the encroachment speed and angle, vehicle orientation, vehicle type, and lane departure/encroachment direction. The adjusted accident cost was then multiplied by the probability of the vehicle encroaching through a given lateral offset. Finally, this analysis was repeated until the resulting average encroachment accident cost converged to within one percent.

9.2 Accident Cost Equations Determined by RSAP

For each considered scenario, there were several traffic volumes simulated to understand the effect of traffic volume on the accident cost. The relationship was approximately linear. However, because the accident cost is a function of the current year's GDP, the impact frequency was used in combination with the severity index to determine the accident cost. For each functional class, a linear regression was conducted in which the regression line was forced through the origin (zero traffic equals zero impact frequency). As a result, a simple y = bx equation could be generated for all scenarios, were y is the impact frequency, b is the slope of the regression line, and x is the traffic volume (ADT). The slope, b, is given with each scenario in the Appendices, and the equation used to determine b is given below as Equation 21. The simulated severity index for each scenario was then used to determine the cost of a single accident on that roadway configuration. This was done using a sixth-degree polynomial that accurately reflects the relationship between severity index and accident cost, as shown in Equation 22. The coefficients of this polynomial were determined using Microsoft Excel and Equation 23. Finally, the cost of a single accident was multiplied by the slope and the traffic volume to determine the accident cost, as shown in Equation 24.

$$b = \frac{\sum x_i y_i}{\sum x_i^2} \tag{21}$$

$$SI_{cost} = c_1(SI)^6 + c_2(SI)^5 + c_3(SI)^4 + c_4(SI)^3 + c_5(SI)^2 + c_6(SI) + c_7 \tag{22}$$

$$c_i = INDEX(LINEST(known\_y's,[known\_x's]^\wedge\{1,2,3,4,5,6\},0),1,i) \tag{23}$$

$$AccCost = b \times ADT \times SI_{cost} \tag{24}$$

Where x_i is the ADT used in the study, y_i is the associated impact frequency, SI is the simulated severity index, known_y's are the cost of each SI from 0 to 10 associated with the current year's GDP, and known_x's are the SI's from 0 to10. For a demonstration of this equation's validity, a plot of the accident cost verses ADT for a 1V:2H foreslope, rural local, straight, four percent grade, 1400-ft (426.7-m) long, 1-ft (0.6-m) high highway with an offset of 7 ft (2.1 m) was created. The slope was calculated by dividing 11,220,313 (xy) by 1,330,625 (x^2) resulting in a quotient of 8.432, as is given in Appendix B. The plot of the accident costs verses ADT and the regression line are shown in Figure 14.

Table 15. Accident Cost Data for a 1V:2H Rural Local Highway

i	x, (ADT)	y, (Impact Frequency)	xy	x^2
1	50	0.0096	0.481	2500
2	75	0.0143	1.076	5625
3	100	0.0187	1.866	10000
4	250	0.0468	11.691	62500
5	500	0.0938	46.877	250000
6	1000	0.1746	174.556	1000000
Sum:			236.547	1330625

Using the GDP implicit price deflator for 2010 (111.141), the costs of each severity index were the same as were presented in Table 14. Using Equation 23, the coefficients of Equation 22 were determined in Microsoft Excel. Those coefficients are given in Table 16. In addition, the simulated severity index for the given scenario was 2.27. Therefore, using Equation 22 and the coefficients in Table 16, the cost of a single accident was $14,822.35. To develop the relationship shown in Figure 14, the accident costs for several traffic volumes were determined by multiplying the slope, b, by the single accident cost and each traffic volume.

Table 16. Coefficients of Equation 22 for the Year 2010

c1	-24.11
c2	585.43
c3	-5288.84
c4	27552.00
c5	-56462.19
c6	40438.19
c7	0.00

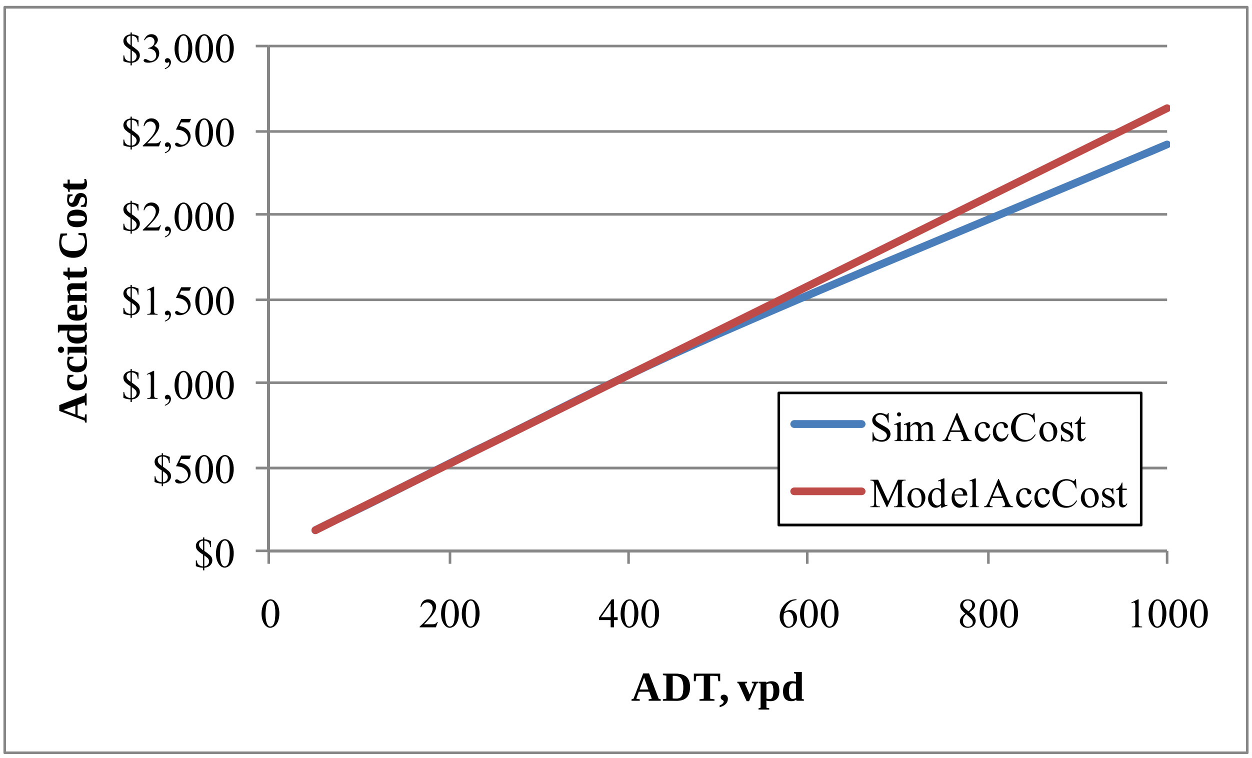

Figure 14. Accident Cost vs. ADT for a 1V:2H Rural Local Highway

9.3 Using the Benefit-Cost Analysis of Foreslopes Program

9.3.1 Background

Looking up values in the appendices of this report can be cumbersome and may lead to errors. In addition, the interpolation between accident costs, when needed, can exponentially complicate the determination of the accident cost. If none of the parameters (degree of curvature, grade, length, height, and offset) match the values used in the study, 32 different accident costs would be required in order to completely interpolate between all of the known values and calculate one overall accident cost. In addition, the accident costs change each year as the GDP fluctuates. Clearly, the need exists for a computer program that is capable of looking up the values presented in this report and using them to calculate an accident cost, using interpolation where needed. In response to this need, Microsoft Excel was used to create the *Benefit-Cost Analysis of Foreslopes Program (BCAFP)*, which contains a series of spreadsheets that allow the user to input the known values of the previously described parameters as well as a traffic volume and direct cost. Other sheets were included that contained the calculations required for each functional class. One sheet contained the results for every scenario involving each functional class and design alternative, which are presented in this report in Appendix B through Appendix JJ.

9.3.2 Development of BCAFP

The first spreadsheet in the Microsoft Excel workbook is reserved for user input and contains the design recommendation based on accident and direct costs. This sheet contains drop down menus to select the functional class and the design alternatives. The user is then allowed to specify the degree of curvature and the percent grade, as well as the length, height, and offset of the roadside feature. The curvature of the roadway was always modeled to the left, as this would provide a higher accident rate. For undivided roadways, the designation of left or right curves was trivial since in one direction the curve is to the right, but in the opposite direction, the curve is to the left. However, on divided highways, the designation is important. However, to simplify the input data and to err on the side of safety, left-hand curves only were considered. As a result, the only input consideration for the degree of curvature is the magnitude of the degree itself. If a negative value is entered, the program will extrapolate to the negative value and the results will not be accurate. Similarly, only down grades were considered in the RSAP analyses. Down grades are considerably more unstable that up grades. RSAP actually treats up grades as flat ground, meaning the traffic adjustment factor that is used in the encroachment module is set to one for all up grades. Therefore, if a down grade is present, the user should enter the magnitude of the down grade as a percent, noting that a negative value would require extrapolation and would be incorrect. If an up grade is present, the percent grade should be set to zero. When determining the offset, the defined value using in RSAP was the distance from the edge of the travel way to the hinge point of the slope. The edge of the travel way includes the shoulder, and the hinge point is simply the intersection of the flat ground (or nearly flat) and the slope.

In addition, the user must input an ADT, in vpd. This ADT would be representative of a point in time and would not be effected by the traffic growth factor. Therefore, the engineer must determine the ADT if some future value were to be used. This can be done by adjusting the known current ADT by the traffic growth factor for that highway. The analyses using RSAP utilized a traffic growth factor of 2 percent over a design life of 25 years [35]. If the actual traffic growth factor for a given highway is unknown, 2 percent may be used. If the future ADT is expected to be lower than the current ADT, the analysis done by BCAFP would be unaffected, so long as the ADT of interest were used. The engineer should use judgment in determining if the current ADT, ADT at the end of the design life, or some other value should be used. It is recommended that the ADT at the mid-life of the design be used as this would yield average annual accident costs that would be indicative of all years in the design life.

In addition, the user must specify the GDP implicit price deflator for the current year, the interest rate (4 percent is relatively constant), the design life, and the minimum BC ratio. In addition, the total direct cost of each alternative must be entered by the engineer. This cost would include material costs, labor, and ROW considerations. The GDP implicit price deflator for the current year is determined by the FHWA and is sent out to all field offices. When conducting a project using BCAFP for the first time in a given year, the local FHWA field office should be contacted to ascertain the GDP implicit price deflator. Also included is a reminder to use a traversable run-out area beyond the toe of 1V:3H slopes. It also warns the user when extrapolation is used to estimate accident cost, prompting the user to use engineering judgment as to whether or not to use the accident cost.

The second sheet displays the accident costs for each design alternative as determined in the Functional Class sheets. The third sheet assembles a BC ratio matrix by using Equation 36. This sheet also interprets the matrix and determines the best overall design alternative, according to the BC ratios.

The fourth sheet contains a combination of the results shown in Appendix B through Appendix JJ. Each scenario was assigned an index number, which was later used to lookup values based on the input parameters. In total, 8,505 index values covered freeways, divided rural arterials, undivided rural arterials, rural locals, divided urban arterials, undivided urban arterials, and urban locals. Each of those functional classes contain to four slopes (1V:2H, 1V:3H, 1V:4H, and 1V:6H) and one guardrail system.

The next seven sheets were created for calculation purposes, each one containing calculations pertinent to one of the seven functional classes mentioned in the preceding paragraph. Each sheet imports data entered in the “BC Analysis” tab. Using these input parameters, the program determines the two standard values surrounding the user’s input value. Those standard values were those chosen for the RSAP simulation. These two values were designated as LOW and HIGH, relative to the input value. For example, if the user specifies a height of 4 ft (12 m), the low value programmed into RSAP was 1 ft (0.3 m), and the high value was 7 ft (2.1 m). Once low and high values were determined for each input parameter, the pertinent coefficients for those low and high values were looked up from the “Coefficients” tab. Once the coefficients were determined, the program interpolated between the two values to determine the proper coefficient for the user’s input value. This interpolation process could become very complex. It was accomplished by first interpolating between offset values. The process continued next by interpolating between heights, lengths, grades, and finally degrees of curvature. The interpolation tree has been illustrated in Figure 15. This tree only shows half of the interpolation process. The top entry represents the low value of the degree of curvature. The other half of the tree would show the high value. The final coefficient was determined by interpolating between these two halves, using the input value for the degree of curvature.

The twelfth sheet orders the design alternatives by ascending direct costs for use in the matrix interpretation. The thirteenth and final sheet calculates the cost of a single accident at the simulated severity index. This is done by reading in the current year’s GDP implicit price deflator, adjust the cost of each SI, and determining the coefficients of Equation 22 using Equation 23. Then, these coefficients are used in the “Coefficients” tab to calculate the accident cost for every scenario (each of the 8,505), based on the user-defined traffic volume and simulated impact frequency.

Finally, when a parameter’s value falls outside the range of used values, interpolation cannot be used. Instead, extrapolation beyond the last known point must be used. This was accomplished by using the slope between the closest two known parameters and applying this slope to the difference between the values of the out-of-range and in-range parameters.

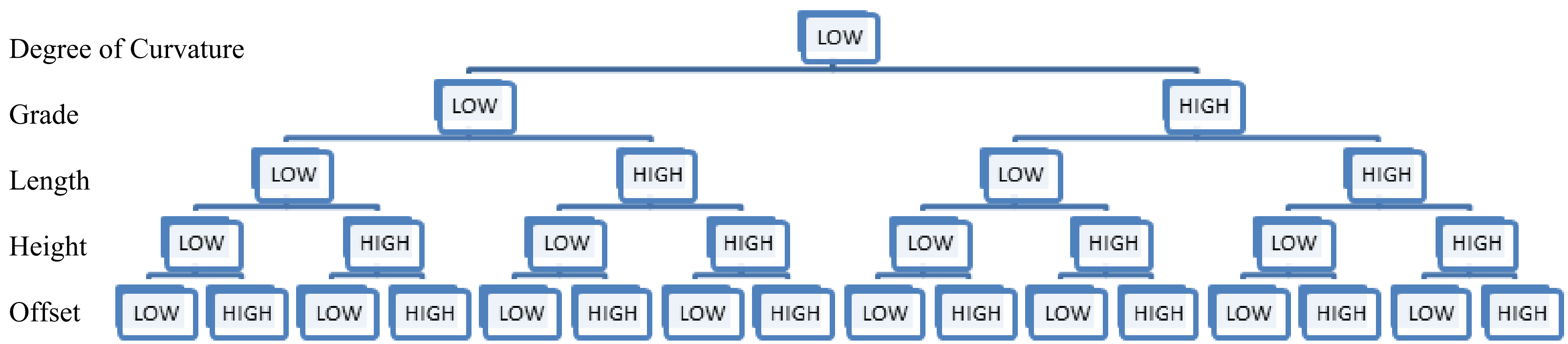

Figure 15. Interpolation Tree used in BCAFP

9.3.3 Using BCAFP

On the "BC Analysis" tab, the user may select the functional class from a drop down menu. The user must then select a design alternative. The options include foreslopes of 1V:2H, 1V:3H, 1V:4H, and 1V:6H in addition to a Guardrail option. Intermediate slopes, such as 1V:3.4H, should be classified as one of the provided slopes. This is done by rounding up or down as needed. For example, the 3.1V:4H slope would round down to 1V:3H. If the engineer needs a more precise estimate for an accident cost (but not necessarily more accurate), linear interpolation may be used between adjacent slopes. In the example, a 1V:3H and a 1V:4H slope would be used in combination with the given slope. The Guardrail option is only included as a rough guideline. If a longitudinal barrier is required, some other means of analysis should be used to determine the best barrier for any given situation.

The remaining parameters are not selected from drop down menus. Instead, the user is allowed to specify any input value, within limits that will be discussed in the next section, to any degree of precision. If the input value exceeds the upper value used in the study or is less than the lowest value, the program will display a warning message that says, "Extrapolation Used," since interpolation was used. The warning is intended to prompt the engineer to use judgment in determining if the accident cost is reasonable for the scenario.

Once the input parameters are completed, BCAFP determines the values that were determined by interpolation or extrapolation. The equations given in Section 9.2 were used to calculate the accident cost. Finally, using the user-defined direct costs, a BC ratio was determined for each alternative comparison, resulting in a BC ratio matrix. BCAFP then interprets this matrix to recommend the most cost-effective design.

9.3.4 Limitations of BCAFP

The coefficients used by BCAFP were determined as outlined in this report. That is, they were based on results from RSAP. RSAP itself has limitations ranging from the data it uses for encroachment frequency to programming errors. These limitations are highlighted in Chapter 12 and are detailed more explicitly in the draft interim report for NCHRP Project 22-27 [16].

The known values of the coefficients fall within a specified range of known input parameters. For example, the range of the length of the feature was 200 to 1,400 ft (61.0 to 426.7 m). As a result, if the accident cost was required for a scenario that falls outside this range, extrapolation was required. However, this was less certain than interpolation results between known values. The engineer is encouraged to use judgment to determine if the accident costs determined by extrapolation are representative of the scenario.

9.4 Accident Cost Trends for Each Parameter

Several parameters contributed to the accident cost. Each contributed in different magnitudes. Some increased the accident cost while others decreased it. The parameters that were allowed to vary and can be selected by the engineer were as follows: (1) design alternative; (2) traffic volume; (3) degree of curvature; (4) grade; (5) length of the feature; (6) height of the feature; and (7) offset of the feature from the edge of the travel way. To understand and demonstrate the effect of each of these parameters on the accident cost, bar graphs were created to show how the accident cost fluctuates when only one of the seven parameters is changed. In general, four cases were used to study each parameter. For example, the ADT for a freeway varied from 10,000 vpd (Case 1) to 100,000 vpd (Case 4). In this example, all other parameters used in Case 4 were the same as used in Case 1 (e.g., Case 4 degree of curvature was 0 degrees when examining ADT). The case descriptions for each functional class and each parameter are detailed in Table 17.

Table 17. Trend Analysis Parameters and Their Values

Freeway							
	Alternative	ADT (vpd)	Degree of Curvature	Grade (%)	Length, ft (m)	Height, ft (m)	Offset, ft (m)
Case 1	1V:3H	10000	0	0	200 (61.0)	1 (0.3)	2 (0.6)
Case 2	1V:4H	40000	1	1	600 (182.9)	5 (1.5)	5 (1.5)
Case 3	1V:6H	70000	2	2	1000 (304.8)	9 (2.7)	9 (2.7)
Case 4	Guardrail	100000	3	3	1400 (426.7)	13 (4.0)	12 (3.7)
Rural Arterial (Divided and Undivided)							
	Alternative	ADT (vpd)	Degree of Curvature	Grade (%)	Length, ft (m)	Height, ft (m)	Offset, ft (m)
Case 1	1V:3H	1000	0	0	200 (61.0)	1 (0.3)	2 (0.6)
Case 2	1V:4H	10000	2	2	600 (182.9)	5 (1.5)	5 (1.5)
Case 3	1V:6H	20000	4	4	1000 (304.8)	9 (2.7)	9 (2.7)
Case 4	Guardrail	30000	6	6	1400 (426.7)	13 (4.0)	12 (3.7)
Rural Local							
	Alternative	ADT (vpd)	Degree of Curvature	Grade (%)	Length, ft (m)	Height, ft (m)	Offset, ft (m)
Case 1	1V:3H	50	0	0	200 (61.0)	1 (0.3)	2 (0.6)
Case 2	1V:4H	300	3	3	600 (182.9)	5 (1.5)	5 (1.5)
Case 3	1V:6H	700	5	5	1000 (304.8)	9 (2.7)	9 (2.7)
Case 4	Guardrail	1000	8	8	1400 (426.7)	13 (4.0)	12 (3.7)
Urban Arterial (Divided and Undivided)							
	Alternative	ADT (vpd)	Degree of Curvature	Grade (%)	Length, ft (m)	Height, ft (m)	Offset, ft (m)
Case 1	1V:3H	1000	0	0	200 (61.0)	1 (0.3)	2 (0.6)
Case 2	1V:4H	10000	3	2	600 (182.9)	5 (1.5)	5 (1.5)
Case 3	1V:6H	20000	5	4	1000 (304.8)	9 (2.7)	9 (2.7)
Case 4	Guardrail	30000	8	6	1400 (426.7)	13 (4.0)	12 (3.7)
Urban Local							
	Alternative	ADT (vpd)	Degree of Curvature	Grade (%)	Length, ft (m)	Height, ft (m)	Offset, ft (m)
Case 1	1V:3H	50	0	0	200 (61.0)	1 (0.3)	2 (0.6)
Case 2	1V:4H	300	2	4	600 (182.9)	5 (1.5)	5 (1.5)
Case 3	1V:6H	700	4	8	1000 (304.8)	9 (2.7)	9 (2.7)
Case 4	Guardrail	1000	6	12	1400 (426.7)	13 (4.0)	12 (3.7)

For all functional classes, slope flattening and increasing the offset reduced the accident cost. As the degree of curvature and the percent grade increased, the accident cost remained steady until the increase became significant, like in Case 4. For this case, the accident cost for these two parameters was always higher than for zero degrees of curvature and zero percent grade. The height tended to increase the accident cost, but it was not usually a significant increase. For a freeway, the cost of Case 4 (13 ft or 4.0 m high) was more than twice as much as Case 1 (1 ft or 0.3 m high), but for an undivided rural arterial, the cost of Case 4 was only 12 percent higher than Case 1. Uniformly, an increase in traffic volume and feature length resulted in a significant increase in accident cost, as is intuitive.

The most revealing trends of all the functional classes could be found in the alternatives. Naturally, the accident costs decreased as the slope was flattened. However, the largest decrease in cost was seen in changing from a 1V:3H foreslope to a 1V:4H. For example, the accident cost was reduced by a factor of 10 on undivided rural arterial highways for a change from 1V:3H to 1V:4H, but a change from 1V:4H to 1V:6H reduced the accident cost by a factor of only 2. In addition, it was shown that implementing guardrail (Case 4 of the alternatives) was extremely more costly than using slope flattening. As a result, the engineer is encouraged to exhaust all possible slope flattening alternatives before considering the use of a guardrail system or any other form of shielding. It should be noted that this program does not examine different barriers, and as a result, it is not capable of selecting the most cost-beneficial system. The trends corresponding to the cases outlined in Table 17 are demonstrated graphically in Figures 16 through 22.

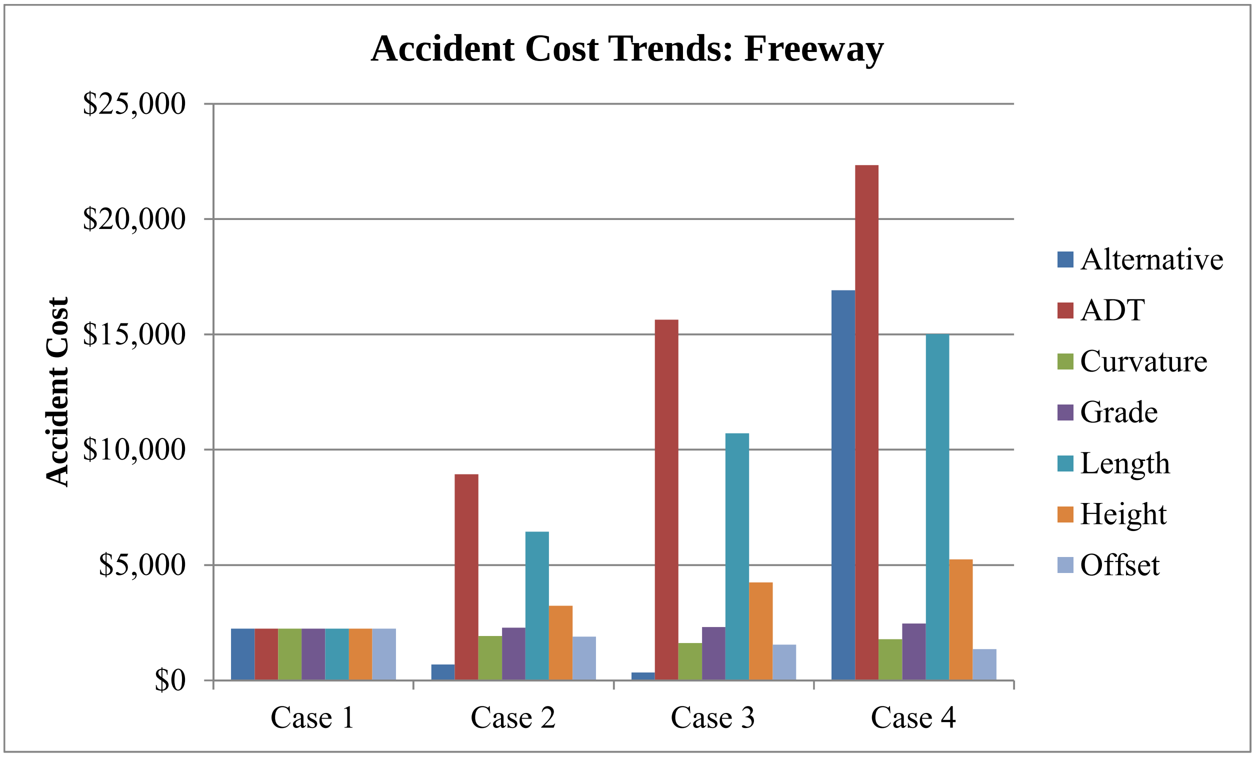

Figure 16. Accident Cost Trend of a Freeway

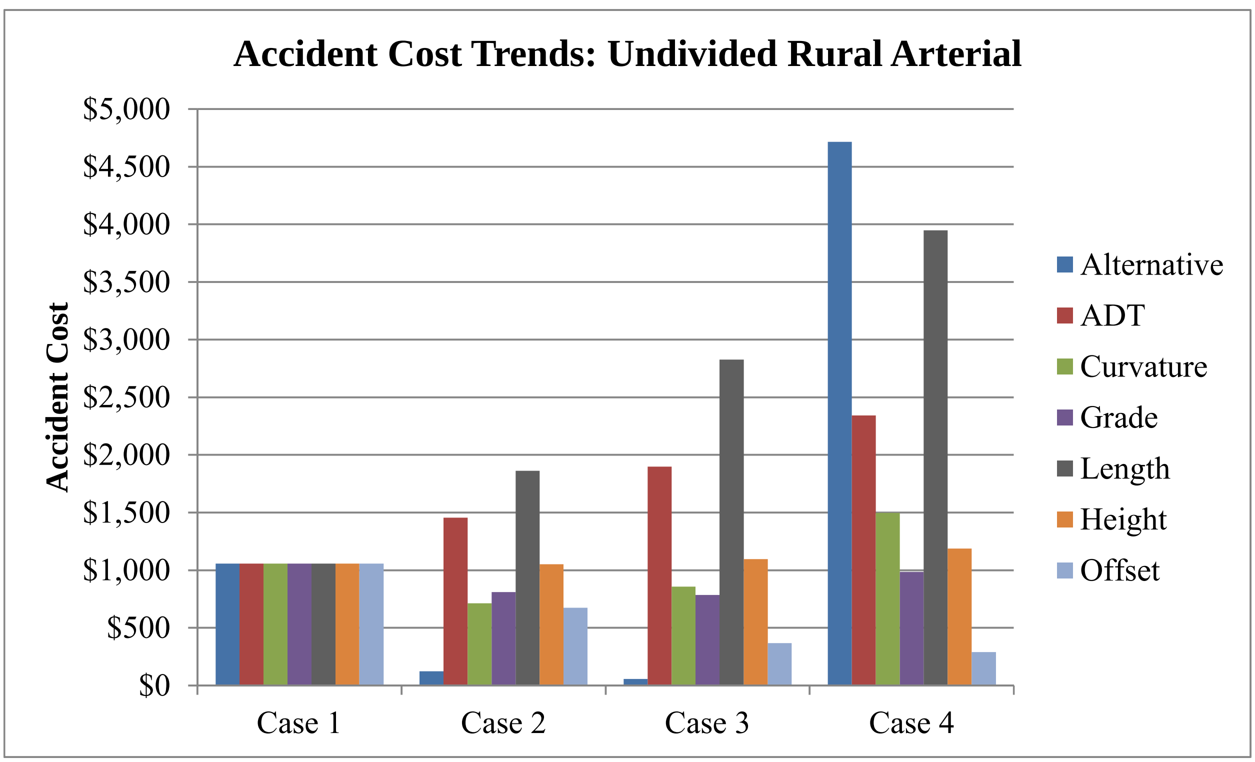

Figure 17. Accident Cost Trend of an Undivided Rural Arterial

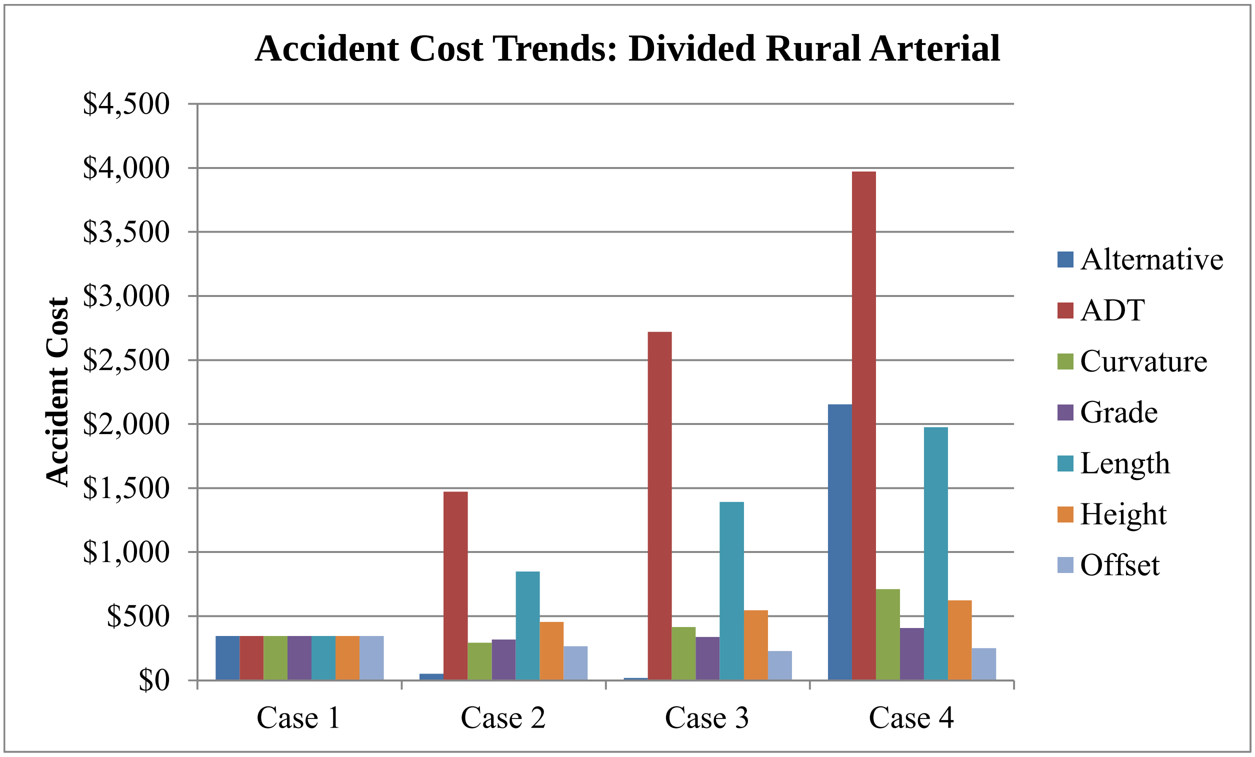

Figure 18. Accident Cost Trend of a Divided Rural Arterial

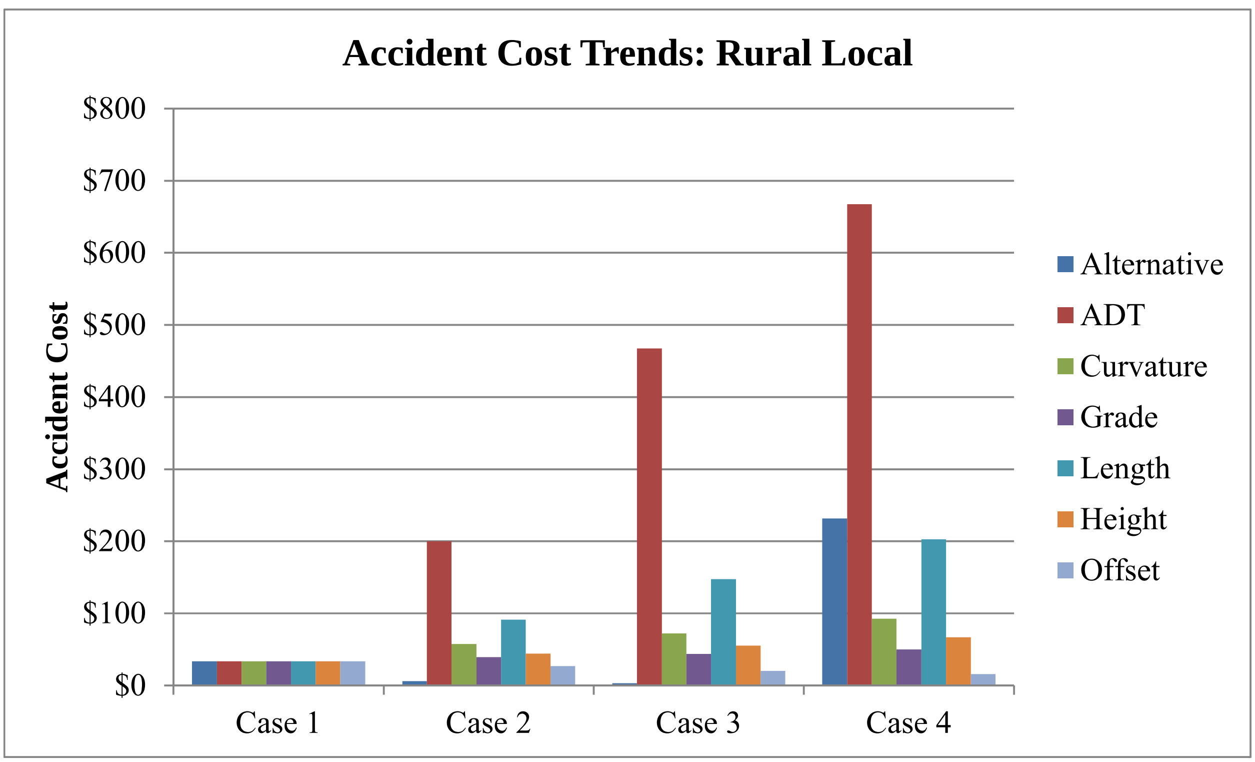

Figure 19. Accident Cost Trend of a Rural Local Highway

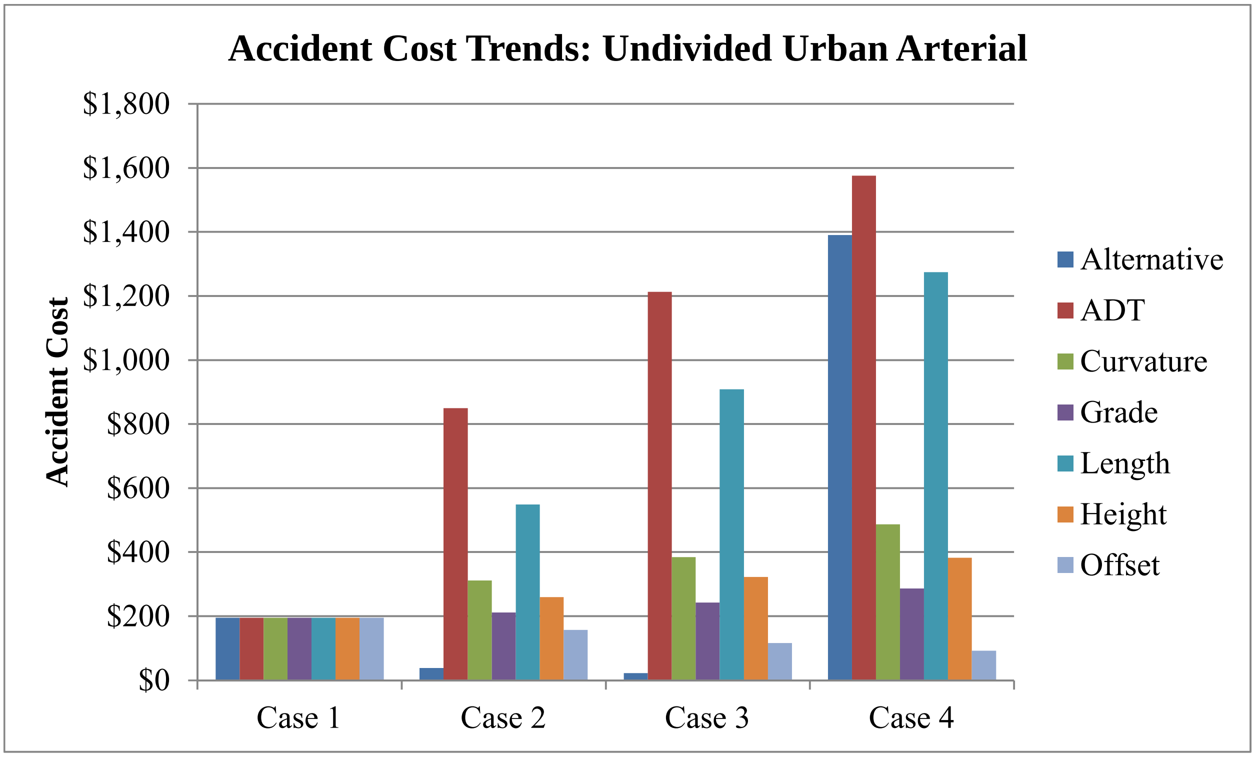

Figure 20. Accident Cost Trend of an Undivided Urban Arterial

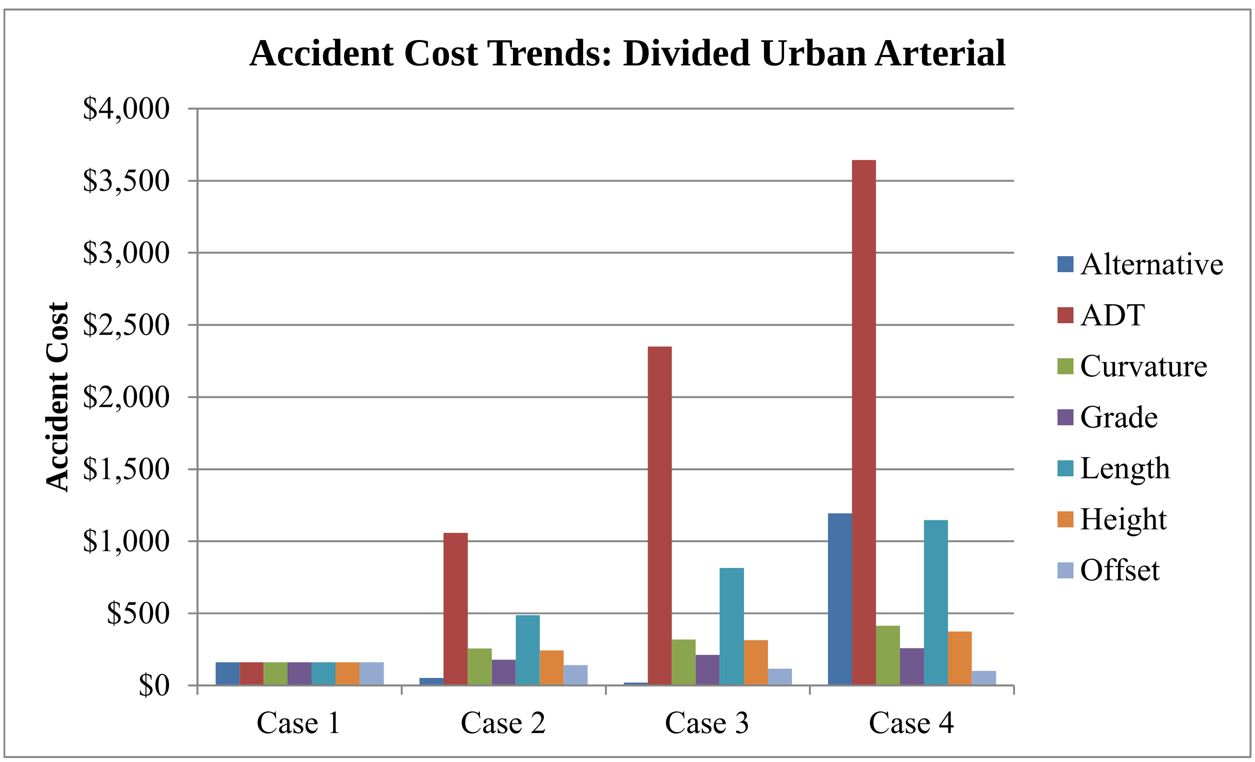

Figure 21. Accident Cost Trend of a Divided Urban Arterial

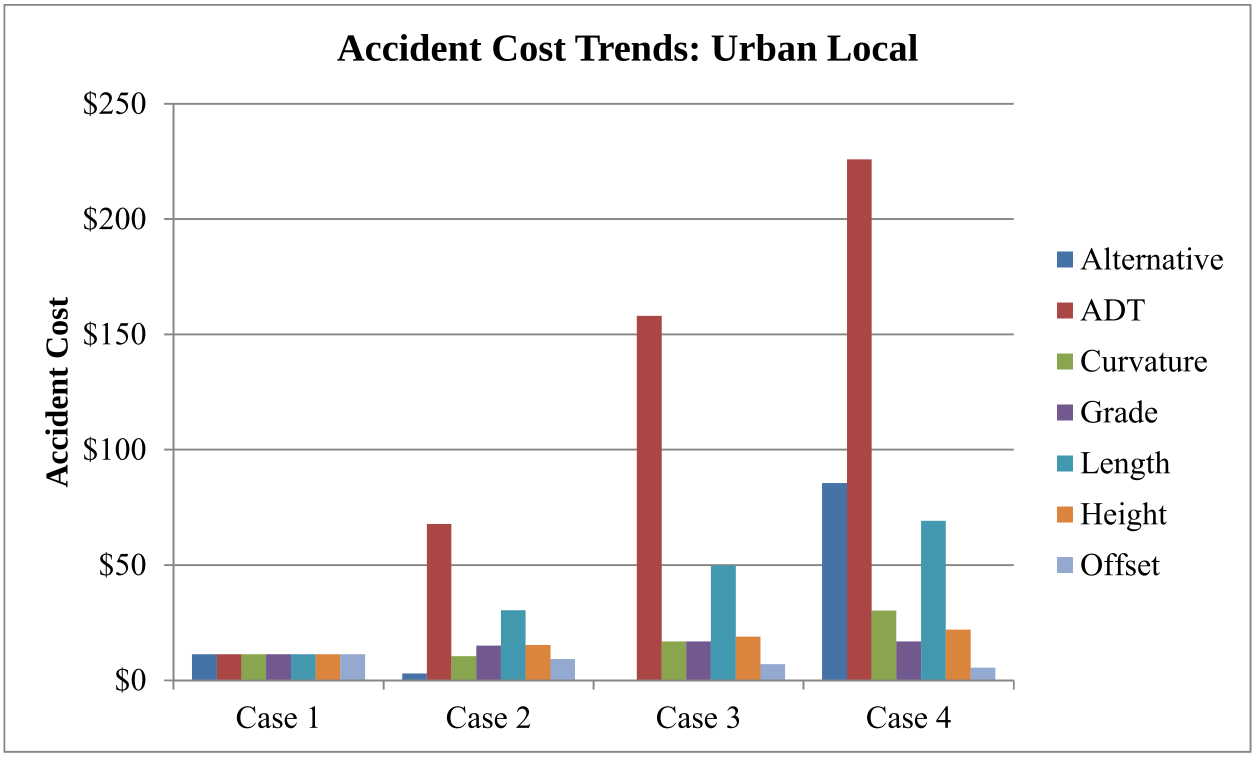

Figure 22. Accident Cost Trend of an Urban Local Highway

9.5 Determining an Accident Cost

9.5.1 Example 1 – Rural Local

Given:

- 1V:2H slope
- ADT = 400 vpd
- Degree of Curvature = 0 degrees
- Grade = 4 percent
- Length of Feature = 200 ft (61.0 m)
- Height of Feature = 7 ft (2.1 m)
- Offset of Feature from the Edge of the Traveled Way = 7 ft (2.1 m)

From Appendix E (1V:2H Slope, Rural Local Highway), b = 0.0000270 and the SI was 2.48. Using the coefficients given in Table 16, the cost per accident could be described by Equation 22. The accident cost, *AccCost*, was given by Equation 24:

$$SI_{cost} = -24.11(2.48)^6 + 585.43(2.48)^5 - 5288.84(2.48)^4 + 27{,}552.00(2.48)^3$$
$$- 56{,}462.19(2.48)^2 + 40{,}438.19(2.48) + 0 = \$22{,}500.13$$

$$AccCost = 2.70 \times 10^{-5} \times 400 \times (\$22{,}500.13) = \$242.91$$

9.5.2 Example 2 – Freeway

Given:

- 1V:4H slope
- ADT = 63,000 vpd
- Degree of Curvature = 2 degrees
- Grade = 2 percent
- Length of Feature = 400 ft (121.9 m)
- Height of Feature = 6 ft (1.8 m)
- Offset of Feature from the Edge of the Traveled Way = 12 ft (3.7 m)

The height and the length of the feature cannot be directly read from the table. Therefore, linear interpolation between 1 and 7 ft (0.3 and 2.1 m) was required for the height, and between 200 and 800 ft (61.0 and 243.8 m) for the length. To do this, Appendix P was used. First, the accident cost for a 200-ft (61.0-m) feature at 1 ft (0.3 m) and 7 ft (2.1 m) heights was determined. The b-coefficient of a 200-ft (61.0-m) long, 1-ft (0.3-m) high feature was $3.23\text{x}10^{-6}$ and the SI was 1.48. Using Equations 22 and 24, the accident cost was \$830.26 per year. The b-coefficient of a 200-ft (61.0-m) long, 7-ft (2.1-m) high feature was $5.02\text{x}10^{-6}$ and the SI was

1.95. using Equations 22 and 24, the accident cost was \$2,272.11 per year. Interpolating at 6 ft (1.8 m) was done as follows:

$$AccCost = \left[\left(\frac{6ft - 1ft}{7ft - 1ft}\right) \times (\$2{,}272.11 - \$830.26)\right] + \$830.26 = \$2{,}031.80$$

Next, the process was repeated for an 800-ft (243.8-m) long feature at 1-ft (0.3-m) and 7-ft (2.1-m) high. The corresponding b-coefficients were 2.02×10^{-5} and 2.58×10^{-5}, respectively. In addition, the respective SI values were 1.49 and 1.95. Using Equations 22 and 24, the accident costs were \$5,104.49 and \$11,524.72. Interpolating at 6 ft (1.8 m) was done as follows:

$$AccCost = \left[\left(\frac{6ft - 1ft}{7ft - 1ft}\right) \times (\$11{,}524.72 - \$5{,}104.49)\right] + \$5{,}104.49 = \$10{,}454.68$$

Finally, the accident cost was determined by interpolating between the two preceding accident costs at a length of 400 ft (121.9 m). The calculation was done as follows:

$$AccCost = \left[\left(\frac{400ft - 200ft}{800ft - 200ft}\right) \times (\$10{,}454.68 - \$2{,}031.80)\right] + \$2{,}031.80 = \$4{,}839.43$$

9.5.3 Example 3 – Rural Arterial

Given:

- Divided
- 1V:3H slope
- ADT = 12,000 vpd
- Degree of Curvature = 0 degrees
- Grade = 6 percent
- Length of Feature = 800 ft (243.8 m)
- Height of Feature = 7 ft (2.1 m)
- Offset of Feature from the Edge of the Traveled Way = 2 ft (0.6 m)

The accident cost was determined from Appendix K. From that appendix, b was 6.39×10^{-5} and the SI was 2.16. No interpolation was required in this example. From Equations 22 and 24 the accident cost was $8,852.35.

9.5.4 Example 4 – Urban Local

Given:

- 1V:3H slope
- ADT = 300 vpd
- Degree of Curvature = 3 degrees
- Grade = 0 percent
- Length of Feature = 1400 ft (426.7 m)
- Height of Feature = 13 ft (4.0 m)
- Offset of Feature from the Edge of the Traveled Way = 2 ft (0.6 m)

The b-coefficient was taken from Appendix O. No interpolation was required in this example; therefore, the coefficient was b = 2.27×10^{-4} and the SI was 2.51. From Equations 22 and 24 the accident cost was $1,631.02.

9.5.5 Example 5 – Urban Arterial Highway

Given:

- Undivided
- Guardrail System
- ADT = 12,000 vpd
- Degree of Curvature = 0 degrees
- Grade = 3 percent
- Length of Feature = 800 ft (243.8 m)

- Height of Feature = 7 ft (2.1 m)
- Offset of Feature from the Edge of the Traveled Way = 7 ft (2.1 m)

The accident cost was determined from Appendix HH. No interpolation was required in this example; therefore, the coefficient was b = 1.42×10^{-4} and the SI was 1.86. Using Equations 22 and 24, the accident cost was $10,049.08.

10 BENEFIT-COST RATIOS

10.1 BC Ratios Defined

The incremental BC ratio compares one alternative to another. Theoretically, a BC ratio of 1 means that the cost to install a new design is approximately the same as the accident costs associated with the original design. It is usually recommended that a BC ratio of at least 1.5 be used, but most state departments prefer nothing less than 2.0; therefore, the minimum BC ratio that would suggest a beneficial design is 2.0. This ratio is obtained from the direct costs and accident costs of each alternative (see Chapters 7 and 8). It is calculated using Equation 23 [3].

$$B/C_{2-1} = \frac{(AC_1 - AC_2)}{(DC_2 - DC_1)} \tag{23}$$

Where

B/C_{2-1} = Incremental BC ratio of Alternative 2 compared to Alternative 1

AC_1 = Annualized accident cost of Alternative 1

AC_2 = Annualized accident cost of Alternative 2

DC_1 = Annualized direct cost of Alternative 1

DC_2 = Annualized direct cost of Alternative 2

A BC matrix compares the cost-effectiveness of each alternative under review to all the other alternatives, including the baseline alternative. A sample BC matrix is given in Figure 23. In general, the alternatives were ordered from left to right and top to bottom based on the direct costs, with the least expensive ("do nothing") on the left and at the top. The last term in the top row, Guardrail, represented the alternative requiring a TL-3 guardrail system be installed in front of the existing slope. To interpret the results, the engineer can start reading the table in the lower right corner. If this value was greater than 2.0, then Guardrail was better than 1V:6H. Then, if the next value from the bottom in the last column is greater than 2.0, Guardrail was better than

1V:4H. This process was continued until either it was determined that Guardrail was better than all alternatives or it was determined that Guardrail was not as beneficial as an alternative. In the sample included, the BC ratio comparing Guardrail to 1V:6H was -27.223 meaning that 1V:6H was better than Guardrail. It should be noted that negative BC ratios indicate that the alternative design actually increases the accident cost. From this point forward, the Guardrail option was no longer considered. Then, 1V:6H was compared to 1V:4H resulting in a BC ratio of 1.544. Although this is positive and greater than 1, it fails to meet the minimum BC ratio of 2.0. The modification of the existing slope to 1V:6H slope was not considered any further. Next, 1V:4H was compared to 1V:3H, and the ratio was 5.636 which was larger than 2.0. As a result, the slope 1V:3H was eliminated from further consideration. Finally, 1V:4H was compared to 1V:2H, the "do nothing" condition. The ratio was 7.916. For the condition given in the figure caption, the most cost-beneficial option was to install a 1V:4H slope. This method allows the engineer to compare different design alternatives directly to one another rather than indirectly by comparing each alternative to the baseline alternative only. Although the 1V:3H alternative appears to be the most beneficial, indirectly, it was shown that the 1V:4H was the best overall selection because its accident cost reduction was larger relative to the accident cost reduction of the 1V:3H slope.

	1V:2H	1V:3H	1V:4H	1V:6H	Guardrail
1V:2H	0	10.195	7.916	4.730	-4.618
1V:3H		0	5.636	2.908	-20.702
1V:4H			0	1.544	-24.210
1V:6H				0	-27.223

Figure 23. Rural Local, Straight, Flat, 200 ft (61 m) Long, 1 ft (0.3 m) High, 2 (0.6 m) ft Offset, ADT = 1000

Although the 1V:3H, 1V:4H, and the 1V:6H slope alternatives are all beneficial relative to the baseline slope of 1V:2H, the best option is the 1V:4H as determined by interpreting the full matrix. Whenever possible, as many alternatives as are feasible should be investigated and compared using the results of this research and contractor bids on materials and labor for the construction of the alternatives. This will ensure that the selected alternative provides the best balance between safety performance and cost.

10.2 Example Calculation

Determine the most cost-beneficial design alternative from slope flattening options and a guardrail option for a freeway with an existing slope of 1V:3H.

Given:

- Freeway
- Design Speed = 55 mph (88.5 km/h)
- Existing slope is a 1V:3H
- ADT = 65,000 vpd
- Degree of Curvature = 0 degrees
- Grade = 2 percent
- Length of Feature = 200 ft (61.0 m)
- Height of Feature = 13 ft (4.0 m)
- Offset of Feature from the Edge of the Traveled Way = 7 ft (2.1 m)
- Assume no additional clear zone is needed for ROW
- Minimum BC Ratio = 4.0

Solution:

Determine the direct costs as per Chapter 7. Assume the cost per cubic yard of fill is \$30, and the cost of ROW is \$5 per square foot. To conduct an accurate BC analysis, these values would need to be determined for every scenario as the costs of fill and ROW vary across a wide range. Assume the shrinkage factor for the volume of borrow soil is zero. Using Equation 14, the required volume for slopes of 1V:4H and 1V:6H were estimated.

$$V_{1V:4H} = \frac{1}{2}h^2 l(X_{II} - X_I) = \frac{1}{2}(13ft)^2(200ft)(4-3) \times \left(\frac{1\,CY}{27\,ft^3}\right) = 625.93\,CY$$

$$V_{1V:6H} = \frac{1}{2}h^2 l(X_{II} - X_I) = \frac{1}{2}(13ft)^2(200ft)(6-3) \times \left(\frac{1\,CY}{27\,ft^3}\right) = 1{,}877.78\,CY$$

The ROW area was determined using the width of the baseline foreslope and the alternative foreslope, which was a function of the slope and the height. The width was the height multiplied by the slope, where the slope was defined by the horizontal component. For example, the slope of a 1V:4H foreslope is 4. In this example, the height was 13 ft (2.1 m). Therefore, the widths of the two alternatives were 52 and 78 ft (15.8 and 23.8 m). The width of the baseline alternative was 39 ft (11.9 m). The net width of the required ROW was the difference between the width of the alternative slope and the baseline slope. The area was then determined by multiplying the net width by the length of the foreslope, or in this case, 200 ft (61.0 m).

The direct cost of each alternative was calculated using Equation 19. The resulting volumes, square footages of ROW, and associated costs are given in Table 18. It should be noted that the direct cost of the baseline slope was \$0.00.

$$DC_{1V:4H} = P \cdot \left[\frac{i(1+i)^n}{(1+i)^n - 1}\right] = 148{,}777.78 \cdot \left[\frac{0.04(1+0.04)^{25}}{(1+0.04)^{25} - 1}\right] = \$9{,}521.78$$

$$DC_{1V:6H} = P \cdot \left[\frac{i(1+i)^n}{(1+i)^n - 1}\right] = 446{,}333.33 \cdot \left[\frac{0.04(1+0.04)^{25}}{(1+0.04)^{25} - 1}\right] = \$28{,}565.33$$

Table 18. Direct Cost Calculations

Slope (1V:XH)	Volume (yard^3)	Fill Cost ($)	ROW area (ft^2)	ROW Cost ($)	Total Cost ($)	Direct Cost ($)
1V:4H	625.93	18777.78	2600	13000	31777.78	2033.78
1V:6H	1877.78	56333.33	7800	39000	95333.33	6101.33

Next, the accident costs associated with the given scenario for all three slopes must be determined. For the 1V:3H slope, BCAFP calculates the accident cost to be $27,545.28. For the 1V:4H slope, BCAFP calculates the accident cost to be $20,171.21 For the 1V:6H slope, BCAFP calculates the accident cost to be $2,579.61. The BC ratios were calculated using Equation 23.

$$B/C_{4-3} = \frac{(27545.28-20171.21)}{(2033.78-0)} = 3.63$$

$$B/C_{6-3} = \frac{(27545.28-2579.61)}{(6101.33-0)} = 4.09$$

$$B/C_{6-4} = \frac{(20171.21-2579.61)}{(6101.33-2033.78)} = 4.32$$

Next, the accident cost and direct cost of the Guardrail option was determined. The total length of material of the guardrail can be estimated using the 2006 RDG or Section 8.2 of this report. The total length would be approximately 550 feet (168 m) with two end terminals. The value was arrived at by using Equations 17 and 18.

$$L = 2 \cdot (x - L_1 - 37.5) + l \qquad (17)$$

$$x = \frac{(H \cdot S) + (L_1 \cdot F)}{F + \left(\frac{H \cdot S + L_2}{L_R}\right)} \qquad (18)$$

Where L_1 was assumed to be 25 ft (7.6 m) and provided a buffer region between the end of the tangent section of guardrail and the beginning of the foreslope. The length, *l*, was 200 ft (61.0 m), or the length of the foreslope. The height of the foreslope (H) was 13 ft (4.0 m). The slope of the foreslope (S) was 3. The flare rate, F, was the flare rate of the ends of the guardrail and the terminal. This value was chosen from the RDG to be 24H:1V and was because the shy line was 7.2 ft (2.2 m) for a 55-mph (88.5 km/h) design speed. This meant that the barrier would be located within the shy line. For use in Equation 18, F was converted to a decimal and was 0.04167 (1/24). The offset distance to the face of the guardrail, L_2, was 7 ft (2.1 m). Finally, the runout length, L_R, was determined by Table 5.8 in the 2006 RDG [2]. This value was 360 ft (109.7 m). It should be noted that the slope is protected from both directions equally, providing a conservative length-of-need.

$$x = \frac{(13 \cdot 3) + (25 \cdot 0.04167)}{0.04167 + \left(\frac{13 \cdot 3 + 7}{360}\right)} = 236.31\,ft$$

$$L = 2 \cdot (236.31 - 25 - 37.5) + 200 = 547.61\,ft = 550\,ft$$

The cost per foot of guardrail was \$15 per foot while the cost per terminal was \$2,000 [30]. The total installation cost would be \$12,250 but the direct cost (assuming 4 percent interest and 25-year design life) would be \$784.00 per year. For a guardrail system, BCAFP calculates the accident cost to be \$781.86. This value includes the length-of-need of 550 ft (167.6 m) for the 200-ft (60.1 m) feature length; therefore, the accident cost is \$118,499.43 per year.

$$B/C_{GR-3} = \frac{(27545.28 - 118499.43)}{(781.86)} = -116.33$$

Therefore, even though the installation cost of the Guardrail option was greatly reduced, the accident cost was higher than the original unprotected slope. This caused the BC ratio to be negative. In addition, the 1V:4H and 1V:6H slopes had large BC ratios compared to the Guardrail option, making any one of the slope flattening options more cost-effective than the Guardrail option, in this example. The engineer would be justified in recommending that the existing slope be flattened to 1V:6H. This recommendation is illustrated by the tabulated BC ratios shown in Figure 24. This figure was taken directly from BCAFP, in which a fifth alternative, “None,” is a placeholder in the event that a fifth alternative is used. Because the 1V:6H to 1V:4H ratio is 8.71, the 1V:4H slope would be dropped from further consideration. Then, because the 1V:6H to Guardrail ratio is 26.98, the Guardrail option would also be dropped from further consideration. Finally, because the 1V:6H to 1V:3H (baseline) ratio is 4.92, the 1V:6H slope would be recommended (i.e., BC $\geq$ 4.0).

Benefit-Cost Analysis of Foreslopes Program

Input Values

		Total Direct Cost		
Baseline Alternative	1V:3H	$ -	GDP Implicit Price Deflator	111.141
Other Alternatives	1V:4H	$ 148,777.78	ADT (vpd)	12,000
	1V:6H	$ 446,333.33	Interest Rate	0.04
	Guardrail	$ 12,250.00	Design Life (yrs)	25
	None	$ -	Minimum BC Ratio	4.0
Functional Class	Freeway			
Degree of Curvature	0			
Grade (%)	2			
Length of Feature, *l* (ft)	200			
Height, *h* (ft)	13			
Offset, *o* (ft)	7			

Summary			
Design Alternative	Direct Cost	Accident Cost	Severity Index
1V:3H	$ -	$ 4,846.06	2.99
Guardrail	$ 784.15	$ 33,899.59	2.95
1V:4H	$ 9,523.56	$ 1,172.94	1.94
1V:6H	$ 28,570.67	$ 517.34	1.47
None	$ -	$ -	NA

B/C Ratio Matrix					
	1V:3H	Guardrail	1V:4H	1V:6H	None
1V:3H	0	-37.05	0.39	0.15	-1000000.00
Guardrail		0	3.74	1.20	-1000000.00
1V:4H			0	0.03	-1000000.00
1V:6H				0	-1000000.00
None					0

Design Recommendation:	1V:3H

The engineer is encouraged to investigate other design issues

Figure 24. BCAFP "BC Analysis" Sheet

11 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

11.1 Summary

Based on accident data collected in 2000 in the State of Ohio, the severity indices on selected foreslopes were estimated, by associating the number of (K+A) accidents with the total mileage for each slope-height combination. In each combination, the severity index was reduced, relative to Wolford and Sicking's results and the default results in RSAP (version 2003.04.01). This was shown graphically for an embankment height of 7 ft (2.1 m) in Figures 7 and 8. This reduction was expected based on comments made in the RSAP Engineer's Manual that stated severity indices were likely biased towards higher-speed impacts.

Once the new severity indices for foreslopes were determined, they were implemented into RSAP and used in the simulation of the extensive test matrix. Each scenario in the test matrix was repeated for several traffic volumes. For each scenario and traffic volume, RSAP estimated an accident cost. From these accident costs, equations were developed to determine linear relationships between the traffic volumes and the accident costs. These equations were described by a series of coefficients and were in the slope-intercept form. For each scenario, these coefficients are presented in the attached appendices. Based on the functional class and the traffic volume, an applicable equation could be chosen from Section 9.2. With the coefficients and the traffic volume, the accident cost for any scenario can be calculated. In addition, a Microsoft Excel program known as BCAFP was developed to automatically lookup those coefficients and interpolate or extrapolate when needed. This program greatly reduced the time and effort needed to determine the accident costs and BC ratios, and it removed the possibility of human error in both looking up values and in making calculation mistakes during interpolation or extrapolation.

Finally, the benefit-cost application of these accident costs was described. The difference in accident costs between two competing alternatives represents the numerator of the BC ratio, which can be used to justify the use of one design alternative over another. In order to successfully complete the benefit-cost analysis, the engineer must ascertain the material costs of each alternative under consideration in order to construct the denominator of the BC ratio. An example of this process was given in Section 10.2.

11.2 Conclusions

Severity indices used in the default version of RSAP were overestimated. This research has presented new severity indices and used them to determined accident costs on an array of different foreslopes. Once the results of the RSAP analysis were available, trends appeared in each of the parameters and for each of the functional classes. Flattening the slope and increasing the offset decreased the accident costs for all functional classes. Likewise, increasing the traffic volume and length of the feature increased the accident costs for all functional classes. The degree of curvature and the percent grade caused initial decreases in accident costs (however slight they were), but then increased accident costs as those parameters continued to increase. As the height of the feature increased, the accident cost tended to increase as well. However, this increase was not as significant as the increase caused by the traffic volume and the length of the feature. Finally, and of most importance, slope flattening dramatically reduced accident costs. On short embankment heights, the largest decrease in accident costs on adjacent slopes occurred when a 1V:3H foreslope was flattened to a 1V:4H foreslope, which reduced the accident cost by approximately 80 percent, but when the slope was flattened from a 1V:4H foreslope to a 1V:6H foreslope, the reduction was approximately 50 percent. On medium and tall heights, that trend was exactly reversed. Therefore, the increased severity on steep, tall embankments may warrant slope flattening beyond 1V:4H. Additionally, no matter what functional class was considered, flattening to a 1V:6H slope provided the largest overall reduction in accident costs. This does not necessarily mean that the 1V:6H slope was the best alternative, as direct costs need to be included in the analysis before the best alternative can be chosen.

Finally, as illustrated in the decision tree in Figure 11, guardrail systems should only be considered after all possible slope flattening alternatives have been explored. The trends in Figures 16 through 22 show an extreme increase in accident cost for the guardrail system relative to the foreslopes. Guardrail systems may only be applicable in areas where slope flattening cannot be accomplished, either because of urban settings or because of some other limiting factor.

11.3 Recommendations for Application

The severity index is directly proportional to the impact speed. As a result, the severity indices were determined for several impact speeds such that a linear equation could be developed from the results. For each slope-height combination, the linear equation is presented in Table 19. In the equations, SI represents the severity index and v represents the impact speed in terms of miles per hour (mph). These severity index equations should be used when estimating accident costs of crashes involving clear foreslopes.

Table 19. Severity Index Equations Based on Impact Speed

Slope-height Combination	SI Equation
1V:6h, h ≥ 1 ft (0.3 m)	SI = 0.0181 · v
1V:4h, h = 1 ft (0.3 m)	SI = 0.0186 · v
1V:4h, h ≥ 7 ft (2.1 m)	SI = 0.0366 · v
1V:3h, h = 1 ft (0.3 m)	SI = 0.0360 · v
1V:3h, h = 7 ft (2.1 m)	SI = 0.0400 · v
1V:3h, h = 13 ft (4.0 m)	SI = 0.0429 · v
1V:2h, h = 1 ft (0.3 m)	SI = 0.0415 · v
1V:2h, h = 7 ft (2.1 m)	SI = 0.0458 · v
1V:2h, h = 13 ft (4.0 m)	SI = 0.0486 · v

11.4 Recommendations for Future Work

There is significant room for improvement beyond this research. A larger sample size would provide more consistent results for both the 1V:6H slope and the tall heights for all slopes. It would also lend more credibility to the results of the remaining slopes and heights. In addition, traffic volumes could be included in the analysis to negate the influence of increased exposure on some highways. With larger volumes, the number of (K+A) accidents would increase over the same length of highway, which in turn would increase the average severity. The same procedure outlined in this research would be used on slope-height-volume combinations. Each volume would then be normalized about some constant traffic volume, which could be programmed into RSAP. The final result would give the number of (K+A) accidents per mile per unit of traffic volume.

A more detailed investigation into the effects of barrier warrants on the number of (K+A) accidents for steep, tall embankments needs to be conducted. The work completed in this study was partially based on an extrapolation done to estimate the number of (K+A) accidents on tall embankments, especially for the 1V:2H foreslope. If barrier warrants investigation can successfully estimate the number of miles of unprotected, steep, tall embankments, then the number of (K+A) accidents per mile of that foreslope would actually be indicative of the severity.

Additionally, the current version of RSAP assumes a straight-line encroachment path. As a result, the driver behavior is not considered. Drivers are more likely to attempt a corrective maneuver when the vehicle is encroaching on a foreslope than they are to continue in a straight line. This corrective maneuver would increase the propensity for rollover; however, RSAP does not incorporate rollover into the calculation of the average severity index of a foreslope. It was assumed that the effect of rollover on the average accident cost was offset by increasing the SI, but this increase was not based on any data pertaining to accident costs of rollovers, but rather engineering judgment. RSAP is currently being updated under NCHRP Project No. 22-27 and will include curvi-linear encroachment paths [16]. Once this update is complete, the number of (K+A) accidents can be recalibrated against the accident data to estimate severity indices that are based on encroachments follow more natural paths.

12 LIMITATIONS

12.1 Severity Index Updates

Results of this analysis were highly dependent on the severity index used to estimate the accident cost of each scenario. Therefore, part of this study focused on developing more accurate severity indices on foreslopes. This part provided the major limitations to this study.

The number of (K+A) accidents can be significantly influenced by the traffic volume. The average severity is determined only after all possible scenarios have been simulated. That is, the damage caused by the severe accidents was divided by the total number of impacts to calculate an average severity for all impacts. If the traffic volume increases, the probability of severe accidents increases, which ultimately would increase the severity index. This is because the severity index is non-linear with its associated societal costs. The more severe accidents have a larger influence than the less severe accidents. Even if the difference in the number of severe and non-severe accidents does not change, the severity index will either increase or decrease, depending on how the traffic volume changes. However, this could not be accounted for in this project because the traffic volume at the accident locations and at the random sample locations was unknown. If the traffic volume was known over the entire highway network (e.g., at every 100-ft or 30.5-m interval), then slope-height-volume combinations could be constructed and the mileage for each one could be determined. As before, the number of (K+A) accidents would be counted for each combination. The results would then be normalized with respect to a unit of traffic volume, say 10,000 vehicles per day. This traffic volume would be entered into RSAP much in the same way as the length of the feature was entered (recall the length was set to 1 mile so that the number of (K+A) accidents was already given in a per-mile format).

Another limitation to this work is the small sample size used to develop the new severity indices. Only 1,296 accidents were analyzed, which was small compared to Wolford and

Sicking's work, which included more than 20,000 accidents. In addition, only one year was used in the data collection. It was the first year of data supplied by Ohio. In addition to that year (2000), data for every year through 2006 was supplied, but time restraints prevented the complete analysis of all this data. The number of accidents from the year 2000 was significantly smaller than in each subsequent year. This may be due to a new data entry system or some change in policy regarding accident reports, however, this is not known.

A limitation related to the small sample size was in the determination of the expected number of (K+A) accidents on a 1V:6H slope. No severe accidents occurred on heights less than 13 ft (4.0 m). Because the expected number of severe accidents for the other slopes was determined by the short and medium heights, the number of expected severe accidents on a 1V:6H slope was set to zero. However, severe accidents occurred on 1V:6H slopes, according to the actual accident data. As a result, the SI values of this slope should be higher than what are presented in this research. With the addition of more data, this conclusion should be supported and this limitation should be eliminated.

Impact speed also plays a pivotal role in the determination of the SI value for a given roadside feature. However, the accident data set could not include exact impact speeds. Only estimations were given and were most likely based on human judgment. The average impact speed from the accident data was 53.9 mph (86.7 km/h). Based on research done at the Midwest Roadside Safety Facility, the average impact speed on a U.S. and State Route is approximately 39 mph (62.8 km/h) [34]. As a result, the impact velocities given in the accident data were too high and unusable. If actual impact speeds were known, the relationship between the impact speed and the SI could be checked. Initially, this relationship was assumed to be linear. However, there may be reason to suspect that this relationship is more parabolic, considering the relationship between kinetic energy and velocity, which is commonly used to describe severities of impacts with barriers.

12.2 RSAP Programming For the Current Version (2003.04.01)

12.2.1 Conceptual Limitations

Encroachment paths are assumed to be linear in the current version of RSAP. This disallows the possibility of overcorrection as the motorists reacts to the unexpected encroachment. An overcorrection could potentially increase the rate of rollover on foreslopes substantially, which in turn, would increase severity indices. Work is being conducted on a new version of RSAP that uses set vehicular encroachment paths, which include curved paths, as opposed to straight-line paths whose angles are determined by Monte Carlo simulation [16]. This may increase the accuracy associated with foreslopes as they are related to rollover incidents. RSAP currently employs a rollover prediction algorithm that is applied to fixed objects only. However, as much as 86 percent of all rollovers occur on roadside features that do not include fixed objects [15]. Instead, RSAP attempts to account for these rollovers by increasing severity indices for the associated feature, such as a foreslope [3].

RSAP uses speed distributions for various functional classes that were based on a study completed before the national speed limit was lifted [33]. In order to predict encroachment speeds indicative of today's traffic, a new study should be undertaken following the same procedures used by Mak, Sicking, and Ross to determine speed distributions without the influence of the national speed limit.

Cross-median crashes are not simulated explicitly. This approach may have a profound effect on the results of a BC analysis because these crashes are typically severe. If a vehicle has encroached that far, a possible reason may be that the driver is already unconscious (for example). In this event, the impact speed and angle may also be severe. Striking a fixed object under these conditions could be worse than a typical impact with a fixed object, provided the driver has time to break in the latter event before striking the object. Head-on collisions are also completely ignored because RSAP assumes one vehicle at a time per simulation. Obviously, the benefit of a median barrier would be greatly underestimated if one of these head-on collisions were possible.

Finally, access density is not considered in RSAP. These access points would include on and off ramps on interstates. These locations experience the greatest crash frequency. This increased frequency is in part due to the changes in driver interactions, as vehicles are added to or removed from the roadway (recall that only one vehicle is simulated).

12.2.2 Cooper Data

Cooper used a statistical design that was dependent on the outcome. In other words, bias was introduced into the data set. This had the tendency to inflate extreme events (e.g., high and low encroachment rates were made higher and lower). However, the extent of this bias was and remains unknown.

The results of Cooper's data showed a similar relationship between ADT and encroachment frequency as Hutchinson and Kennedy's data showed. However, the latter study's encroachment rate was shown to be influenced by seasonal effects more than the traffic volume [13]. This reanalysis of the classic study had not been performed on the Cooper data yet but needs to be done to determine if traffic volume alone can be used to describe the encroachment frequency.

The data was collected in the late 1970s. Technological and mathematical break throughs had not yet been achieved that would have allowed the author to collect and analyze the data in a better way. With a wider network of traffic cameras, perhaps more encroachment data could have been taken. At the time of the report, Cooper's statistical approach was based on the relatively new concept of clustering. It was this approach that ultimately led to the bias previously mentioned. Today's clustering approach is used in studies like the Census, in which statistical tools have been developed that can handle clustered data.

No distinction was made in the data set between controlled and uncontrolled encroachments. This distinction could not be made either because the intent of the driver was impossible to determine. Controlled encroachments could include pulling over to switch drivers, among many other possibilities. Attempts have been made to estimate the number of controlled verses uncontrolled accidents for various roadside features, but applying this ratio to the Cooper data, as RSAP does, needs investigated further. Unfortunately, due to the enormous cost that would be associated with a study to ascertain the intent behind each encroachment, the current practice utilized by RSAP had to be sufficient.

Finally, the small sample size of the Cooper data was a concern. The intent of that study was to increase the sample size by creating smaller segments of the highway. However, this also reduced the number of encroachments per segment, which statistically did nothing to improve the results of the analysis. Only when additional segments are studied and/or the time included in the data collection is extended will the sample size be increased, which can only lend stability to the statistical results.

12.2.3 Discrepancies, Bugs, and Errors

Since the completion of the RSAP code, several problems have been discovered. Because the code is very large, it remains possible that more problems exist. Currently known problems include discrepancies between what is coded and what is mentioned in the Engineer's Manual, bugs, and errors. Bugs are caused by programming errors relative to the language used. Errors are mistakes in the code that lead to incorrect results. All three of these problems have been found in the current code. In an ongoing project intended to update RSAP, Dr. Malcolm Ray and his research team have discovered many of these errors. They are outlined in the draft report of that project (NCHRP Project No. 22-27) [16]. The problems are only listed here. For a more detailed description of the problems, see the draft report of NCHRP Project No. 22-27.

12.2.3.1 Discrepancies

- Base encroachment rates for two-lane undivided and multi-lane divided highways do not have the same adjustment factor in the code as are presented in the Engineer's Manual.
- Lane encroachment rates are equal for all lanes despite unequal traffic volume distributions, which should indicate differing encroachment rates as demonstrated by the Cooper data.
- The probability of the lateral extent of encroachment uses a cubic function instead of the correct exponential function. As a result, the probability may be negative for extents greater than 72 ft (22 m). These negative probabilities are then forced to zero; however, the exponential function would indicate a positive probability.
- The traffic growth factor in the code increases the ADT each year and adjusts the encroachment frequency accordingly. The Engineer's Manual says it increases in only one increment, at the time of the design life. In this discrepancy alone, the code appears to be more accurate than the Engineer's Manual.

12.2.3.2 Bugs or Errors

- Base encroachment rates are not reduced to 60 percent for the effect of unreported accidents on two-lane undivided and one-way highways.
- The traffic growth factor is divided by 100 to get a decimal form of the percentage. It is then divided by 100 again by mistake when determining the encroachment frequency.

- Highway types are distinguished between undivided, divided, and one-way highways; however, RSAP appears to change how these categories are referenced. It is possible that the highway type is incorrectly chosen.
- Curvature adjustments in the vehicle swath equations convert the degrees to a radius in units of 100-ft (30.5-m) stations; however, that radius is used as if it were in units of 328-ft (100-m) stations. This problem is only applicable to the user interface. If the radius of curvature is specified in the data files, the conversion from radius to degree is correct. The original code was in U.S. units but was converted to SI units. Due to the large size of the code, it is possible that more unit conversion errors exist.
- Lane encroachment rates are approximately half of what they should be for two-lane undivided highways.

13 NOTATION

*All notations are given in alphabetical order.

#(K+A) = Number of fatal and severe injury accidents
1V:XH = Slope designation describing a foreslope
A_X = Area of the cross-section of the new slope
A = Severe injury accident
AC = Annualized accident cost
AccCost = Accident cost
ADT = Traffic volume in vehicles per day (vpd)
A_I = Area of the cross-section of the minimum slope
A_{II} = Area of the cross-section of the new minus the original slope
B = Moderate injury accident
b = Slope of the equation to determine *AccCost*
$BC_{2\text{-}1}$ = Incremental benefit/cost ratio of alternative 2 compared to alternative 1
b_1 = Base of the cross-sectional area of the minimum slope
b_2 = Base of the cross-sectional area of the new slope
C = Slight injury accident
DC = Annualized direct cost
F = Flare rate of the guardrail
h = Height of the foreslope
H = Horizontal component of the foreslope
i = Interest rate
K = Fatal accident
l = Length of the foreslope
L = Total length of guardrail required
L_1 = Buffer length of guardrail = 25 ft (7.6 m)
L_2 = Offset of the guardrail
L_R = Runout length
n = Design life
O = Property damage only (PDO) accident
P = Principal investment required for construction
S = Horizontal component of the foreslope designation (S = X in the form 1V:XH)
SI = Severity index
t = Time between Consumer Price Index readings
v = Impact speed in terms of miles per hour
V = Vertical component of the foreslope
V_{borrow} = Volume of borrowed soil required to meet V_{fill} demand
V_{fill} = Volume of fill required to flatten the slope

x = Length of guardrail required beyond the 25-ft (7.6-m) buffer
X_I = Slope of the baseline foreslope (1V:X_IH)
X_{II} = Slope of the baseline foreslope (1V:X_{II}H)
φ_2 = Accident rate equation for 1V:2H slopes
φ_3 = Accident rate equation for 1V:3H slopes
φ_4 = Accident rate equation for 1V:4H slopes
$(\bar{\gamma}_d)_c$ = Average dry unit weight of borrow soil
$(\bar{\gamma}_d)_f$ = Average dry unit weight of fill soil
$\frac{\Delta V}{V_f}$ = Shrinkage factor applied to borrow soil

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15 APPENDICES

Appendix A. Roadway Description Inventory Example

DISTRICT - 09 ROADWAY DESCRIPTION INVENTORY REPORT - DESTAPE RT-02N PAGE- 1
COUNTY - ADA RUN DATE: 10/25/2010

LOCATION ROUTE	LOGPT	DIR	MUNI/TWP (M/T-) NAME	REFERENCE TYPE	CROSS ROUTE NUMBER	LOGPT	REFERENCE POINT DESCRIPTION		STLOG	LATITUDE	LONGITUDE
SR 0032R	00.000	1 E	T-WINCHESTER	BEGIN ROUTE -A			LEAVE BRO CO AT 19832		044.142	38.946967	-83.679363
SR 0032R	00.334	1 E	M-WINCHESTER	CORP LIMIT -C			ENTER WINCHESTER		044.476	38.943555	-83.674984
SR 0032R	00.620	1 E	M-WINCHESTER	INTERSECTION -I	TR 00048	00.645	T00048 DORSEY	RO	044.762	38.940461	-83.671447
SR 0032R	00.658	1 E	M-WINCHESTER	CORP LIMIT -C			LEAVE WINCHESTER		044.800	38.940047	-83.670974
SR 0032R	00.807	1 E	T-WINCHESTER	RAILRD UNDER -N			NORFOLK SOUTHERN R R		044.949	38.938411	-83.669111
SR 0032R	00.999	1 E	T-WINCHESTER	MILEPOST -M			MILE POST = 001		045.141	38.936444	-83.666617
SR 0032R	01.101	1 E	M-WINCHESTER	CORP LIMIT -C			ENTER WINCHESTER		045.243	38.935726	-83.664993
SR 0032R	01.708	1 E	M-WINCHESTER	INTERSECTION -I	SR 00136R	18.949	S00136R MAIN	ST	045.850	38.934939	-83.653825
SR 0032R	02.293	1 E	M-WINCHESTER	CORP LIMIT -C			LEAVE WINCHESTER		046.435	38.934577	-83.642984
SR 0032R	02.841	1 E	T-WINCHESTER	INTERSECTION -I	CR 00001	27.059	C00001 GRACES RUN	RO	046.983	38.934229	-83.632811
SR 0032R	02.961	1 E	T-WINCHESTER	MILEPOST -M			MILE POST = 003		047.103	38.934152	-83.630559
SR 0032R	03.524	1 E	T-WINCHESTER	INTERSECTION -I	TR 00325	00.304	T00325 REED	RO	047.666	38.933798	-83.620163
SR 0032R	03.987	1 E	T-WINCHESTER	MILEPOST -M			MILE POST = 004		048.129	38.933501	-83.611458
SR 0032R	04.796	1 E	T-SCOTT	INTERSECTION -I	CR 00060	01.704	C00060 MOORES	RO	048.938	38.932995	-83.596576
SR 0032R	04.985	1 E	T-SCOTT	MILEPOST -M			MILE POST = 005		049.127	38.932866	-83.592914
SR 0032R	05.985	1 E	T-SCOTT	MILEPOST -M			MILE POST = 006		050.127	38.932230	-83.574370
SR 0032R	06.133	1 E	M-SEAMAN	CORP LIMIT -C			ENTER SEAMAN		050.275	38.932140	-83.571773
SR 0032R	06.277	1 E	M-SEAMAN	INTERSECTION -I	SR 00247R	17.125	S00247R MAIN	ST	050.419	38.932053	-83.569102
SR 0032R	06.657	1 E	M-SEAMAN	CORP LIMIT -C			LEAVE SEAMAN		050.799	38.931807	-83.562064
SR 0032R	06.657	1 E	T-SCOTT	INTERSECTION -I	CR 00014	00.677	C00014 TRANQUILITY	PI	050.799	38.931807	-83.562064
SR 0032R	06.973	1 E	T-SCOTT	MILEPOST -M			MILE POST = 007		051.115	38.931610	-83.556316
SR 0032R	07.992	1 E	T-SCOTT	MILEPOST -M			MILE POST = 008		052.134	38.929684	-83.537602
SR 0032R	08.508	1 E	T-SCOTT	INTERSECTION -I	CR 00039	02.667	C00039 BURNT CABIN	ROR	052.650	38.928145	-83.528135
SR 0032R	08.508	2 E	T-SCOTT	INTERSECTION -I	TR 01097	00.969	T01097 NATHAN DENTON	ROL	052.650	38.928145	-83.528135
SR 0032R	08.999	1 E	T-SCOTT	MILEPOST -M			MILE POST = 009		053.141	38.926693	-83.519253
SR 0032R	09.269	1 E	T-SCOTT	BRIDGE -G			BRIDGE		053.411	38.925890	-83.514349
SR 0032R	09.610	1 E	T-OLIVER	INTERSECTION -I	CR 00010	12.649	C00010 UNITY	RO	053.752	38.926799	-83.508261
SR 0032R	09.989	1 E	T-OLIVER	MILEPOST -M			MILE POST = 010		054.131	38.928425	-83.501605
SR 0032R	10.338	1 E	T-OLIVER	INTERSECTION -I	TR 02004	00.013	T02004 BARRY MCFARLAND	DR	054.480	38.929319	-83.495213
SR 0032R	10.986	1 E	T-OLIVER	MILEPOST -M			MILE POST = 011		055.128	38.933005	-83.484219
SR 0032R	11.104	1 E	T-OLIVER	INTERSECTION -I	TR 00088	05.217	T00088 TATER RIDGE	RO	055.246	38.933305	-83.482100
SR 0032R	11.575	1 E	T-OLIVER	INTERSECTION -I	TR 00092	01.315	T00092 PETERSON	RO	055.717	38.934537	-83.473500
SR 0032R	11.831	1 E	T-OLIVER	BRIDGE -G			BRIDGE		055.973	38.935727	-83.469075
SR 0032R	11.992	1 E	T-MEIGS	INTERSECTION -I	CR 00013	03.244	C00013 LAWSHE	ROR	056.134	38.936674	-83.466272
SR 0032R	11.992	2 E	T-MEIGS	INTERSECTION -I	CR 00103	00.000	C00103 DOWNING	ROL	056.134	38.936674	-83.466272
SR 0032R	12.026	1 E	T-MEIGS	MILEPOST -M			MILE POST = 012		056.168	38.936879	-83.465669
SR 0032R	13.008	1 E	T-MEIGS	MILEPOST -M			MILE POST = 013		057.150	38.936163	-83.447887
SR 0032R	13.299	1 E	T-MEIGS	INTERSECTION -I	CR 00041	01.373	C00041 MEASLEY RIDGE	RO	057.441	38.935424	-83.442578
SR 0032R	13.995	1 E	T-MEIGS	MILEPOST -M			MILE POST = 014		058.137	38.933828	-83.429765
SR 0032R	14.699	1 E	T-MEIGS	INTERSECTION -I	SR 00041R	25.198	S00041R SR-41		058.841	38.933756	-83.416791
SR 0032R	14.992	1 E	T-MEIGS	MILEPOST -M			MILE POST = 015		059.134	38.934417	-83.411416
SR 0032R	15.967	1 E	T-MEIGS	INTERSECTION -I	CR 00027	09.701	C00027 STEAM FURNACE	RO	060.109	38.936846	-83.393592
SR 0032R	15.990	1 E	T-MEIGS	MILEPOST -M			MILE POST = 016		060.132	38.936908	-83.393124
SR 0032R	16.593	1 E	T-MEIGS	INTERSECTION -I	TR 00130	00.319	T00130 MENDENHALL	RO	060.735	38.941465	-83.383986
SR 0032R	16.987	1 E	T-MEIGS	RAILRD UNDER -N			NORFOLK SOUTHERN R R		061.129	38.946487	-83.380269
SR 0032R	17.007	1 E	T-MEIGS	MILEPOST -M			MILE POST = 017		061.149	38.946739	-83.380085
SR 0032R	18.000	1 E	T-MEIGS	MILEPOST -M			MILE POST = 018		062.142	38.954595	-83.365135
SR 0032R	18.088	1 E	T-FRANKLIN	INTERSECTION -I	TR 00126	02.174	T00126 PLUM RUN	RO	062.230	38.955391	-83.363946
SR 0032R	18.483	1 E	T-FRANKLIN	INTERSECTION -I	CR 00198	02.930	C00198 PORTSMOUTH	RO	062.625	38.959562	-83.358906
SR 0032R	19.002	1 E	T-FRANKLIN	MILEPOST -M			MILE POST = 019		063.144	38.965065	-83.352298
SR 0032R	19.409	1 E	T-FRANKLIN	BRIDGE -G			BRIDGE		063.551	38.969407	-83.347095
SR 0032R	19.984	1 E	T-FRANKLIN	INTERSECTION -I	SR 00073R	10.379	S00073R SR-73		064.126	38.974894	-83.339228

Appendix B. 1V:2H Freeway

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	2.89	7.08E-06
				7	2.88	5.09E-06
				12	2.89	4.01E-06
			7	2	3.15	7.25E-06
				7	3.14	5.31E-06
				12	3.14	4.20E-06
			13	2	3.34	7.97E-06
				7	3.34	6.05E-06
				12	3.34	4.82E-06
		800	1	2	2.88	2.77E-05
				7	2.89	2.16E-05
				12	2.89	1.76E-05
			7	2	3.14	2.63E-05
				7	3.15	2.08E-05
				12	3.15	1.70E-05
			13	2	3.34	2.71E-05
				7	3.35	2.12E-05
				12	3.35	1.71E-05
		1400	1	2	2.89	4.93E-05
				7	2.89	3.88E-05
				12	2.88	3.12E-05
			7	2	3.15	4.48E-05
				7	3.16	3.57E-05
				12	3.14	2.93E-05
			13	2	3.34	4.67E-05
				7	3.35	3.66E-05
				12	3.34	3.01E-05
	2	200	1	2	2.88	6.81E-06
				7	2.88	5.12E-06
				12	2.88	3.91E-06
			7	2	3.13	6.91E-06
				7	3.16	5.34E-06
				12	3.14	4.30E-06
			13	2	3.33	7.90E-06
				7	3.35	5.73E-06
				12	3.34	4.90E-06
		800	1	2	2.89	2.79E-05
				7	2.89	2.19E-05
				12	2.88	1.77E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	2	800	7	2	3.16	2.60E-05
				7	3.15	2.07E-05
				12	3.15	1.67E-05
			13	2	3.34	2.69E-05
				7	3.35	2.14E-05
				12	3.35	1.72E-05
		1400	1	2	2.88	4.92E-05
				7	2.88	3.88E-05
				12	2.89	3.15E-05
			7	2	3.15	4.59E-05
				7	3.15	3.56E-05
				12	3.15	2.91E-05
			13	2	3.34	4.64E-05
				7	3.35	3.74E-05
				12	3.34	2.94E-05
	3	200	1	2	2.88	7.91E-06
				7	2.90	5.74E-06
				12	2.88	4.34E-06
			7	2	3.16	7.82E-06
				7	3.16	5.91E-06
				12	3.16	4.61E-06
			13	2	3.34	8.74E-06
				7	3.36	6.98E-06
				12	3.34	5.48E-06
		800	1	2	2.89	3.14E-05
				7	2.89	2.40E-05
				12	2.89	1.98E-05
			7	2	3.15	2.92E-05
				7	3.15	2.34E-05
				12	3.14	1.87E-05
			13	2	3.35	3.04E-05
				7	3.35	2.38E-05
				12	3.34	1.97E-05
		1400	1	2	2.89	5.51E-05
				7	2.88	4.38E-05
				12	2.88	3.58E-05
			7	2	3.15	5.09E-05
				7	3.15	4.05E-05
				12	3.15	3.31E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	1400	13	2	3.34	5.26E-05
				7	3.34	4.16E-05
				12	3.35	3.35E-05
2	0	200	1	2	2.87	5.47E-06
				7	2.90	3.80E-06
				12	2.87	2.45E-06
			7	2	3.15	5.06E-06
				7	3.16	3.37E-06
				12	3.14	2.38E-06
			13	2	3.34	5.39E-06
				7	3.35	3.64E-06
				12	3.35	2.54E-06
		800	1	2	2.87	2.56E-05
				7	2.88	1.91E-05
				12	2.88	1.55E-05
			7	2	3.15	2.32E-05
				7	3.15	1.75E-05
				12	3.15	1.42E-05
			13	2	3.35	2.33E-05
				7	3.34	1.77E-05
				12	3.34	1.42E-05
		1400	1	2	2.89	4.40E-05
				7	2.89	3.39E-05
				12	2.88	2.77E-05
			7	2	3.15	3.98E-05
				7	3.15	3.08E-05
				12	3.15	2.51E-05
			13	2	3.35	4.06E-05
				7	3.35	3.15E-05
				12	3.34	2.53E-05
	2	200	1	2	2.89	5.26E-06
				7	2.88	3.59E-06
				12	2.88	2.50E-06
			7	2	3.16	5.31E-06
				7	3.15	3.30E-06
				12	3.15	2.36E-06
			13	2	3.34	5.22E-06
				7	3.33	3.59E-06
				12	3.36	2.60E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
2	2	800	1	2	2.90	2.49E-05
				7	2.88	1.91E-05
				12	2.88	1.50E-05
			7	2	3.15	2.26E-05
				7	3.15	1.72E-05
				12	3.15	1.40E-05
			13	2	3.35	2.33E-05
				7	3.35	1.80E-05
				12	3.34	1.40E-05
		1400	1	2	2.89	4.36E-05
				7	2.89	3.38E-05
				12	2.88	2.75E-05
			7	2	3.15	3.98E-05
				7	3.15	3.04E-05
				12	3.15	2.50E-05
			13	2	3.34	4.01E-05
				7	3.35	3.15E-05
				12	3.35	2.53E-05
	3	200	1	2	2.89	6.20E-06
				7	2.89	4.00E-06
				12	2.88	2.70E-06
			7	2	3.14	5.25E-06
				7	3.16	3.68E-06
				12	3.15	2.63E-06
			13	2	3.33	6.01E-06
				7	3.34	3.90E-06
				12	3.34	2.96E-06
		800	1	2	2.89	2.83E-05
				7	2.88	2.17E-05
				12	2.89	1.73E-05
			7	2	3.15	2.56E-05
				7	3.16	1.98E-05
				12	3.15	1.60E-05
			13	2	3.35	2.58E-05
				7	3.34	2.02E-05
				12	3.34	1.61E-05
		1400	1	2	2.89	4.95E-05
				7	2.88	3.83E-05
				12	2.89	3.11E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
2	3	1400	7	2	3.15	4.47E-05
				7	3.15	3.45E-05
				12	3.15	2.82E-05
			13	2	3.34	4.46E-05
				7	3.35	3.51E-05
				12	3.34	2.87E-05
3	0	200	1	2	2.87	6.20E-06
				7	2.88	3.95E-06
				12	2.90	2.78E-06
			7	2	3.16	5.51E-06
				7	3.15	3.70E-06
				12	3.16	2.51E-06
			13	2	3.34	5.77E-06
				7	3.33	3.64E-06
				12	3.34	2.66E-06
		800	1	2	2.88	2.69E-05
				7	2.88	2.05E-05
				12	2.89	1.59E-05
			7	2	3.15	2.44E-05
				7	3.15	1.88E-05
				12	3.16	1.46E-05
			13	2	3.34	2.42E-05
				7	3.34	1.91E-05
				12	3.35	1.49E-05
		1400	1	2	2.89	4.54E-05
				7	2.88	3.62E-05
				12	2.89	2.86E-05
			7	2	3.15	4.14E-05
				7	3.15	3.28E-05
				12	3.15	2.60E-05
			13	2	3.35	4.18E-05
				7	3.34	3.24E-05
				12	3.34	2.64E-05
	2	200	1	2	2.89	5.97E-06
				7	2.89	3.98E-06
				12	2.91	2.87E-06
			7	2	3.15	5.68E-06
				7	3.15	3.53E-06
				12	3.15	2.53E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	2	200	13	2	3.33	5.47E-06
				7	3.33	3.70E-06
				12	3.33	2.63E-06
		800	1	2	2.89	2.67E-05
				7	2.89	2.08E-05
				12	2.88	1.61E-05
			7	2	3.15	2.43E-05
				7	3.16	1.86E-05
				12	3.14	1.47E-05
			13	2	3.35	2.44E-05
				7	3.34	1.83E-05
				12	3.34	1.46E-05
		1400	1	2	2.88	4.48E-05
				7	2.88	3.60E-05
				12	2.89	2.81E-05
			7	2	3.15	4.14E-05
				7	3.15	3.19E-05
				12	3.16	2.59E-05
			13	2	3.34	4.17E-05
				7	3.34	3.19E-05
				12	3.35	2.63E-05
	3	200	1	2	2.90	6.72E-06
				7	2.87	4.20E-06
				12	2.88	3.10E-06
			7	2	3.16	6.17E-06
				7	3.14	3.95E-06
				12	3.16	2.94E-06
			13	2	3.34	6.25E-06
				7	3.34	4.12E-06
				12	3.35	3.04E-06
		800	1	2	2.88	3.06E-05
				7	2.90	2.29E-05
				12	2.88	1.79E-05
			7	2	3.15	2.73E-05
				7	3.16	2.08E-05
				12	3.15	1.68E-05
			13	2	3.35	2.74E-05
				7	3.35	2.16E-05
				12	3.34	1.67E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	3	1400	1	2	2.88	5.10E-05
				7	2.88	4.01E-05
				12	2.89	3.18E-05
			7	2	3.15	4.65E-05
				7	3.14	3.64E-05
				12	3.15	2.86E-05
			13	2	3.34	4.70E-05
				7	3.34	3.69E-05
				12	3.35	2.92E-05

Appendix C. 1V:2H Undivided Rural Arterial

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	2.30	4.65E-06
				7	2.30	3.24E-06
				12	2.29	2.31E-06
			7	2	2.67	4.47E-06
				7	2.50	3.19E-06
				12	2.51	2.20E-06
			13	2	2.68	4.88E-06
				7	2.65	3.30E-06
				12	2.66	2.31E-06
		800	1	2	2.29	1.73E-05
				7	2.31	1.26E-05
				12	2.30	8.91E-06
			7	2	2.67	1.53E-05
				7	2.50	1.15E-05
				12	2.51	8.17E-06
			13	2	2.66	1.57E-05
				7	2.67	1.12E-05
				12	2.66	8.08E-06
		1400	1	2	2.30	3.04E-05
				7	2.29	2.22E-05
				12	2.30	1.59E-05
			7	2	2.66	2.66E-05
				7	2.51	1.96E-05
				12	2.51	1.40E-05
			13	2	2.66	2.69E-05
				7	2.66	1.93E-05
				12	2.67	1.37E-05
	3	200	1	2	2.30	5.18E-06
				7	2.29	3.71E-06
				12	2.31	2.46E-06
			7	2	2.66	5.16E-06
				7	2.51	3.56E-06
				12	2.51	2.54E-06
			13	2	2.67	5.46E-06
				7	2.66	3.79E-06
				12	2.66	2.63E-06
		800	1	2	2.30	1.98E-05
				7	2.30	1.43E-05
				12	2.30	9.99E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	800	7	2	2.66	1.72E-05
				7	2.50	1.31E-05
				12	2.51	9.12E-06
			13	2	2.66	1.82E-05
				7	2.66	1.31E-05
				12	2.67	8.98E-06
		1400	1	2	2.30	3.42E-05
				7	2.30	2.47E-05
				12	2.30	1.76E-05
			7	2	2.67	2.98E-05
				7	2.52	2.22E-05
				12	2.51	1.59E-05
			13	2	2.66	2.99E-05
				7	2.66	2.17E-05
				12	2.67	1.53E-05
	6	200	1	2	2.30	7.24E-06
				7	2.30	4.77E-06
				12	2.32	3.28E-06
			7	2	2.65	6.80E-06
				7	2.52	4.91E-06
				12	2.52	3.33E-06
			13	2	2.65	7.30E-06
				7	2.67	4.84E-06
				12	2.67	3.43E-06
		800	1	2	2.31	2.60E-05
				7	2.30	1.88E-05
				12	2.31	1.33E-05
			7	2	2.66	2.37E-05
				7	2.51	1.71E-05
				12	2.51	1.20E-05
			13	2	2.66	2.39E-05
				7	2.67	1.70E-05
				12	2.66	1.20E-05
		1400	1	2	2.29	4.60E-05
				7	2.30	3.34E-05
				12	2.30	2.39E-05
			7	2	2.66	3.98E-05
				7	2.51	2.97E-05
				12	2.51	2.05E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	1400	13	2	2.67	4.03E-05
				7	2.67	2.92E-05
				12	2.67	2.04E-05
3	0	200	1	2	2.32	3.74E-06
				7	2.30	2.37E-06
				12	2.32	1.44E-06
			7	2	2.69	3.34E-06
				7	2.51	2.11E-06
				12	2.50	1.37E-06
			13	2	2.65	3.59E-06
				7	2.66	2.08E-06
				12	2.65	1.31E-06
		800	1	2	2.30	1.61E-05
				7	2.30	1.12E-05
				12	2.29	7.80E-06
			7	2	2.66	1.37E-05
				7	2.51	9.86E-06
				12	2.51	6.89E-06
			13	2	2.66	1.36E-05
				7	2.66	9.73E-06
				12	2.66	6.84E-06
		1400	1	2	2.30	2.71E-05
				7	2.30	1.95E-05
				12	2.30	1.35E-05
			7	2	2.67	2.32E-05
				7	2.51	1.67E-05
				12	2.51	1.17E-05
			13	2	2.66	2.31E-05
				7	2.66	1.65E-05
				12	2.67	1.15E-05
	3	200	1	2	2.31	4.53E-06
				7	2.28	2.73E-06
				12	2.29	1.82E-06
			7	2	2.64	3.93E-06
				7	2.51	2.36E-06
				12	2.48	1.60E-06
			13	2	2.67	3.83E-06
				7	2.67	2.26E-06
				12	2.67	1.42E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	3	800	1	2	2.31	1.75E-05
				7	2.30	1.29E-05
				12	2.30	8.90E-06
			7	2	2.66	1.53E-05
				7	2.51	1.10E-05
				12	2.50	7.69E-06
			13	2	2.67	1.56E-05
				7	2.66	1.09E-05
				12	2.66	7.39E-06
		1400	1	2	2.30	3.07E-05
				7	2.30	2.18E-05
				12	2.29	1.53E-05
			7	2	2.66	2.61E-05
				7	2.51	1.89E-05
				12	2.51	1.34E-05
			13	2	2.66	2.62E-05
				7	2.67	1.87E-05
				12	2.66	1.30E-05
	6	200	1	2	2.33	5.67E-06
				7	2.29	3.50E-06
				12	2.32	2.18E-06
			7	2	2.67	4.93E-06
				7	2.51	3.12E-06
				12	2.50	1.95E-06
			13	2	2.68	5.13E-06
				7	2.65	3.15E-06
				12	2.67	1.95E-06
		800	1	2	2.30	2.38E-05
				7	2.30	1.68E-05
				12	2.30	1.16E-05
			7	2	2.67	2.00E-05
				7	2.52	1.50E-05
				12	2.50	1.03E-05
			13	2	2.66	2.04E-05
				7	2.65	1.49E-05
				12	2.67	9.93E-06
		1400	1	2	2.30	4.05E-05
				7	2.30	2.90E-05
				12	2.29	2.07E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	6	1400	7	2	2.66	3.44E-05
3	6	1400	7	7	2.51	2.50E-05
3	6	1400	7	12	2.50	1.76E-05
3	6	1400	13	2	2.66	3.47E-05
3	6	1400	13	7	2.67	2.46E-05
3	6	1400	13	12	2.67	1.71E-05
6	0	200	1	2	2.32	1.11E-05
6	0	200	1	7	2.30	8.05E-06
6	0	200	1	12	2.30	4.84E-06
6	0	200	7	2	2.65	1.00E-05
6	0	200	7	7	2.50	6.78E-06
6	0	200	7	12	2.53	4.15E-06
6	0	200	13	2	2.64	1.01E-05
6	0	200	13	7	2.68	6.22E-06
6	0	200	13	12	2.65	4.41E-06
6	0	800	1	2	2.30	4.75E-05
6	0	800	1	7	2.30	3.32E-05
6	0	800	1	12	2.29	2.36E-05
6	0	800	7	2	2.66	4.03E-05
6	0	800	7	7	2.50	2.96E-05
6	0	800	7	12	2.51	2.04E-05
6	0	800	13	2	2.66	3.97E-05
6	0	800	13	7	2.67	2.81E-05
6	0	800	13	12	2.66	2.01E-05
6	0	1400	1	2	2.30	7.73E-05
6	0	1400	1	7	2.29	5.48E-05
6	0	1400	1	12	2.29	3.89E-05
6	0	1400	7	2	2.67	6.54E-05
6	0	1400	7	7	2.51	4.77E-05
6	0	1400	7	12	2.51	3.38E-05
6	0	1400	13	2	2.66	6.52E-05
6	0	1400	13	7	2.66	4.65E-05
6	0	1400	13	12	2.66	3.29E-05
6	3	200	1	2	2.29	1.27E-05
6	3	200	1	7	2.28	8.89E-06
6	3	200	1	12	2.31	5.21E-06
6	3	200	7	2	2.65	1.15E-05
6	3	200	7	7	2.51	7.68E-06
6	3	200	7	12	2.50	4.87E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	3	200	13	2	2.68	1.10E-05
				7	2.66	7.23E-06
				12	2.64	4.78E-06
		800	1	2	2.30	5.28E-05
				7	2.30	3.84E-05
				12	2.29	2.62E-05
			7	2	2.65	4.55E-05
				7	2.51	3.26E-05
				12	2.51	2.25E-05
			13	2	2.67	4.37E-05
				7	2.66	3.25E-05
				12	2.67	2.26E-05
		1400	1	2	2.30	8.69E-05
				7	2.31	6.16E-05
				12	2.30	4.43E-05
			7	2	2.66	7.45E-05
				7	2.51	5.30E-05
				12	2.51	3.80E-05
			13	2	2.67	7.34E-05
				7	2.66	5.25E-05
				12	2.66	3.69E-05
	6	200	1	2	2.30	1.74E-05
				7	2.31	1.13E-05
				12	2.30	7.29E-06
			7	2	2.66	1.50E-05
				7	2.50	1.09E-05
				12	2.50	6.57E-06
			13	2	2.68	1.57E-05
				7	2.68	9.40E-06
				12	2.65	6.34E-06
		800	1	2	2.30	7.02E-05
				7	2.30	5.05E-05
				12	2.29	3.62E-05
			7	2	2.66	6.06E-05
				7	2.51	4.49E-05
				12	2.50	3.09E-05
			13	2	2.67	5.97E-05
				7	2.67	4.23E-05
				12	2.66	2.98E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	6	1400	1	2	2.30	1.15E-04
				7	2.29	8.54E-05
				12	2.29	5.86E-05
			7	2	2.67	9.77E-05
				7	2.52	7.06E-05
				12	2.51	5.02E-05
			13	2	2.67	9.90E-05
				7	2.66	7.06E-05
				12	2.66	4.88E-05

Appendix D. 1V:2H Divided Rural Arterial

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	2.30	9.63E-06
				7	2.30	7.28E-06
				12	2.30	5.90E-06
			7	2	2.49	9.42E-06
				7	2.51	7.23E-06
				12	2.49	6.30E-06
			13	2	2.66	1.01E-05
				7	2.65	8.36E-06
				12	2.67	7.08E-06
		800	1	2	2.30	3.73E-05
				7	2.30	2.91E-05
				12	2.30	2.26E-05
			7	2	2.51	3.35E-05
				7	2.51	2.63E-05
				12	2.51	2.20E-05
			13	2	2.66	3.34E-05
				7	2.66	2.67E-05
				12	2.66	2.18E-05
		1400	1	2	2.30	6.41E-05
				7	2.30	5.02E-05
				12	2.29	4.16E-05
			7	2	2.51	5.69E-05
				7	2.51	4.57E-05
				12	2.51	3.70E-05
			13	2	2.67	5.80E-05
				7	2.67	4.55E-05
				12	2.66	3.71E-05
	3	200	1	2	2.29	1.04E-05
				7	2.28	8.16E-06
				12	2.32	6.36E-06
			7	2	2.50	1.10E-05
				7	2.53	8.26E-06
				12	2.51	6.85E-06
			13	2	2.66	1.19E-05
				7	2.67	9.10E-06
				12	2.67	7.84E-06
		800	1	2	2.29	4.15E-05
				7	2.30	3.25E-05
				12	2.30	2.64E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	800	7	2	2.51	3.70E-05
				7	2.51	3.01E-05
				12	2.51	2.43E-05
			13	2	2.67	3.77E-05
				7	2.66	3.00E-05
				12	2.67	2.44E-05
		1400	1	2	2.30	7.33E-05
				7	2.30	5.65E-05
				12	2.30	4.71E-05
			7	2	2.51	6.31E-05
				7	2.51	5.14E-05
				12	2.51	4.18E-05
			13	2	2.67	6.39E-05
				7	2.67	5.11E-05
				12	2.67	4.20E-05
	6	200	1	2	2.30	1.42E-05
				7	2.29	1.08E-05
				12	2.30	9.22E-06
			7	2	2.52	1.40E-05
				7	2.52	1.12E-05
				12	2.53	9.08E-06
			13	2	2.66	1.58E-05
				7	2.67	1.25E-05
				12	2.67	1.01E-05
		800	1	2	2.29	5.62E-05
				7	2.30	4.31E-05
				12	2.30	3.45E-05
			7	2	2.51	4.93E-05
				7	2.51	3.95E-05
				12	2.51	3.17E-05
			13	2	2.66	5.11E-05
				7	2.66	4.02E-05
				12	2.67	3.34E-05
		1400	1	2	2.30	9.64E-05
				7	2.30	7.65E-05
				12	2.31	6.12E-05
			7	2	2.51	8.71E-05
				7	2.51	6.91E-05
				12	2.51	5.58E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	1400	13	2	2.67	8.49E-05
				7	2.66	6.93E-05
				12	2.67	5.58E-05
3	0	200	1	2	2.29	7.87E-06
				7	2.29	5.11E-06
				12	2.29	3.63E-06
			7	2	2.52	6.70E-06
				7	2.50	4.35E-06
				12	2.49	3.04E-06
			13	2	2.66	6.56E-06
				7	2.67	4.26E-06
				12	2.65	3.22E-06
		800	1	2	2.30	3.24E-05
				7	2.30	2.49E-05
				12	2.30	1.95E-05
			7	2	2.50	2.85E-05
				7	2.51	2.16E-05
				12	2.51	1.71E-05
			13	2	2.66	2.65E-05
				7	2.66	2.09E-05
				12	2.65	1.71E-05
		1400	1	2	2.30	5.51E-05
				7	2.29	4.35E-05
				12	2.30	3.44E-05
			7	2	2.51	4.66E-05
				7	2.51	3.74E-05
				12	2.51	3.01E-05
			13	2	2.66	4.68E-05
				7	2.67	3.70E-05
				12	2.67	2.93E-05
	3	200	1	2	2.29	8.66E-06
				7	2.29	5.44E-06
				12	2.30	4.05E-06
			7	2	2.51	7.46E-06
				7	2.51	4.65E-06
				12	2.49	3.66E-06
			13	2	2.67	7.54E-06
				7	2.66	4.66E-06
				12	2.66	3.43E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	3	800	1	2	2.31	3.61E-05
				7	2.30	2.81E-05
				12	2.30	2.20E-05
			7	2	2.51	3.15E-05
				7	2.52	2.40E-05
				12	2.51	1.95E-05
			13	2	2.68	3.06E-05
				7	2.67	2.41E-05
				12	2.66	1.86E-05
		1400	1	2	2.29	6.23E-05
				7	2.29	4.92E-05
				12	2.30	3.86E-05
			7	2	2.51	5.29E-05
				7	2.51	4.18E-05
				12	2.51	3.35E-05
			13	2	2.66	5.23E-05
				7	2.67	4.16E-05
				12	2.66	3.32E-05
	6	200	1	2	2.31	1.20E-05
				7	2.30	7.33E-06
				12	2.30	5.20E-06
			7	2	2.51	9.81E-06
				7	2.51	6.32E-06
				12	2.53	4.29E-06
			13	2	2.65	1.01E-05
				7	2.66	6.32E-06
				12	2.66	5.04E-06
		800	1	2	2.30	4.86E-05
				7	2.30	3.70E-05
				12	2.30	3.02E-05
			7	2	2.51	4.18E-05
				7	2.50	3.21E-05
				12	2.51	2.55E-05
			13	2	2.67	4.10E-05
				7	2.65	3.18E-05
				12	2.67	2.53E-05
		1400	1	2	2.29	8.29E-05
				7	2.30	6.40E-05
				12	2.31	5.17E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	6	1400	7	2	2.51	7.21E-05
				7	2.50	5.63E-05
				12	2.51	4.51E-05
			13	2	2.66	7.01E-05
				7	2.66	5.58E-05
				12	2.67	4.40E-05
6	0	200	1	2	2.30	2.33E-05
				7	2.31	1.55E-05
				12	2.30	1.09E-05
			7	2	2.52	2.01E-05
				7	2.51	1.36E-05
				12	2.52	1.02E-05
			13	2	2.66	1.88E-05
				7	2.66	1.34E-05
				12	2.67	9.47E-06
		800	1	2	2.30	9.23E-05
				7	2.29	7.32E-05
				12	2.30	5.90E-05
			7	2	2.51	8.10E-05
				7	2.52	6.34E-05
				12	2.51	5.15E-05
			13	2	2.67	8.14E-05
				7	2.66	6.57E-05
				12	2.67	4.88E-05
		1400	1	2	2.30	1.52E-04
				7	2.29	1.22E-04
				12	2.30	9.78E-05
			7	2	2.51	1.32E-04
				7	2.51	1.04E-04
				12	2.50	8.50E-05
			13	2	2.67	1.31E-04
				7	2.67	1.04E-04
				12	2.66	8.36E-05
	3	200	1	2	2.29	2.68E-05
				7	2.28	1.82E-05
				12	2.30	1.30E-05
			7	2	2.51	2.15E-05
				7	2.52	1.44E-05
				12	2.51	1.18E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	3	200	13	2	2.67	2.12E-05
				7	2.67	1.53E-05
				12	2.66	1.12E-05
		800	1	2	2.30	1.05E-04
				7	2.30	8.19E-05
				12	2.30	6.66E-05
			7	2	2.50	9.40E-05
				7	2.51	7.17E-05
				12	2.50	5.90E-05
			13	2	2.65	9.18E-05
				7	2.67	6.93E-05
				12	2.67	5.37E-05
		1400	1	2	2.30	1.75E-04
				7	2.29	1.39E-04
				12	2.30	1.10E-04
			7	2	2.52	1.52E-04
				7	2.50	1.21E-04
				12	2.51	9.64E-05
			13	2	2.66	1.47E-04
				7	2.67	1.16E-04
				12	2.67	9.55E-05
	6	200	1	2	2.29	3.37E-05
				7	2.31	2.45E-05
				12	2.29	1.62E-05
			7	2	2.51	2.98E-05
				7	2.50	2.09E-05
				12	2.51	1.53E-05
			13	2	2.66	3.06E-05
				7	2.67	2.04E-05
				12	2.68	1.34E-05
		800	1	2	2.30	1.38E-04
				7	2.30	1.09E-04
				12	2.30	8.77E-05
			7	2	2.51	1.23E-04
				7	2.52	9.58E-05
				12	2.51	7.76E-05
			13	2	2.65	1.20E-04
				7	2.65	9.46E-05
				12	2.67	7.32E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	6	1400	1	2	2.30	2.36E-04
				7	2.29	1.85E-04
				12	2.30	1.47E-04
			7	2	2.51	2.02E-04
				7	2.51	1.61E-04
				12	2.50	1.26E-04
			13	2	2.66	1.99E-04
				7	2.67	1.52E-04
				12	2.66	1.25E-04

Appendix E. 1V:2H Rural Local

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	2.27	3.12E-05
				7	2.27	2.14E-05
				12	2.28	1.51E-05
			7	2	2.49	3.03E-05
				7	2.48	2.18E-05
				12	2.49	1.55E-05
			13	2	2.63	3.08E-05
				7	2.65	2.09E-05
				12	2.64	1.48E-05
		800	1	2	2.28	1.14E-04
				7	2.28	8.23E-05
				12	2.28	5.62E-05
			7	2	2.49	1.01E-04
				7	2.48	7.36E-05
				12	2.48	5.22E-05
			13	2	2.64	9.66E-05
				7	2.63	7.21E-05
				12	2.64	4.91E-05
		1400	1	2	2.27	1.90E-04
				7	2.27	1.43E-04
				12	2.27	1.01E-04
			7	2	2.48	1.73E-04
				7	2.48	1.26E-04
				12	2.48	9.02E-05
			13	2	2.64	1.62E-04
				7	2.63	1.19E-04
				12	2.64	8.40E-05
	4	200	1	2	2.27	3.91E-05
				7	2.27	2.70E-05
				12	2.28	1.89E-05
			7	2	2.48	4.04E-05
				7	2.48	2.70E-05
				12	2.49	1.97E-05
			13	2	2.64	3.78E-05
				7	2.63	2.69E-05
				12	2.64	1.87E-05
		800	1	2	2.27	1.43E-04
				7	2.28	1.00E-04
				12	2.27	7.24E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	4	800	7	2	2.48	1.24E-04
				7	2.49	9.20E-05
				12	2.48	6.63E-05
			13	2	2.63	1.21E-04
				7	2.64	8.53E-05
				12	2.64	6.10E-05
		1400	1	2	2.27	2.38E-04
				7	2.27	1.78E-04
				12	2.27	1.26E-04
			7	2	2.48	2.16E-04
				7	2.48	1.59E-04
				12	2.48	1.12E-04
			13	2	2.64	2.02E-04
				7	2.64	1.46E-04
				12	2.64	1.04E-04
	8	200	1	2	2.28	4.62E-05
				7	2.27	3.33E-05
				12	2.26	2.26E-05
			7	2	2.48	4.73E-05
				7	2.48	3.25E-05
				12	2.49	2.25E-05
			13	2	2.64	4.42E-05
				7	2.64	3.19E-05
				12	2.64	2.22E-05
		800	1	2	2.28	1.69E-04
				7	2.27	1.22E-04
				12	2.27	8.62E-05
			7	2	2.48	1.56E-04
				7	2.49	1.11E-04
				12	2.48	7.98E-05
			13	2	2.64	1.46E-04
				7	2.63	1.05E-04
				12	2.64	7.35E-05
		1400	1	2	2.28	2.87E-04
				7	2.27	2.13E-04
				12	2.27	1.51E-04
			7	2	2.48	2.59E-04
				7	2.48	1.92E-04
				12	2.48	1.34E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	8	1400	13	2	2.64	2.42E-04
				7	2.63	1.78E-04
				12	2.64	1.27E-04
4	0	200	1	2	2.26	5.56E-05
				7	2.27	3.91E-05
				12	2.28	2.59E-05
			7	2	2.48	5.16E-05
				7	2.50	3.58E-05
				12	2.50	2.34E-05
			13	2	2.65	4.74E-05
				7	2.64	3.46E-05
				12	2.63	2.28E-05
		800	1	2	2.27	2.26E-04
				7	2.28	1.59E-04
				12	2.28	1.16E-04
			7	2	2.48	1.94E-04
				7	2.48	1.43E-04
				12	2.49	9.99E-05
			13	2	2.64	1.85E-04
				7	2.64	1.34E-04
				12	2.64	9.37E-05
		1400	1	2	2.27	3.88E-04
				7	2.28	2.78E-04
				12	2.27	1.95E-04
			7	2	2.49	3.39E-04
				7	2.49	2.45E-04
				12	2.49	1.73E-04
			13	2	2.64	3.10E-04
				7	2.63	2.29E-04
				12	2.64	1.61E-04
	4	200	1	2	2.27	7.10E-05
				7	2.28	4.92E-05
				12	2.30	3.29E-05
			7	2	2.48	6.55E-05
				7	2.49	4.32E-05
				12	2.49	2.95E-05
			13	2	2.64	6.09E-05
				7	2.64	4.14E-05
				12	2.64	2.72E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	4	800	1	2	2.27	2.73E-04
				7	2.28	1.99E-04
				12	2.27	1.39E-04
			7	2	2.48	2.45E-04
				7	2.48	1.78E-04
				12	2.49	1.26E-04
			13	2	2.64	2.31E-04
				7	2.63	1.68E-04
				12	2.64	1.15E-04
		1400	1	2	2.28	4.81E-04
				7	2.27	3.48E-04
				12	2.27	2.50E-04
			7	2	2.48	4.25E-04
				7	2.48	3.10E-04
				12	2.48	2.16E-04
			13	2	2.64	3.94E-04
				7	2.64	2.84E-04
				12	2.63	2.02E-04
	8	200	1	2	2.26	8.80E-05
				7	2.28	5.79E-05
				12	2.28	3.78E-05
			7	2	2.49	7.59E-05
				7	2.48	5.15E-05
				12	2.49	3.64E-05
			13	2	2.64	7.03E-05
				7	2.64	5.07E-05
				12	2.63	3.42E-05
		800	1	2	2.27	3.34E-04
				7	2.28	2.41E-04
				12	2.27	1.71E-04
			7	2	2.49	2.96E-04
				7	2.48	2.14E-04
				12	2.49	1.48E-04
			13	2	2.64	2.73E-04
				7	2.64	2.01E-04
				12	2.64	1.40E-04
		1400	1	2	2.27	5.73E-04
				7	2.28	4.12E-04
				12	2.28	2.90E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	8	1400	7	2	2.48	5.03E-04
				7	2.49	3.67E-04
				12	2.48	2.61E-04
			13	2	2.63	4.76E-04
				7	2.64	3.45E-04
				12	2.63	2.39E-04
8	0	200	1	2	2.26	8.97E-05
				7	2.28	5.41E-05
				12	2.27	3.59E-05
			7	2	2.49	7.17E-05
				7	2.48	4.99E-05
				12	2.48	3.07E-05
			13	2	2.65	6.81E-05
				7	2.63	4.62E-05
				12	2.63	2.98E-05
		800	1	2	2.27	3.04E-04
				7	2.28	2.15E-04
				12	2.27	1.55E-04
			7	2	2.48	2.64E-04
				7	2.48	1.92E-04
				12	2.49	1.34E-04
			13	2	2.63	2.47E-04
				7	2.64	1.81E-04
				12	2.64	1.26E-04
		1400	1	2	2.28	4.82E-04
				7	2.27	3.63E-04
				12	2.27	2.46E-04
			7	2	2.49	4.26E-04
				7	2.48	3.12E-04
				12	2.49	2.20E-04
			13	2	2.64	4.01E-04
				7	2.64	2.91E-04
				12	2.64	2.01E-04
	4	200	1	2	2.28	1.02E-04
				7	2.28	6.83E-05
				12	2.28	4.23E-05
			7	2	2.48	9.42E-05
				7	2.48	6.03E-05
				12	2.49	4.04E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	4	200	13	2	2.63	9.01E-05
				7	2.64	5.72E-05
				12	2.63	3.80E-05
		800	1	2	2.28	3.85E-04
				7	2.27	2.66E-04
				12	2.27	1.89E-04
			7	2	2.48	3.33E-04
				7	2.49	2.37E-04
				12	2.47	1.73E-04
			13	2	2.64	3.02E-04
				7	2.64	2.19E-04
				12	2.64	1.57E-04
		1400	1	2	2.28	5.96E-04
				7	2.27	4.50E-04
				12	2.28	3.09E-04
			7	2	2.48	5.43E-04
				7	2.48	3.88E-04
				12	2.49	2.73E-04
			13	2	2.64	4.95E-04
				7	2.63	3.67E-04
				12	2.64	2.54E-04
	8	200	1	2	2.28	1.02E-04
				7	2.27	6.84E-05
				12	2.29	4.25E-05
			7	2	2.49	9.08E-05
				7	2.49	5.91E-05
				12	2.48	3.85E-05
			13	2	2.65	8.44E-05
				7	2.65	5.72E-05
				12	2.64	3.68E-05
		800	1	2	2.27	3.71E-04
				7	2.27	2.74E-04
				12	2.28	1.86E-04
			7	2	2.48	3.31E-04
				7	2.48	2.38E-04
				12	2.48	1.71E-04
			13	2	2.64	3.01E-04
				7	2.64	2.24E-04
				12	2.63	1.53E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	8	1400	1	2	2.28	6.14E-04
				7	2.27	4.41E-04
				12	2.27	3.11E-04
			7	2	2.48	5.30E-04
				7	2.48	3.91E-04
				12	2.48	2.75E-04
			13	2	2.64	4.96E-04
				7	2.64	3.55E-04
				12	2.63	2.53E-04

Appendix F. 1V:2H Undivided Urban Arterial

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	1.99	5.98E-06
				7	1.98	4.17E-06
				12	1.97	2.72E-06
			7	2	2.28	5.45E-06
				7	2.30	3.76E-06
				12	2.30	2.59E-06
			13	2	2.29	5.61E-06
				7	2.30	3.88E-06
				12	2.30	2.77E-06
		800	1	2	1.97	2.37E-05
				7	1.98	1.66E-05
				12	1.97	1.18E-05
			7	2	2.30	1.92E-05
				7	2.29	1.41E-05
				12	2.29	1.00E-05
			13	2	2.29	1.99E-05
				7	2.30	1.41E-05
				12	2.29	1.02E-05
		1400	1	2	1.98	4.03E-05
				7	1.98	2.91E-05
				12	1.98	2.06E-05
			7	2	2.29	3.40E-05
				7	2.29	2.49E-05
				12	2.29	1.74E-05
			13	2	2.29	3.44E-05
				7	2.30	2.48E-05
				12	2.29	1.76E-05
	3	200	1	2	1.98	6.62E-06
				7	1.98	4.56E-06
				12	1.98	3.11E-06
			7	2	2.29	6.15E-06
				7	2.28	4.28E-06
				12	2.28	2.99E-06
			13	2	2.29	6.36E-06
				7	2.29	4.43E-06
				12	2.28	3.09E-06
		800	1	2	1.98	2.61E-05
				7	1.98	1.85E-05
				12	1.97	1.34E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	800	7	2	2.30	2.18E-05
				7	2.30	1.57E-05
				12	2.29	1.13E-05
			13	2	2.29	2.31E-05
				7	2.29	1.63E-05
				12	2.29	1.14E-05
		1400	1	2	1.98	4.55E-05
				7	1.98	3.29E-05
				12	1.98	2.36E-05
			7	2	2.29	3.81E-05
				7	2.29	2.80E-05
				12	2.29	1.98E-05
			13	2	2.29	3.88E-05
				7	2.29	2.83E-05
				12	2.30	1.95E-05
	6	200	1	2	1.99	8.88E-06
				7	1.97	6.25E-06
				12	1.98	4.16E-06
			7	2	2.30	8.24E-06
				7	2.27	5.88E-06
				12	2.29	3.98E-06
			13	2	2.29	8.48E-06
				7	2.29	5.90E-06
				12	2.29	4.15E-06
		800	1	2	1.98	3.44E-05
				7	1.98	2.49E-05
				12	1.97	1.76E-05
			7	2	2.29	2.98E-05
				7	2.29	2.14E-05
				12	2.30	1.50E-05
			13	2	2.29	3.02E-05
				7	2.30	2.12E-05
				12	2.29	1.52E-05
		1400	1	2	1.97	6.07E-05
				7	1.97	4.38E-05
				12	1.98	3.11E-05
			7	2	2.29	5.09E-05
				7	2.28	3.76E-05
				12	2.29	2.64E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	1400	13	2	2.30	5.08E-05
				7	2.30	3.72E-05
				12	2.29	2.64E-05
4	0	200	1	2	1.97	1.12E-05
				7	1.99	7.27E-06
				12	1.97	5.05E-06
			7	2	2.31	9.16E-06
				7	2.29	6.14E-06
				12	2.29	3.87E-06
			13	2	2.28	9.40E-06
				7	2.28	6.24E-06
				12	2.30	3.99E-06
		800	1	2	1.99	4.49E-05
				7	1.98	3.27E-05
				12	1.97	2.28E-05
			7	2	2.29	3.84E-05
				7	2.29	2.73E-05
				12	2.30	1.87E-05
			13	2	2.29	3.81E-05
				7	2.30	2.66E-05
				12	2.29	1.91E-05
		1400	1	2	1.98	7.80E-05
				7	1.97	5.72E-05
				12	1.98	3.95E-05
			7	2	2.29	6.50E-05
				7	2.29	4.72E-05
				12	2.29	3.27E-05
			13	2	2.29	6.56E-05
				7	2.30	4.71E-05
				12	2.29	3.31E-05
	3	200	1	2	1.97	1.25E-05
				7	1.97	8.04E-06
				12	1.98	5.06E-06
			7	2	2.31	1.01E-05
				7	2.30	6.76E-06
				12	2.29	4.45E-06
			13	2	2.29	1.04E-05
				7	2.28	7.00E-06
				12	2.29	4.52E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	3	800	1	2	1.97	5.18E-05
				7	1.97	3.67E-05
				12	1.98	2.52E-05
			7	2	2.29	4.29E-05
				7	2.29	3.06E-05
				12	2.29	2.14E-05
			13	2	2.28	4.31E-05
				7	2.29	3.08E-05
				12	2.30	2.14E-05
		1400	1	2	1.98	8.81E-05
				7	1.98	6.28E-05
				12	1.97	4.51E-05
			7	2	2.29	7.41E-05
				7	2.30	5.28E-05
				12	2.29	3.69E-05
			13	2	2.29	7.33E-05
				7	2.29	5.29E-05
				12	2.29	3.69E-05
	6	200	1	2	1.98	1.65E-05
				7	1.98	1.06E-05
				12	1.98	6.87E-06
			7	2	2.30	1.35E-05
				7	2.29	9.41E-06
				12	2.30	5.81E-06
			13	2	2.29	1.39E-05
				7	2.29	9.29E-06
				12	2.30	5.95E-06
		800	1	2	1.98	6.89E-05
				7	1.98	4.87E-05
				12	1.98	3.49E-05
			7	2	2.29	5.71E-05
				7	2.29	4.10E-05
				12	2.29	2.84E-05
			13	2	2.29	5.68E-05
				7	2.30	3.99E-05
				12	2.29	2.86E-05
		1400	1	2	1.98	1.17E-04
				7	1.98	8.38E-05
				12	1.98	5.95E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	6	1400	7	2	2.30	9.73E-05
				7	2.29	7.07E-05
				12	2.29	4.92E-05
			13	2	2.29	9.89E-05
				7	2.29	7.00E-05
				12	2.30	4.90E-05
8	0	200	1	2	1.97	1.59E-05
				7	1.98	1.04E-05
				12	1.98	6.12E-06
			7	2	2.27	1.35E-05
				7	2.30	8.28E-06
				12	2.27	5.38E-06
			13	2	2.29	1.33E-05
				7	2.30	8.39E-06
				12	2.30	5.23E-06
		800	1	2	1.98	5.87E-05
				7	1.99	4.17E-05
				12	1.98	2.95E-05
			7	2	2.29	5.03E-05
				7	2.29	3.50E-05
				12	2.29	2.52E-05
			13	2	2.29	5.06E-05
				7	2.30	3.51E-05
				12	2.29	2.48E-05
		1400	1	2	1.98	9.43E-05
				7	1.97	6.82E-05
				12	1.97	4.81E-05
			7	2	2.29	7.91E-05
				7	2.29	5.66E-05
				12	2.29	4.01E-05
			13	2	2.29	7.96E-05
				7	2.29	5.61E-05
				12	2.29	3.98E-05
	3	200	1	2	1.98	1.79E-05
				7	1.97	1.15E-05
				12	1.98	7.07E-06
			7	2	2.29	1.44E-05
				7	2.30	9.71E-06
				12	2.30	5.90E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	3	200	13	2	2.29	1.45E-05
				7	2.29	9.52E-06
				12	2.29	5.92E-06
		800	1	2	1.97	6.83E-05
				7	1.98	4.81E-05
				12	1.98	3.36E-05
			7	2	2.30	5.57E-05
				7	2.29	3.98E-05
				12	2.30	2.75E-05
			13	2	2.28	5.66E-05
				7	2.29	4.07E-05
				12	2.28	2.86E-05
		1400	1	2	1.98	1.07E-04
				7	1.98	7.66E-05
				12	1.98	5.34E-05
			7	2	2.29	9.00E-05
				7	2.30	6.34E-05
				12	2.29	4.53E-05
			13	2	2.29	8.97E-05
				7	2.29	6.45E-05
				12	2.29	4.49E-05
	6	200	1	2	1.97	2.38E-05
				7	1.97	1.53E-05
				12	1.99	9.12E-06
			7	2	2.28	2.09E-05
				7	2.30	1.27E-05
				12	2.29	7.74E-06
			13	2	2.29	2.03E-05
				7	2.28	1.29E-05
				12	2.30	7.65E-06
		800	1	2	1.98	8.92E-05
				7	1.98	6.29E-05
				12	1.98	4.41E-05
			7	2	2.30	7.42E-05
				7	2.29	5.41E-05
				12	2.29	3.74E-05
			13	2	2.29	7.55E-05
				7	2.29	5.33E-05
				12	2.29	3.77E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	6	1400	1	2	1.98	1.42E-04
				7	1.98	1.03E-04
				12	1.97	7.25E-05
			7	2	2.29	1.18E-04
				7	2.29	8.51E-05
				12	2.29	6.00E-05
			13	2	2.29	1.16E-04
				7	2.29	8.49E-05
				12	2.30	5.93E-05

Appendix G. 1V:2H Divided Urban Arterial

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	1.99	5.98E-06
				7	1.98	4.17E-06
				12	1.97	2.72E-06
			7	2	2.28	5.45E-06
				7	2.30	3.76E-06
				12	2.30	2.59E-06
			13	2	2.29	5.61E-06
				7	2.30	3.88E-06
				12	2.30	2.77E-06
		800	1	2	1.97	2.37E-05
				7	1.98	1.66E-05
				12	1.97	1.18E-05
			7	2	2.30	1.92E-05
				7	2.29	1.41E-05
				12	2.29	1.00E-05
			13	2	2.29	1.99E-05
				7	2.30	1.41E-05
				12	2.29	1.02E-05
		1400	1	2	1.98	4.03E-05
				7	1.98	2.91E-05
				12	1.98	2.06E-05
			7	2	2.29	3.40E-05
				7	2.29	2.49E-05
				12	2.29	1.74E-05
			13	2	2.29	3.44E-05
				7	2.30	2.48E-05
				12	2.29	1.76E-05
	3	200	1	2	1.98	6.62E-06
				7	1.98	4.56E-06
				12	1.98	3.11E-06
			7	2	2.29	6.15E-06
				7	2.28	4.28E-06
				12	2.28	2.99E-06
			13	2	2.29	6.36E-06
				7	2.29	4.43E-06
				12	2.28	3.09E-06
		800	1	2	1.98	2.61E-05
				7	1.98	1.85E-05
				12	1.97	1.34E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	800	7	2	2.30	2.18E-05
				7	2.30	1.57E-05
				12	2.29	1.13E-05
			13	2	2.29	2.31E-05
				7	2.29	1.63E-05
				12	2.29	1.14E-05
		1400	1	2	1.98	4.55E-05
				7	1.98	3.29E-05
				12	1.98	2.36E-05
			7	2	2.29	3.81E-05
				7	2.29	2.80E-05
				12	2.29	1.98E-05
			13	2	2.29	3.88E-05
				7	2.29	2.83E-05
				12	2.30	1.95E-05
	6	200	1	2	1.99	8.88E-06
				7	1.97	6.25E-06
				12	1.98	4.16E-06
			7	2	2.30	8.24E-06
				7	2.27	5.88E-06
				12	2.29	3.98E-06
			13	2	2.29	8.48E-06
				7	2.29	5.90E-06
				12	2.29	4.15E-06
		800	1	2	1.98	3.44E-05
				7	1.98	2.49E-05
				12	1.97	1.76E-05
			7	2	2.29	2.98E-05
				7	2.29	2.14E-05
				12	2.30	1.50E-05
			13	2	2.29	3.02E-05
				7	2.30	2.12E-05
				12	2.29	1.52E-05
		1400	1	2	1.97	6.07E-05
				7	1.97	4.38E-05
				12	1.98	3.11E-05
			7	2	2.29	5.09E-05
				7	2.28	3.76E-05
				12	2.29	2.64E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	1400	13	2	2.30	5.08E-05
				7	2.30	3.72E-05
				12	2.29	2.64E-05
4	0	200	1	2	1.97	1.12E-05
				7	1.99	7.27E-06
				12	1.97	5.05E-06
			7	2	2.31	9.16E-06
				7	2.29	6.14E-06
				12	2.29	3.87E-06
			13	2	2.28	9.40E-06
				7	2.28	6.24E-06
				12	2.30	3.99E-06
		800	1	2	1.99	4.49E-05
				7	1.98	3.27E-05
				12	1.97	2.28E-05
			7	2	2.29	3.84E-05
				7	2.29	2.73E-05
				12	2.30	1.87E-05
			13	2	2.29	3.81E-05
				7	2.30	2.66E-05
				12	2.29	1.91E-05
		1400	1	2	1.98	7.80E-05
				7	1.97	5.72E-05
				12	1.98	3.95E-05
			7	2	2.29	6.50E-05
				7	2.29	4.72E-05
				12	2.29	3.27E-05
			13	2	2.29	6.56E-05
				7	2.30	4.71E-05
				12	2.29	3.31E-05
	3	200	1	2	1.97	1.25E-05
				7	1.97	8.04E-06
				12	1.98	5.06E-06
			7	2	2.31	1.01E-05
				7	2.30	6.76E-06
				12	2.29	4.45E-06
			13	2	2.29	1.04E-05
				7	2.28	7.00E-06
				12	2.29	4.52E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	3	800	1	2	1.97	5.18E-05
				7	1.97	3.67E-05
				12	1.98	2.52E-05
			7	2	2.29	4.29E-05
				7	2.29	3.06E-05
				12	2.29	2.14E-05
			13	2	2.28	4.31E-05
				7	2.29	3.08E-05
				12	2.30	2.14E-05
		1400	1	2	1.98	8.81E-05
				7	1.98	6.28E-05
				12	1.97	4.51E-05
			7	2	2.29	7.41E-05
				7	2.30	5.28E-05
				12	2.29	3.69E-05
			13	2	2.29	7.33E-05
				7	2.29	5.29E-05
				12	2.29	3.69E-05
	6	200	1	2	1.98	1.65E-05
				7	1.98	1.06E-05
				12	1.98	6.87E-06
			7	2	2.30	1.35E-05
				7	2.29	9.41E-06
				12	2.30	5.81E-06
			13	2	2.29	1.39E-05
				7	2.29	9.29E-06
				12	2.30	5.95E-06
		800	1	2	1.98	6.89E-05
				7	1.98	4.87E-05
				12	1.98	3.49E-05
			7	2	2.29	5.71E-05
				7	2.29	4.10E-05
				12	2.29	2.84E-05
			13	2	2.29	5.68E-05
				7	2.30	3.99E-05
				12	2.29	2.86E-05
		1400	1	2	1.98	1.17E-04
				7	1.98	8.38E-05
				12	1.98	5.95E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	6	1400	7	2	2.30	9.73E-05
				7	2.29	7.07E-05
				12	2.29	4.92E-05
			13	2	2.29	9.89E-05
				7	2.29	7.00E-05
				12	2.30	4.90E-05
8	0	200	1	2	1.97	1.59E-05
				7	1.98	1.04E-05
				12	1.98	6.12E-06
			7	2	2.27	1.35E-05
				7	2.30	8.28E-06
				12	2.27	5.38E-06
			13	2	2.29	1.33E-05
				7	2.30	8.39E-06
				12	2.30	5.23E-06
		800	1	2	1.98	5.87E-05
				7	1.99	4.17E-05
				12	1.98	2.95E-05
			7	2	2.29	5.03E-05
				7	2.29	3.50E-05
				12	2.29	2.52E-05
			13	2	2.29	5.06E-05
				7	2.30	3.51E-05
				12	2.29	2.48E-05
		1400	1	2	1.98	9.43E-05
				7	1.97	6.82E-05
				12	1.97	4.81E-05
			7	2	2.29	7.91E-05
				7	2.29	5.66E-05
				12	2.29	4.01E-05
			13	2	2.29	7.96E-05
				7	2.29	5.61E-05
				12	2.29	3.98E-05
	3	200	1	2	1.98	1.79E-05
				7	1.97	1.15E-05
				12	1.98	7.07E-06
			7	2	2.29	1.44E-05
				7	2.30	9.71E-06
				12	2.30	5.90E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	3	200	13	2	2.29	1.45E-05
				7	2.29	9.52E-06
				12	2.29	5.92E-06
		800	1	2	1.97	6.83E-05
				7	1.98	4.81E-05
				12	1.98	3.36E-05
			7	2	2.30	5.57E-05
				7	2.29	3.98E-05
				12	2.30	2.75E-05
			13	2	2.28	5.66E-05
				7	2.29	4.07E-05
				12	2.28	2.86E-05
		1400	1	2	1.98	1.07E-04
				7	1.98	7.66E-05
				12	1.98	5.34E-05
			7	2	2.29	9.00E-05
				7	2.30	6.34E-05
				12	2.29	4.53E-05
			13	2	2.29	8.97E-05
				7	2.29	6.45E-05
				12	2.29	4.49E-05
	6	200	1	2	1.97	2.38E-05
				7	1.97	1.53E-05
				12	1.99	9.12E-06
			7	2	2.28	2.09E-05
				7	2.30	1.27E-05
				12	2.29	7.74E-06
			13	2	2.29	2.03E-05
				7	2.28	1.29E-05
				12	2.30	7.65E-06
		800	1	2	1.98	8.92E-05
				7	1.98	6.29E-05
				12	1.98	4.41E-05
			7	2	2.30	7.42E-05
				7	2.29	5.41E-05
				12	2.29	3.74E-05
			13	2	2.29	7.55E-05
				7	2.29	5.33E-05
				12	2.29	3.77E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	6	1400	1	2	1.98	1.42E-04
				7	1.98	1.03E-04
				12	1.97	7.25E-05
			7	2	2.29	1.18E-04
				7	2.29	8.51E-05
				12	2.29	6.00E-05
			13	2	2.29	1.16E-04
				7	2.29	8.49E-05
				12	2.30	5.93E-05

Appendix H. 1V:2H Urban Local

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	2.43	3.69E-05
				7	2.43	2.49E-05
				12	2.45	1.61E-05
			7	2	2.66	3.53E-05
				7	2.67	2.35E-05
				12	2.66	1.66E-05
			13	2	2.82	3.51E-05
				7	2.82	2.31E-05
				12	2.82	1.59E-05
		800	1	2	2.43	1.35E-04
				7	2.43	1.01E-04
				12	2.43	6.68E-05
			7	2	2.65	1.27E-04
				7	2.67	8.83E-05
				12	2.65	6.42E-05
			13	2	2.82	1.16E-04
				7	2.83	8.31E-05
				12	2.82	5.93E-05
		1400	1	2	2.44	2.33E-04
				7	2.43	1.75E-04
				12	2.43	1.22E-04
			7	2	2.65	2.19E-04
				7	2.65	1.63E-04
				12	2.66	1.11E-04
			13	2	2.81	1.99E-04
				7	2.82	1.46E-04
				12	2.82	1.03E-04
	6	200	1	2	2.44	5.82E-05
				7	2.42	4.08E-05
				12	2.43	2.46E-05
			7	2	2.67	5.33E-05
				7	2.65	3.68E-05
				12	2.67	2.39E-05
			13	2	2.81	5.08E-05
				7	2.83	3.55E-05
				12	2.81	2.50E-05
		800	1	2	2.43	2.02E-04
				7	2.43	1.45E-04
				12	2.44	1.03E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	800	7	2	2.65	1.90E-04
				7	2.66	1.35E-04
				12	2.65	9.71E-05
			13	2	2.82	1.71E-04
				7	2.81	1.26E-04
				12	2.81	9.14E-05
		1400	1	2	2.43	3.55E-04
				7	2.44	2.54E-04
				12	2.43	1.86E-04
			7	2	2.66	3.22E-04
				7	2.65	2.36E-04
				12	2.66	1.65E-04
			13	2	2.82	2.98E-04
				7	2.82	2.19E-04
				12	2.82	1.59E-04
	12	200	1	2	2.43	5.44E-05
				7	2.43	3.62E-05
				12	2.43	2.49E-05
			7	2	2.66	5.12E-05
				7	2.66	3.58E-05
				12	2.66	2.54E-05
			13	2	2.82	4.87E-05
				7	2.83	3.56E-05
				12	2.82	2.41E-05
		800	1	2	2.44	2.04E-04
				7	2.43	1.47E-04
				12	2.44	1.02E-04
			7	2	2.66	1.82E-04
				7	2.66	1.36E-04
				12	2.67	9.44E-05
			13	2	2.83	1.73E-04
				7	2.82	1.28E-04
				12	2.82	8.97E-05
		1400	1	2	2.44	3.51E-04
				7	2.43	2.59E-04
				12	2.43	1.85E-04
			7	2	2.66	3.21E-04
				7	2.66	2.33E-04
				12	2.65	1.70E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	12	1400	13	2	2.82	2.97E-04
				7	2.82	2.22E-04
				12	2.82	1.57E-04
3	0	200	1	2	2.43	3.63E-05
				7	2.43	2.36E-05
				12	2.43	1.59E-05
			7	2	2.66	3.45E-05
				7	2.65	2.31E-05
				12	2.65	1.53E-05
			13	2	2.81	3.19E-05
				7	2.83	2.05E-05
				12	2.80	1.36E-05
		800	1	2	2.42	1.44E-04
				7	2.43	1.00E-04
				12	2.42	7.13E-05
			7	2	2.65	1.31E-04
				7	2.66	9.31E-05
				12	2.66	6.38E-05
			13	2	2.83	1.24E-04
				7	2.82	8.60E-05
				12	2.82	6.01E-05
		1400	1	2	2.43	2.42E-04
				7	2.43	1.77E-04
				12	2.43	1.28E-04
			7	2	2.66	2.15E-04
				7	2.65	1.59E-04
				12	2.66	1.11E-04
			13	2	2.82	2.03E-04
				7	2.81	1.50E-04
				12	2.81	1.05E-04
	6	200	1	2	2.42	5.79E-05
				7	2.42	3.58E-05
				12	2.44	2.42E-05
			7	2	2.66	5.31E-05
				7	2.65	3.32E-05
				12	2.68	2.18E-05
			13	2	2.82	5.02E-05
				7	2.81	3.41E-05
				12	2.83	2.15E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	6	800	1	2	2.44	2.13E-04
				7	2.44	1.54E-04
				12	2.43	1.12E-04
			7	2	2.66	1.92E-04
				7	2.65	1.40E-04
				12	2.66	9.93E-05
			13	2	2.82	1.82E-04
				7	2.82	1.32E-04
				12	2.82	9.26E-05
		1400	1	2	2.43	3.58E-04
				7	2.43	2.60E-04
				12	2.43	1.86E-04
			7	2	2.65	3.35E-04
				7	2.66	2.34E-04
				12	2.65	1.69E-04
			13	2	2.82	3.06E-04
				7	2.82	2.24E-04
				12	2.82	1.53E-04
	12	200	1	2	2.43	5.44E-05
				7	2.44	3.66E-05
				12	2.44	2.26E-05
			7	2	2.65	5.34E-05
				7	2.66	3.27E-05
				12	2.66	2.32E-05
			13	2	2.82	4.70E-05
				7	2.82	3.04E-05
				12	2.81	2.04E-05
		800	1	2	2.43	2.18E-04
				7	2.43	1.56E-04
				12	2.43	1.09E-04
			7	2	2.66	1.92E-04
				7	2.66	1.39E-04
				12	2.66	9.59E-05
			13	2	2.82	1.78E-04
				7	2.82	1.30E-04
				12	2.83	8.90E-05
		1400	1	2	2.43	3.60E-04
				7	2.43	2.64E-04
				12	2.42	1.88E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	12	1400	7	2	2.65	3.32E-04
				7	2.66	2.37E-04
				12	2.66	1.69E-04
			13	2	2.82	3.05E-04
				7	2.82	2.29E-04
				12	2.81	1.58E-04
6	0	200	1	2	2.43	1.11E-04
				7	2.42	7.50E-05
				12	2.42	5.07E-05
			7	2	2.65	1.01E-04
				7	2.66	7.14E-05
				12	2.66	4.89E-05
			13	2	2.84	9.86E-05
				7	2.81	6.49E-05
				12	2.84	4.19E-05
		800	1	2	2.43	4.23E-04
				7	2.43	3.14E-04
				12	2.42	2.15E-04
			7	2	2.66	3.79E-04
				7	2.66	2.80E-04
				12	2.66	1.96E-04
			13	2	2.82	3.67E-04
				7	2.82	2.58E-04
				12	2.83	1.83E-04
		1400	1	2	2.44	6.90E-04
				7	2.43	5.02E-04
				12	2.43	3.60E-04
			7	2	2.65	6.48E-04
				7	2.65	4.69E-04
				12	2.65	3.32E-04
			13	2	2.81	5.89E-04
				7	2.82	4.30E-04
				12	2.81	3.09E-04
	6	200	1	2	2.43	1.74E-04
				7	2.43	1.10E-04
				12	2.44	7.24E-05
			7	2	2.66	1.51E-04
				7	2.67	1.04E-04
				12	2.64	6.63E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	6	200	13	2	2.82	1.56E-04
				7	2.82	1.03E-04
				12	2.81	6.88E-05
		800	1	2	2.43	6.52E-04
				7	2.44	4.69E-04
				12	2.42	3.37E-04
			7	2	2.66	5.79E-04
				7	2.66	4.21E-04
				12	2.65	3.01E-04
			13	2	2.83	5.53E-04
				7	2.82	3.90E-04
				12	2.82	2.69E-04
		1400	1	2	2.43	1.03E-03
				7	2.44	7.70E-04
				12	2.43	5.39E-04
			7	2	2.66	9.57E-04
				7	2.65	7.00E-04
				12	2.65	4.87E-04
			13	2	2.82	8.70E-04
				7	2.82	6.43E-04
				12	2.82	4.54E-04
	12	200	1	2	2.44	1.61E-04
				7	2.42	1.15E-04
				12	2.43	7.39E-05
			7	2	2.65	1.56E-04
				7	2.65	1.08E-04
				12	2.68	7.00E-05
			13	2	2.82	1.45E-04
				7	2.80	9.67E-05
				12	2.81	6.51E-05
		800	1	2	2.43	6.49E-04
				7	2.43	4.69E-04
				12	2.42	3.28E-04
			7	2	2.65	5.80E-04
				7	2.65	4.21E-04
				12	2.66	3.01E-04
			13	2	2.82	5.37E-04
				7	2.81	3.97E-04
				12	2.81	2.79E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	12	1400	1	2	2.43	1.04E-03
				7	2.44	7.45E-04
				12	2.43	5.42E-04
			7	2	2.65	9.71E-04
				7	2.65	6.88E-04
				12	2.66	4.87E-04
			13	2	2.82	8.80E-04
				7	2.82	6.40E-04
				12	2.82	4.59E-04

Appendix I. 1V:3H Freeway

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	2.48	7.74E-06
				7	2.49	5.68E-06
				12	2.48	4.38E-06
			7	2	2.70	8.51E-06
				7	2.72	6.81E-06
				12	2.71	4.85E-06
			13	2	2.97	8.66E-06
				7	2.98	6.63E-06
				12	2.98	5.57E-06
		800	1	2	2.48	3.07E-05
				7	2.49	2.48E-05
				12	2.49	1.96E-05
			7	2	2.71	3.09E-05
				7	2.72	2.47E-05
				12	2.72	1.93E-05
			13	2	2.97	2.99E-05
				7	2.98	2.29E-05
				12	2.98	1.87E-05
		1400	1	2	2.48	5.50E-05
				7	2.48	4.33E-05
				12	2.49	3.51E-05
			7	2	2.73	5.34E-05
				7	2.72	4.17E-05
				12	2.72	3.42E-05
			13	2	2.98	4.98E-05
				7	2.98	3.91E-05
				12	2.98	3.23E-05
	2	200	1	2	2.48	7.90E-06
				7	2.48	5.87E-06
				12	2.50	4.29E-06
			7	2	2.72	8.79E-06
				7	2.71	6.85E-06
				12	2.72	4.78E-06
			13	2	2.97	8.53E-06
				7	2.97	6.87E-06
				12	2.98	5.51E-06
		800	1	2	2.48	3.11E-05
				7	2.48	2.47E-05
				12	2.48	2.03E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	2	800	7	2	2.72	3.15E-05
				7	2.71	2.38E-05
				12	2.72	1.95E-05
			13	2	2.98	2.91E-05
				7	2.97	2.29E-05
				12	2.98	1.88E-05
		1400	1	2	2.48	5.55E-05
				7	2.48	4.34E-05
				12	2.48	3.54E-05
			7	2	2.72	5.35E-05
				7	2.72	4.26E-05
				12	2.71	3.41E-05
			13	2	2.98	4.99E-05
				7	2.98	3.94E-05
				12	2.98	3.19E-05
	3	200	1	2	2.49	8.56E-06
				7	2.49	6.40E-06
				12	2.49	4.76E-06
			7	2	2.72	9.71E-06
				7	2.71	7.48E-06
				12	2.71	5.53E-06
			13	2	2.98	1.00E-05
				7	2.99	7.69E-06
				12	2.98	6.15E-06
		800	1	2	2.48	3.54E-05
				7	2.48	2.75E-05
				12	2.48	2.27E-05
			7	2	2.72	3.52E-05
				7	2.71	2.75E-05
				12	2.72	2.16E-05
			13	2	2.98	3.21E-05
				7	2.98	2.63E-05
				12	2.98	2.12E-05
		1400	1	2	2.48	6.29E-05
				7	2.49	4.87E-05
				12	2.48	3.94E-05
			7	2	2.71	6.10E-05
				7	2.72	4.76E-05
				12	2.71	3.88E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	1400	13	2	2.98	5.63E-05
				7	2.98	4.46E-05
				12	2.97	3.63E-05
2	0	200	1	2	2.49	6.21E-06
				7	2.48	4.08E-06
				12	2.49	2.79E-06
			7	2	2.71	5.75E-06
				7	2.72	4.05E-06
				12	2.74	2.75E-06
			13	2	2.98	5.96E-06
				7	2.99	4.04E-06
				12	2.98	3.01E-06
		800	1	2	2.48	2.86E-05
				7	2.48	2.17E-05
				12	2.48	1.71E-05
			7	2	2.71	2.62E-05
				7	2.71	2.05E-05
				12	2.72	1.62E-05
			13	2	2.98	2.48E-05
				7	2.98	1.94E-05
				12	2.98	1.50E-05
		1400	1	2	2.48	4.94E-05
				7	2.49	3.86E-05
				12	2.48	3.01E-05
			7	2	2.71	4.65E-05
				7	2.72	3.64E-05
				12	2.71	2.99E-05
			13	2	2.97	4.18E-05
				7	2.98	3.40E-05
				12	2.98	2.75E-05
	2	200	1	2	2.48	6.17E-06
				7	2.49	4.13E-06
				12	2.50	3.07E-06
			7	2	2.71	5.91E-06
				7	2.72	4.18E-06
				12	2.71	2.82E-06
			13	2	2.98	5.63E-06
				7	2.99	4.14E-06
				12	2.97	3.07E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
2	2	800	1	2	2.48	2.80E-05
				7	2.49	2.15E-05
				12	2.50	1.74E-05
			7	2	2.71	2.66E-05
				7	2.72	2.02E-05
				12	2.72	1.61E-05
			13	2	2.98	2.46E-05
				7	2.98	1.93E-05
				12	2.97	1.53E-05
		1400	1	2	2.48	4.87E-05
				7	2.48	3.87E-05
				12	2.48	3.09E-05
			7	2	2.72	4.66E-05
				7	2.71	3.60E-05
				12	2.72	2.93E-05
			13	2	2.98	4.23E-05
				7	2.97	3.33E-05
				12	2.98	2.69E-05
	3	200	1	2	2.48	6.85E-06
				7	2.50	4.68E-06
				12	2.48	2.99E-06
			7	2	2.72	6.49E-06
				7	2.71	4.57E-06
				12	2.72	3.18E-06
			13	2	2.97	6.53E-06
				7	2.98	4.56E-06
				12	2.98	3.32E-06
		800	1	2	2.48	3.17E-05
				7	2.48	2.41E-05
				12	2.48	1.93E-05
			7	2	2.71	3.00E-05
				7	2.71	2.30E-05
				12	2.72	1.80E-05
			13	2	2.98	2.82E-05
				7	2.98	2.15E-05
				12	2.98	1.68E-05
		1400	1	2	2.48	5.51E-05
				7	2.49	4.28E-05
				12	2.48	3.48E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
2	3	1400	7	2	2.72	5.16E-05
				7	2.72	4.12E-05
				12	2.71	3.34E-05
			13	2	2.98	4.80E-05
				7	2.98	3.75E-05
				12	2.98	3.00E-05
3	0	200	1	2	2.48	6.92E-06
				7	2.49	4.40E-06
				12	2.50	3.32E-06
			7	2	2.73	6.56E-06
				7	2.71	4.19E-06
				12	2.72	2.94E-06
			13	2	2.98	6.07E-06
				7	3.00	4.07E-06
				12	2.98	2.81E-06
		800	1	2	2.49	2.97E-05
				7	2.48	2.29E-05
				12	2.48	1.81E-05
			7	2	2.71	2.87E-05
				7	2.73	2.21E-05
				12	2.71	1.70E-05
			13	2	2.98	2.57E-05
				7	2.97	2.04E-05
				12	2.98	1.58E-05
		1400	1	2	2.48	5.08E-05
				7	2.48	3.95E-05
				12	2.48	3.23E-05
			7	2	2.72	4.84E-05
				7	2.72	3.70E-05
				12	2.72	3.04E-05
			13	2	2.98	4.44E-05
				7	2.97	3.46E-05
				12	2.98	2.82E-05
	2	200	1	2	2.49	6.74E-06
				7	2.48	4.79E-06
				12	2.49	3.14E-06
			7	2	2.73	6.45E-06
				7	2.71	4.19E-06
				12	2.71	3.07E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	2	200	13	2	2.98	6.32E-06
				7	2.97	4.08E-06
				12	2.96	3.13E-06
		800	1	2	2.48	3.02E-05
				7	2.48	2.28E-05
				12	2.48	1.79E-05
			7	2	2.71	2.87E-05
				7	2.72	2.18E-05
				12	2.72	1.73E-05
			13	2	2.98	2.62E-05
				7	2.97	1.99E-05
				12	2.99	1.58E-05
		1400	1	2	2.49	5.12E-05
				7	2.48	4.02E-05
				12	2.49	3.22E-05
			7	2	2.72	4.86E-05
				7	2.72	3.82E-05
				12	2.72	3.06E-05
			13	2	2.98	4.45E-05
				7	2.97	3.45E-05
				12	2.97	2.79E-05
	3	200	1	2	2.49	7.69E-06
				7	2.48	4.92E-06
				12	2.48	3.53E-06
			7	2	2.72	7.59E-06
				7	2.72	4.64E-06
				12	2.71	3.32E-06
			13	2	2.97	6.48E-06
				7	2.99	4.55E-06
				12	2.97	3.45E-06
		800	1	2	2.49	3.38E-05
				7	2.48	2.60E-05
				12	2.48	2.02E-05
			7	2	2.72	3.15E-05
				7	2.72	2.42E-05
				12	2.71	1.91E-05
			13	2	2.97	2.97E-05
				7	2.98	2.26E-05
				12	2.99	1.75E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	3	1400	1	2	2.49	5.74E-05
				7	2.49	4.49E-05
				12	2.49	3.61E-05
			7	2	2.72	5.43E-05
				7	2.72	4.20E-05
				12	2.72	3.39E-05
			13	2	2.98	4.94E-05
				7	2.98	3.84E-05
				12	2.98	3.20E-05

Appendix J. 1V:3H Undivided Rural Arterial

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	1.97	5.41E-06
				7	1.96	3.81E-06
				12	1.97	2.66E-06
			7	2	2.17	5.94E-06
				7	2.17	4.20E-06
				12	2.15	2.89E-06
			13	2	2.37	5.46E-06
				7	2.37	3.79E-06
				12	2.37	2.66E-06
		800	1	2	1.98	1.99E-05
				7	1.98	1.42E-05
				12	1.97	1.02E-05
			7	2	2.16	2.00E-05
				7	2.16	1.42E-05
				12	2.16	1.02E-05
			13	2	2.38	1.75E-05
				7	2.37	1.28E-05
				12	2.37	9.14E-06
		1400	1	2	1.98	3.49E-05
				7	1.98	2.54E-05
				12	1.98	1.78E-05
			7	2	2.17	3.35E-05
				7	2.16	2.48E-05
				12	2.16	1.73E-05
			13	2	2.37	3.03E-05
				7	2.37	2.20E-05
				12	2.38	1.54E-05
	3	200	1	2	1.98	6.13E-06
				7	1.98	4.22E-06
				12	1.98	3.14E-06
			7	2	2.17	6.47E-06
				7	2.16	4.72E-06
				12	2.17	3.20E-06
			13	2	2.37	6.13E-06
				7	2.38	4.11E-06
				12	2.37	3.13E-06
		800	1	2	1.98	2.27E-05
				7	1.98	1.61E-05
				12	1.98	1.15E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	800	7	2	2.16	2.22E-05
0	3	800	7	7	2.15	1.63E-05
0	3	800	7	12	2.16	1.14E-05
0	3	800	13	2	2.38	1.97E-05
0	3	800	13	7	2.38	1.42E-05
0	3	800	13	12	2.38	1.02E-05
0	3	1400	1	2	1.97	3.86E-05
0	3	1400	1	7	1.97	2.83E-05
0	3	1400	1	12	1.98	1.98E-05
0	3	1400	7	2	2.17	3.85E-05
0	3	1400	7	7	2.17	2.79E-05
0	3	1400	7	12	2.16	1.98E-05
0	3	1400	13	2	2.37	3.36E-05
0	3	1400	13	7	2.38	2.46E-05
0	3	1400	13	12	2.37	1.72E-05
0	6	200	1	2	1.97	8.04E-06
0	6	200	1	7	1.98	5.43E-06
0	6	200	1	12	1.98	3.97E-06
0	6	200	7	2	2.17	8.87E-06
0	6	200	7	7	2.16	6.33E-06
0	6	200	7	12	2.17	4.35E-06
0	6	200	13	2	2.38	7.99E-06
0	6	200	13	7	2.38	5.50E-06
0	6	200	13	12	2.37	4.02E-06
0	6	800	1	2	1.98	3.01E-05
0	6	800	1	7	1.99	2.15E-05
0	6	800	1	12	1.98	1.51E-05
0	6	800	7	2	2.16	2.99E-05
0	6	800	7	7	2.16	2.16E-05
0	6	800	7	12	2.16	1.51E-05
0	6	800	13	2	2.37	2.66E-05
0	6	800	13	7	2.37	1.92E-05
0	6	800	13	12	2.36	1.37E-05
0	6	1400	1	2	1.98	5.20E-05
0	6	1400	1	7	1.98	3.74E-05
0	6	1400	1	12	1.98	2.68E-05
0	6	1400	7	2	2.16	5.07E-05
0	6	1400	7	7	2.16	3.69E-05
0	6	1400	7	12	2.17	2.60E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	1400	13	2	2.37	4.49E-05
				7	2.37	3.28E-05
				12	2.37	2.35E-05
3	0	200	1	2	1.98	4.44E-06
				7	1.98	2.79E-06
				12	1.96	1.71E-06
			7	2	2.19	4.20E-06
				7	2.17	2.60E-06
				12	2.17	1.72E-06
			13	2	2.38	3.88E-06
				7	2.35	2.38E-06
				12	2.39	1.48E-06
		800	1	2	1.97	1.81E-05
				7	1.98	1.27E-05
				12	1.98	8.80E-06
			7	2	2.16	1.74E-05
				7	2.16	1.23E-05
				12	2.17	8.31E-06
			13	2	2.38	1.53E-05
				7	2.37	1.06E-05
				12	2.38	7.38E-06
		1400	1	2	1.98	3.06E-05
				7	1.98	2.16E-05
				12	1.97	1.54E-05
			7	2	2.16	2.93E-05
				7	2.16	2.11E-05
				12	2.17	1.44E-05
			13	2	2.37	2.57E-05
				7	2.37	1.87E-05
				12	2.37	1.28E-05
	3	200	1	2	1.98	5.06E-06
				7	1.99	2.95E-06
				12	1.99	1.94E-06
			7	2	2.16	4.83E-06
				7	2.15	3.10E-06
				12	2.17	1.87E-06
			13	2	2.37	4.40E-06
				7	2.36	2.52E-06
				12	2.38	1.69E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	3	800	1	2	1.97	2.03E-05
				7	1.98	1.46E-05
				12	1.98	9.81E-06
			7	2	2.17	1.90E-05
				7	2.17	1.37E-05
				12	2.16	9.84E-06
			13	2	2.37	1.70E-05
				7	2.37	1.21E-05
				12	2.37	8.34E-06
		1400	1	2	1.98	3.42E-05
				7	1.99	2.41E-05
				12	1.97	1.71E-05
			7	2	2.17	3.29E-05
				7	2.16	2.32E-05
				12	2.16	1.66E-05
			13	2	2.38	2.85E-05
				7	2.37	2.07E-05
				12	2.38	1.44E-05
	6	200	1	2	1.98	6.78E-06
				7	1.98	3.86E-06
				12	1.97	2.65E-06
			7	2	2.15	6.67E-06
				7	2.16	3.93E-06
				12	2.16	2.49E-06
			13	2	2.37	5.89E-06
				7	2.35	3.51E-06
				12	2.38	2.21E-06
		800	1	2	1.98	2.75E-05
				7	1.98	1.91E-05
				12	1.97	1.32E-05
			7	2	2.17	2.58E-05
				7	2.17	1.77E-05
				12	2.17	1.26E-05
			13	2	2.37	2.27E-05
				7	2.37	1.60E-05
				12	2.38	1.10E-05
		1400	1	2	1.98	4.56E-05
				7	1.98	3.32E-05
				12	1.98	2.26E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	6	1400	7	2	2.16	4.33E-05
				7	2.17	3.09E-05
				12	2.17	2.18E-05
			13	2	2.37	3.86E-05
				7	2.37	2.74E-05
				12	2.38	1.91E-05
6	0	200	1	2	1.98	1.31E-05
				7	1.98	8.58E-06
				12	1.97	5.30E-06
			7	2	2.17	1.28E-05
				7	2.16	9.08E-06
				12	2.17	5.18E-06
			13	2	2.38	1.08E-05
				7	2.36	7.38E-06
				12	2.36	4.77E-06
		800	1	2	1.98	5.30E-05
				7	1.97	3.91E-05
				12	1.98	2.66E-05
			7	2	2.17	5.05E-05
				7	2.16	3.78E-05
				12	2.16	2.57E-05
			13	2	2.37	4.51E-05
				7	2.37	3.17E-05
				12	2.36	2.31E-05
		1400	1	2	1.98	8.72E-05
				7	1.98	6.21E-05
				12	1.98	4.44E-05
			7	2	2.16	8.25E-05
				7	2.16	5.83E-05
				12	2.18	4.17E-05
			13	2	2.38	7.22E-05
				7	2.37	5.17E-05
				12	2.37	3.75E-05
	3	200	1	2	1.98	1.52E-05
				7	1.97	9.99E-06
				12	1.98	6.18E-06
			7	2	2.17	1.47E-05
				7	2.15	9.75E-06
				12	2.16	6.19E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	3	200	13	2	2.38	1.26E-05
				7	2.39	8.00E-06
				12	2.37	5.15E-06
		800	1	2	1.98	5.95E-05
				7	1.98	4.25E-05
				12	1.98	2.96E-05
			7	2	2.16	5.85E-05
				7	2.17	4.04E-05
				12	2.16	2.94E-05
			13	2	2.37	5.00E-05
				7	2.38	3.56E-05
				12	2.38	2.54E-05
		1400	1	2	1.98	1.00E-04
				7	1.98	7.02E-05
				12	1.98	4.94E-05
			7	2	2.16	9.35E-05
				7	2.16	6.69E-05
				12	2.16	4.72E-05
			13	2	2.38	8.33E-05
				7	2.38	5.80E-05
				12	2.36	4.23E-05
	6	200	1	2	1.97	2.10E-05
				7	1.98	1.28E-05
				12	1.96	8.06E-06
			7	2	2.17	1.89E-05
				7	2.16	1.25E-05
				12	2.16	7.89E-06
			13	2	2.37	1.69E-05
				7	2.39	1.11E-05
				12	2.37	7.01E-06
		800	1	2	1.97	8.10E-05
				7	1.98	5.68E-05
				12	1.98	3.92E-05
			7	2	2.17	7.46E-05
				7	2.17	5.48E-05
				12	2.16	3.84E-05
			13	2	2.37	6.76E-05
				7	2.37	4.86E-05
				12	2.38	3.40E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	6	1400	1	2	1.98	1.31E-04
				7	1.98	9.35E-05
				12	1.98	6.53E-05
			7	2	2.16	1.26E-04
				7	2.17	8.97E-05
				12	2.17	6.34E-05
			13	2	2.37	1.11E-04
				7	2.38	7.83E-05
				12	2.37	5.58E-05

Appendix K. 1V:3H Divided Rural Arterial

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	1.99	1.09E-05
				7	1.98	8.11E-06
				12	1.98	8.09E-06
			7	2	2.16	1.31E-05
				7	2.16	9.86E-06
				12	2.16	9.80E-06
			13	2	2.38	1.28E-05
				7	2.37	1.02E-05
				12	2.36	1.04E-05
		800	1	2	1.98	4.08E-05
				7	1.98	3.26E-05
				12	1.98	3.24E-05
			7	2	2.17	4.26E-05
				7	2.17	3.29E-05
				12	2.17	3.35E-05
			13	2	2.37	3.92E-05
				7	2.37	3.12E-05
				12	2.38	3.16E-05
		1400	1	2	1.98	7.24E-05
				7	1.98	5.84E-05
				12	1.98	5.74E-05
			7	2	2.16	7.25E-05
				7	2.16	5.77E-05
				12	2.17	5.69E-05
			13	2	2.37	6.56E-05
				7	2.37	5.13E-05
				12	2.38	5.15E-05
	3	200	1	2	1.98	1.21E-05
				7	1.98	9.49E-06
				12	1.99	8.53E-06
			7	2	2.16	1.48E-05
				7	2.18	1.09E-05
				12	2.16	1.15E-05
			13	2	2.38	1.39E-05
				7	2.39	1.13E-05
				12	2.37	1.15E-05
		800	1	2	1.98	4.69E-05
				7	1.98	3.72E-05
				12	1.98	3.65E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	800	7	2	2.17	4.73E-05
				7	2.17	3.72E-05
				12	2.17	3.75E-05
			13	2	2.37	4.37E-05
				7	2.37	3.50E-05
				12	2.37	3.43E-05
		1400	1	2	1.98	8.25E-05
				7	1.98	6.54E-05
				12	1.98	6.48E-05
			7	2	2.16	8.03E-05
				7	2.16	6.43E-05
				12	2.17	6.42E-05
			13	2	2.37	7.33E-05
				7	2.37	5.89E-05
				12	2.37	5.80E-05
	6	200	1	2	1.99	1.60E-05
				7	1.98	1.22E-05
				12	1.98	1.21E-05
			7	2	2.16	2.00E-05
				7	2.16	1.51E-05
				12	2.16	1.52E-05
			13	2	2.36	1.95E-05
				7	2.37	1.53E-05
				12	2.37	1.53E-05
		800	1	2	1.98	6.17E-05
				7	1.98	4.91E-05
				12	1.98	4.78E-05
			7	2	2.16	6.39E-05
				7	2.17	4.91E-05
				12	2.17	5.09E-05
			13	2	2.36	5.88E-05
				7	2.37	4.56E-05
				12	2.38	4.64E-05
		1400	1	2	1.98	1.08E-04
				7	1.98	8.68E-05
				12	1.98	8.60E-05
			7	2	2.17	1.06E-04
				7	2.16	8.74E-05
				12	2.17	8.58E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	1400	13	2	2.37	9.84E-05
				7	2.37	7.83E-05
				12	2.37	7.69E-05
3	0	200	1	2	1.97	8.78E-06
				7	1.98	5.39E-06
				12	1.98	5.57E-06
			7	2	2.18	8.67E-06
				7	2.17	5.16E-06
				12	2.15	5.38E-06
			13	2	2.37	7.61E-06
				7	2.38	5.04E-06
				12	2.38	4.59E-06
		800	1	2	1.98	3.67E-05
				7	1.98	2.86E-05
				12	1.98	2.83E-05
			7	2	2.16	4.24E-05
				7	2.16	3.30E-05
				12	2.16	3.38E-05
			13	2	2.37	3.85E-05
				7	2.37	3.09E-05
				12	2.37	3.19E-05
		1400	1	2	1.98	6.20E-05
				7	1.98	4.91E-05
				12	1.98	4.84E-05
			7	2	2.16	5.93E-05
				7	2.17	4.66E-05
				12	2.17	4.61E-05
			13	2	2.37	5.32E-05
				7	2.37	4.20E-05
				12	2.37	4.18E-05
	3	200	1	2	1.98	1.03E-05
				7	1.98	6.01E-06
				12	1.97	6.08E-06
			7	2	2.17	9.13E-06
				7	2.14	6.04E-06
				12	2.17	5.62E-06
			13	2	2.38	8.46E-06
				7	2.38	5.15E-06
				12	2.39	5.41E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	3	800	1	2	1.98	4.13E-05
				7	1.98	3.22E-05
				12	1.98	3.18E-05
			7	2	2.17	3.95E-05
				7	2.17	3.04E-05
				12	2.16	3.04E-05
			13	2	2.38	3.49E-05
				7	2.38	2.68E-05
				12	2.37	2.73E-05
		1400	1	2	1.98	6.91E-05
				7	1.98	5.50E-05
				12	1.98	5.40E-05
			7	2	2.17	6.56E-05
				7	2.16	5.19E-05
				12	2.16	5.18E-05
			13	2	2.37	5.86E-05
				7	2.38	4.57E-05
				12	2.37	4.66E-05
	6	200	1	2	1.98	1.35E-05
				7	1.99	7.85E-06
				12	1.99	7.89E-06
			7	2	2.17	1.21E-05
				7	2.15	7.55E-06
				12	2.19	7.21E-06
			13	2	2.36	1.15E-05
				7	2.38	7.18E-06
				12	2.38	7.00E-06
		800	1	2	1.97	5.49E-05
				7	1.98	4.23E-05
				12	1.97	4.33E-05
			7	2	2.17	5.13E-05
				7	2.16	4.00E-05
				12	2.16	4.10E-05
			13	2	2.37	4.73E-05
				7	2.38	3.54E-05
				12	2.37	3.65E-05
		1400	1	2	1.98	9.42E-05
				7	1.98	7.22E-05
				12	1.98	7.27E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	6	1400	7	2	2.17	8.88E-05
				7	2.16	6.88E-05
				12	2.16	6.98E-05
			13	2	2.36	7.91E-05
				7	2.37	6.18E-05
				12	2.38	6.24E-05
6	0	200	1	2	1.98	2.62E-05
				7	1.98	1.82E-05
				12	1.97	1.80E-05
			7	2	2.16	2.38E-05
				7	2.16	1.70E-05
				12	2.16	1.71E-05
			13	2	2.37	2.22E-05
				7	2.38	1.52E-05
				12	2.38	1.61E-05
		800	1	2	1.98	1.05E-04
				7	1.98	8.34E-05
				12	1.98	8.44E-05
			7	2	2.17	1.01E-04
				7	2.17	7.92E-05
				12	2.16	7.95E-05
			13	2	2.36	8.98E-05
				7	2.37	7.09E-05
				12	2.38	7.02E-05
		1400	1	2	1.98	1.76E-04
				7	1.98	1.38E-04
				12	1.98	1.36E-04
			7	2	2.16	1.65E-04
				7	2.17	1.32E-04
				12	2.16	1.33E-04
			13	2	2.37	1.48E-04
				7	2.37	1.14E-04
				12	2.37	1.20E-04
	3	200	1	2	1.99	2.85E-05
				7	1.99	2.03E-05
				12	1.99	1.97E-05
			7	2	2.18	2.74E-05
				7	2.17	1.93E-05
				12	2.16	1.93E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	3	200	13	2	2.35	2.67E-05
				7	2.37	1.83E-05
				12	2.36	1.70E-05
		800	1	2	1.98	1.24E-04
				7	1.98	9.31E-05
				12	1.97	9.38E-05
			7	2	2.15	1.18E-04
				7	2.17	9.03E-05
				12	2.17	8.83E-05
			13	2	2.38	1.01E-04
				7	2.36	7.87E-05
				12	2.37	7.90E-05
		1400	1	2	1.98	1.97E-04
				7	1.98	1.57E-04
				12	1.98	1.55E-04
			7	2	2.16	1.91E-04
				7	2.16	1.47E-04
				12	2.16	1.51E-04
			13	2	2.38	1.64E-04
				7	2.37	1.33E-04
				12	2.38	1.29E-04
	6	200	1	2	1.97	4.09E-05
				7	1.98	2.66E-05
				12	1.98	2.82E-05
			7	2	2.15	3.77E-05
				7	2.14	2.71E-05
				12	2.17	2.56E-05
			13	2	2.37	3.27E-05
				7	2.37	2.42E-05
				12	2.38	2.34E-05
		800	1	2	1.97	1.62E-04
				7	1.98	1.26E-04
				12	1.98	1.27E-04
			7	2	2.16	1.54E-04
				7	2.16	1.21E-04
				12	2.16	1.18E-04
			13	2	2.37	1.35E-04
				7	2.37	1.07E-04
				12	2.37	1.06E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	6	1400	1	2	1.98	2.63E-04
				7	1.98	2.09E-04
				12	1.98	2.06E-04
			7	2	2.17	2.54E-04
				7	2.17	1.97E-04
				12	2.17	1.96E-04
			13	2	2.38	2.15E-04
				7	2.37	1.76E-04
				12	2.36	1.76E-04

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Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	1.96	3.77E-05
				7	1.95	2.70E-05
				12	1.96	1.87E-05
			7	2	2.14	3.84E-05
				7	2.15	2.80E-05
				12	2.15	1.89E-05
			13	2	2.35	3.66E-05
				7	2.35	2.52E-05
				12	2.35	1.81E-05
		800	1	2	1.96	1.33E-04
				7	1.96	9.72E-05
				12	1.96	6.75E-05
			7	2	2.14	1.28E-04
				7	2.14	9.17E-05
				12	2.14	6.43E-05
			13	2	2.35	1.15E-04
				7	2.35	8.20E-05
				12	2.35	5.85E-05
		1400	1	2	1.96	2.26E-04
				7	1.96	1.71E-04
				12	1.96	1.20E-04
			7	2	2.14	2.13E-04
				7	2.14	1.55E-04
				12	2.14	1.12E-04
			13	2	2.35	1.90E-04
				7	2.35	1.39E-04
				12	2.35	9.88E-05
	4	200	1	2	1.96	4.72E-05
				7	1.96	3.35E-05
				12	1.96	2.24E-05
			7	2	2.14	4.91E-05
				7	2.14	3.41E-05
				12	2.14	2.42E-05
			13	2	2.35	4.61E-05
				7	2.36	3.06E-05
				12	2.35	2.31E-05
		800	1	2	1.96	1.65E-04
				7	1.96	1.20E-04
				12	1.96	8.61E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	4	800	7	2	2.14	1.60E-04
				7	2.14	1.16E-04
				12	2.14	8.19E-05
			13	2	2.35	1.39E-04
				7	2.35	1.05E-04
				12	2.35	7.34E-05
		1400	1	2	1.96	2.86E-04
				7	1.96	2.07E-04
				12	1.96	1.51E-04
			7	2	2.14	2.64E-04
				7	2.14	1.97E-04
				12	2.14	1.39E-04
			13	2	2.35	2.35E-04
				7	2.35	1.74E-04
				12	2.34	1.25E-04
	8	200	1	2	1.95	5.61E-05
				7	1.96	3.99E-05
				12	1.96	2.72E-05
			7	2	2.14	6.02E-05
				7	2.14	4.19E-05
				12	2.14	3.02E-05
			13	2	2.34	5.44E-05
				7	2.36	3.79E-05
				12	2.35	2.60E-05
		800	1	2	1.96	1.99E-04
				7	1.96	1.47E-04
				12	1.95	1.05E-04
			7	2	2.14	1.88E-04
				7	2.14	1.37E-04
				12	2.14	9.80E-05
			13	2	2.35	1.68E-04
				7	2.35	1.25E-04
				12	2.35	8.76E-05
		1400	1	2	1.96	3.40E-04
				7	1.96	2.50E-04
				12	1.96	1.78E-04
			7	2	2.14	3.21E-04
				7	2.14	2.35E-04
				12	2.14	1.65E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	8	1400	13	2	2.35	2.88E-04
				7	2.35	2.10E-04
				12	2.35	1.49E-04
4	0	200	1	2	1.96	7.19E-05
				7	1.95	4.74E-05
				12	1.97	3.05E-05
			7	2	2.13	6.47E-05
				7	2.15	4.29E-05
				12	2.14	2.98E-05
			13	2	2.35	5.64E-05
				7	2.35	3.96E-05
				12	2.34	2.70E-05
		800	1	2	1.95	2.63E-04
				7	1.95	1.96E-04
				12	1.95	1.37E-04
			7	2	2.15	2.43E-04
				7	2.15	1.78E-04
				12	2.14	1.25E-04
			13	2	2.35	2.15E-04
				7	2.35	1.54E-04
				12	2.35	1.08E-04
		1400	1	2	1.96	4.52E-04
				7	1.96	3.27E-04
				12	1.96	2.34E-04
			7	2	2.14	4.13E-04
				7	2.14	3.04E-04
				12	2.14	2.12E-04
			13	2	2.35	3.76E-04
				7	2.35	2.67E-04
				12	2.35	1.88E-04
	4	200	1	2	1.96	8.70E-05
				7	1.94	6.08E-05
				12	1.96	4.01E-05
			7	2	2.14	7.67E-05
				7	2.14	5.42E-05
				12	2.15	3.70E-05
			13	2	2.35	6.97E-05
				7	2.34	5.21E-05
				12	2.35	3.37E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	4	800	1	2	1.96	3.34E-04
				7	1.96	2.42E-04
				12	1.96	1.69E-04
			7	2	2.15	3.07E-04
				7	2.15	2.17E-04
				12	2.15	1.53E-04
			13	2	2.35	2.74E-04
				7	2.35	1.95E-04
				12	2.35	1.36E-04
		1400	1	2	1.96	5.70E-04
				7	1.96	4.11E-04
				12	1.96	2.92E-04
			7	2	2.14	5.14E-04
				7	2.14	3.80E-04
				12	2.14	2.64E-04
			13	2	2.35	4.65E-04
				7	2.35	3.31E-04
				12	2.34	2.38E-04
	8	200	1	2	1.95	8.58E-05
				7	1.97	5.97E-05
				12	1.95	3.92E-05
			7	2	2.14	7.75E-05
				7	2.14	5.25E-05
				12	2.14	3.89E-05
			13	2	2.35	7.14E-05
				7	2.35	5.01E-05
				12	2.35	3.29E-05
		800	1	2	1.96	3.36E-04
				7	1.96	2.40E-04
				12	1.96	1.72E-04
			7	2	2.14	3.10E-04
				7	2.14	2.25E-04
				12	2.14	1.51E-04
			13	2	2.35	2.68E-04
				7	2.35	1.92E-04
				12	2.35	1.37E-04
		1400	1	2	1.96	5.66E-04
				7	1.96	4.11E-04
				12	1.96	2.91E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	8	1400	7	2	2.13	5.24E-04
				7	2.14	3.71E-04
				12	2.14	2.65E-04
			13	2	2.34	4.56E-04
				7	2.35	3.38E-04
				12	2.35	2.35E-04
8	0	200	1	2	1.96	9.75E-05
				7	1.96	6.49E-05
				12	1.97	4.09E-05
			7	2	2.14	9.02E-05
				7	2.15	5.98E-05
				12	2.15	3.86E-05
			13	2	2.34	8.34E-05
				7	2.35	5.38E-05
				12	2.35	3.34E-05
		800	1	2	1.96	3.55E-04
				7	1.95	2.59E-04
				12	1.96	1.82E-04
			7	2	2.14	3.27E-04
				7	2.14	2.41E-04
				12	2.14	1.64E-04
			13	2	2.35	2.87E-04
				7	2.36	2.07E-04
				12	2.35	1.48E-04
		1400	1	2	1.96	5.76E-04
				7	1.96	4.19E-04
				12	1.96	2.98E-04
			7	2	2.14	5.22E-04
				7	2.15	3.72E-04
				12	2.14	2.68E-04
			13	2	2.35	4.69E-04
				7	2.35	3.38E-04
				12	2.35	2.40E-04
	4	200	1	2	1.97	9.85E-05
				7	1.96	6.23E-05
				12	1.96	4.08E-05
			7	2	2.14	9.03E-05
				7	2.14	6.23E-05
				12	2.14	3.76E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	4	200	13	2	2.35	8.13E-05
				7	2.35	5.35E-05
				12	2.35	3.49E-05
		800	1	2	1.96	3.52E-04
				7	1.96	2.61E-04
				12	1.96	1.79E-04
			7	2	2.14	3.14E-04
				7	2.14	2.37E-04
				12	2.14	1.67E-04
			13	2	2.35	2.85E-04
				7	2.35	2.05E-04
				12	2.35	1.49E-04
		1400	1	2	1.96	5.81E-04
				7	1.96	4.17E-04
				12	1.96	2.97E-04
			7	2	2.14	5.30E-04
				7	2.14	3.91E-04
				12	2.14	2.71E-04
			13	2	2.34	4.73E-04
				7	2.35	3.37E-04
				12	2.34	2.38E-04
	8	200	1	2	1.97	1.41E-04
				7	1.95	9.64E-05
				12	1.97	5.95E-05
			7	2	2.15	1.40E-04
				7	2.15	9.09E-05
				12	2.14	5.83E-05
			13	2	2.34	1.21E-04
				7	2.34	8.04E-05
				12	2.36	5.02E-05
		800	1	2	1.96	5.37E-04
				7	1.96	3.77E-04
				12	1.96	2.72E-04
			7	2	2.14	4.80E-04
				7	2.14	3.47E-04
				12	2.14	2.55E-04
			13	2	2.35	4.33E-04
				7	2.35	3.12E-04
				12	2.35	2.22E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	8	1400	1	2	1.96	8.71E-04
				7	1.96	6.23E-04
				12	1.96	4.42E-04
			7	2	2.14	7.99E-04
				7	2.14	5.69E-04
				12	2.15	3.99E-04
			13	2	2.35	7.01E-04
				7	2.35	5.07E-04
				12	2.35	3.55E-04

Appendix M. 1V:3H Undivided Urban Arterial

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	1.70	5.89E-06
				7	1.71	3.98E-06
				12	1.70	2.80E-06
			7	2	1.87	6.99E-06
				7	1.87	4.78E-06
				12	1.87	3.30E-06
			13	2	2.04	6.77E-06
				7	2.04	4.66E-06
				12	2.04	3.32E-06
		800	1	2	1.70	2.25E-05
				7	1.70	1.64E-05
				12	1.70	1.16E-05
			7	2	1.86	2.45E-05
				7	1.86	1.76E-05
				12	1.86	1.24E-05
			13	2	2.04	2.38E-05
				7	2.04	1.69E-05
				12	2.04	1.18E-05
		1400	1	2	1.70	3.95E-05
				7	1.70	2.89E-05
				12	1.70	2.04E-05
			7	2	1.86	4.19E-05
				7	1.87	3.05E-05
				12	1.86	2.18E-05
			13	2	2.05	3.99E-05
				7	2.04	2.90E-05
				12	2.04	2.06E-05
	3	200	1	2	1.70	6.66E-06
				7	1.70	4.57E-06
				12	1.70	3.18E-06
			7	2	1.86	8.03E-06
				7	1.85	5.61E-06
				12	1.86	3.85E-06
			13	2	2.04	7.80E-06
				7	2.04	5.29E-06
				12	2.04	3.65E-06
		800	1	2	1.70	2.58E-05
				7	1.70	1.83E-05
				12	1.70	1.31E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	800	7	2	1.86	2.77E-05
				7	1.86	2.01E-05
				12	1.86	1.41E-05
			13	2	2.04	2.63E-05
				7	2.04	1.88E-05
				12	2.04	1.32E-05
		1400	1	2	1.70	4.46E-05
				7	1.71	3.21E-05
				12	1.70	2.30E-05
			7	2	1.86	4.78E-05
				7	1.86	3.47E-05
				12	1.86	2.46E-05
			13	2	2.04	4.49E-05
				7	2.04	3.26E-05
				12	2.04	2.30E-05
	6	200	1	2	1.71	8.85E-06
				7	1.71	6.19E-06
				12	1.71	4.14E-06
			7	2	1.86	1.05E-05
				7	1.86	7.20E-06
				12	1.86	4.98E-06
			13	2	2.04	1.02E-05
				7	2.04	7.04E-06
				12	2.05	4.73E-06
		800	1	2	1.70	3.39E-05
				7	1.70	2.47E-05
				12	1.70	1.73E-05
			7	2	1.86	3.69E-05
				7	1.87	2.64E-05
				12	1.86	1.88E-05
			13	2	2.04	3.52E-05
				7	2.04	2.51E-05
				12	2.04	1.77E-05
		1400	1	2	1.70	5.99E-05
				7	1.70	4.29E-05
				12	1.70	3.07E-05
			7	2	1.87	6.37E-05
				7	1.86	4.63E-05
				12	1.86	3.31E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	1400	13	2	2.04	5.96E-05
				7	2.04	4.35E-05
				12	2.04	3.08E-05
4	0	200	1	2	1.70	1.07E-05
				7	1.70	7.17E-06
				12	1.70	4.54E-06
			7	2	1.87	1.16E-05
				7	1.87	7.59E-06
				12	1.88	4.79E-06
			13	2	2.04	1.11E-05
				7	2.05	7.20E-06
				12	2.03	4.64E-06
		800	1	2	1.71	4.45E-05
				7	1.71	3.20E-05
				12	1.70	2.23E-05
			7	2	1.86	4.67E-05
				7	1.86	3.34E-05
				12	1.86	2.37E-05
			13	2	2.03	4.44E-05
				7	2.04	3.11E-05
				12	2.04	2.25E-05
		1400	1	2	1.70	7.71E-05
				7	1.70	5.51E-05
				12	1.70	3.88E-05
			7	2	1.86	8.15E-05
				7	1.86	5.92E-05
				12	1.86	4.12E-05
			13	2	2.04	7.65E-05
				7	2.04	5.45E-05
				12	2.04	3.88E-05
	3	200	1	2	1.71	1.20E-05
				7	1.70	7.95E-06
				12	1.70	5.26E-06
			7	2	1.85	1.30E-05
				7	1.86	8.47E-06
				12	1.86	5.46E-06
			13	2	2.03	1.22E-05
				7	2.05	8.11E-06
				12	2.03	5.39E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	3	800	1	2	1.71	5.00E-05
				7	1.70	3.61E-05
				12	1.70	2.48E-05
			7	2	1.87	5.25E-05
				7	1.86	3.77E-05
				12	1.86	2.62E-05
			13	2	2.04	4.97E-05
				7	2.04	3.58E-05
				12	2.04	2.50E-05
		1400	1	2	1.70	8.62E-05
				7	1.70	6.24E-05
				12	1.71	4.36E-05
			7	2	1.86	9.20E-05
				7	1.86	6.63E-05
				12	1.86	4.63E-05
			13	2	2.04	8.72E-05
				7	2.04	6.13E-05
				12	2.05	4.30E-05
	6	200	1	2	1.70	1.61E-05
				7	1.72	1.06E-05
				12	1.70	6.85E-06
			7	2	1.86	1.69E-05
				7	1.86	1.13E-05
				12	1.86	7.42E-06
			13	2	2.05	1.57E-05
				7	2.04	1.08E-05
				12	2.03	7.13E-06
		800	1	2	1.70	6.67E-05
				7	1.70	4.74E-05
				12	1.70	3.37E-05
			7	2	1.86	7.14E-05
				7	1.86	5.05E-05
				12	1.86	3.55E-05
			13	2	2.04	6.63E-05
				7	2.05	4.67E-05
				12	2.04	3.31E-05
		1400	1	2	1.70	1.15E-04
				7	1.70	8.22E-05
				12	1.71	5.81E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	6	1400	7	2	1.86	1.22E-04
				7	1.86	8.67E-05
				12	1.86	6.09E-05
			13	2	2.04	1.14E-04
				7	2.04	8.12E-05
				12	2.04	5.87E-05
8	0	200	1	2	1.71	1.56E-05
				7	1.70	9.91E-06
				12	1.71	6.03E-06
			7	2	1.86	1.67E-05
				7	1.88	1.05E-05
				12	1.86	6.37E-06
			13	2	2.04	1.58E-05
				7	2.03	1.00E-05
				12	2.03	6.04E-06
		800	1	2	1.70	5.78E-05
				7	1.71	4.14E-05
				12	1.70	2.93E-05
			7	2	1.86	6.19E-05
				7	1.86	4.43E-05
				12	1.86	3.11E-05
			13	2	2.04	5.77E-05
				7	2.05	4.13E-05
				12	2.03	2.91E-05
		1400	1	2	1.70	9.27E-05
				7	1.70	6.65E-05
				12	1.70	4.64E-05
			7	2	1.86	9.79E-05
				7	1.86	6.99E-05
				12	1.86	4.89E-05
			13	2	2.05	9.07E-05
				7	2.04	6.67E-05
				12	2.04	4.57E-05
	3	200	1	2	1.70	1.75E-05
				7	1.70	1.12E-05
				12	1.71	6.79E-06
			7	2	1.86	1.87E-05
				7	1.86	1.19E-05
				12	1.87	7.17E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	3	200	13	2	2.05	1.68E-05
				7	2.05	1.09E-05
				12	2.04	6.85E-06
		800	1	2	1.71	6.47E-05
				7	1.70	4.74E-05
				12	1.71	3.26E-05
			7	2	1.86	7.02E-05
				7	1.86	4.86E-05
				12	1.86	3.44E-05
			13	2	2.04	6.55E-05
				7	2.04	4.72E-05
				12	2.04	3.25E-05
		1400	1	2	1.71	1.05E-04
				7	1.70	7.61E-05
				12	1.70	5.30E-05
			7	2	1.86	1.11E-04
				7	1.86	7.95E-05
				12	1.86	5.62E-05
			13	2	2.03	1.05E-04
				7	2.04	7.48E-05
				12	2.04	5.24E-05
	6	200	1	2	1.70	2.27E-05
				7	1.70	1.50E-05
				12	1.70	9.05E-06
			7	2	1.87	2.50E-05
				7	1.85	1.60E-05
				12	1.87	9.69E-06
			13	2	2.02	2.44E-05
				7	2.02	1.57E-05
				12	2.03	9.45E-06
		800	1	2	1.70	8.75E-05
				7	1.70	6.26E-05
				12	1.70	4.41E-05
			7	2	1.86	9.45E-05
				7	1.86	6.60E-05
				12	1.86	4.64E-05
			13	2	2.04	8.59E-05
				7	2.03	6.26E-05
				12	2.04	4.36E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	6	1400	1	2	1.70	1.41E-04
				7	1.70	1.00E-04
				12	1.70	7.03E-05
			7	2	1.86	1.47E-04
				7	1.86	1.05E-04
				12	1.86	7.35E-05
			13	2	2.04	1.38E-04
				7	2.04	9.79E-05
				12	2.04	6.85E-05

Appendix N. 1V:4H Divided Urban Arterial

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	1.71	1.18E-05
				7	1.70	8.74E-06
				12	1.70	6.88E-06
			7	2	1.86	1.49E-05
				7	1.85	1.14E-05
				12	1.85	9.34E-06
			13	2	2.04	1.54E-05
				7	2.05	1.16E-05
				12	2.04	9.82E-06
		800	1	2	1.70	4.62E-05
				7	1.70	3.65E-05
				12	1.70	2.97E-05
			7	2	1.86	5.09E-05
				7	1.86	4.09E-05
				12	1.86	3.34E-05
			13	2	2.04	4.93E-05
				7	2.04	3.93E-05
				12	1.86	3.31E-05
		1400	1	2	1.70	8.07E-05
				7	1.70	6.43E-05
				12	1.71	5.23E-05
			7	2	1.86	8.79E-05
				7	1.86	7.00E-05
				12	1.86	5.67E-05
			13	2	2.04	8.37E-05
				7	2.04	6.83E-05
				12	1.86	5.77E-05
	3	200	1	2	1.69	1.32E-05
				7	1.70	9.71E-06
				12	1.71	7.57E-06
			7	2	1.86	1.64E-05
				7	1.86	1.25E-05
				12	1.86	1.01E-05
			13	2	2.04	1.68E-05
				7	2.05	1.32E-05
				12	1.87	1.03E-05
		800	1	2	1.70	5.20E-05
				7	1.70	4.06E-05
				12	1.70	3.27E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	800	7	2	1.86	5.76E-05
				7	1.86	4.56E-05
				12	1.86	3.70E-05
			13	2	2.05	5.45E-05
				7	2.04	4.38E-05
				12	1.86	3.74E-05
		1400	1	2	1.70	9.16E-05
				7	1.70	7.27E-05
				12	1.70	5.92E-05
			7	2	1.86	9.90E-05
				7	1.86	7.88E-05
				12	1.86	6.50E-05
			13	2	2.04	9.42E-05
				7	2.04	7.54E-05
				12	1.86	6.42E-05
	6	200	1	2	1.70	1.75E-05
				7	1.70	1.27E-05
				12	1.70	1.02E-05
			7	2	1.86	2.18E-05
				7	1.86	1.72E-05
				12	1.86	1.37E-05
			13	2	2.04	2.36E-05
				7	2.04	1.81E-05
				12	1.86	1.39E-05
		800	1	2	1.70	6.93E-05
				7	1.70	5.54E-05
				12	1.71	4.46E-05
			7	2	1.86	7.74E-05
				7	1.86	6.03E-05
				12	1.86	4.93E-05
			13	2	2.04	7.43E-05
				7	2.04	5.85E-05
				12	1.87	4.95E-05
		1400	1	2	1.70	1.23E-04
				7	1.70	9.69E-05
				12	1.70	7.82E-05
			7	2	1.86	1.32E-04
				7	1.86	1.05E-04
				12	1.86	8.57E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	1400	13	2	2.04	1.26E-04
				7	2.04	1.00E-04
				12	1.86	8.65E-05
4	0	200	1	2	1.70	2.03E-05
				7	1.70	1.43E-05
				12	1.70	1.09E-05
			7	2	1.87	2.25E-05
				7	1.86	1.53E-05
				12	1.86	1.13E-05
			13	2	2.06	2.00E-05
				7	2.05	1.45E-05
				12	2.05	1.07E-05
		800	1	2	1.70	8.85E-05
				7	1.70	7.04E-05
				12	1.71	5.52E-05
			7	2	1.86	9.47E-05
				7	1.86	7.40E-05
				12	1.86	5.85E-05
			13	2	2.04	8.62E-05
				7	2.05	6.81E-05
				12	1.86	5.79E-05
		1400	1	2	1.70	1.54E-04
				7	1.70	1.21E-04
				12	1.70	9.91E-05
			7	2	1.86	1.64E-04
				7	1.86	1.27E-04
				12	1.86	1.03E-04
			13	2	2.04	1.55E-04
				7	2.04	1.18E-04
				12	1.86	1.04E-04
	3	200	1	2	1.70	2.28E-05
				7	1.70	1.63E-05
				12	1.71	1.19E-05
			7	2	1.86	2.45E-05
				7	1.84	1.81E-05
				12	1.86	1.28E-05
			13	2	2.04	2.28E-05
				7	2.04	1.66E-05
				12	1.87	1.25E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	3	800	1	2	1.70	1.01E-04
				7	1.70	7.78E-05
				12	1.70	6.34E-05
			7	2	1.86	1.05E-04
				7	1.86	8.21E-05
				12	1.86	6.47E-05
			13	2	2.04	9.93E-05
				7	2.04	7.72E-05
				12	1.86	6.58E-05
		1400	1	2	1.70	1.75E-04
				7	1.70	1.37E-04
				12	1.71	1.11E-04
			7	2	1.86	1.85E-04
				7	1.86	1.43E-04
				12	1.86	1.16E-04
			13	2	2.04	1.70E-04
				7	2.04	1.36E-04
				12	1.86	1.15E-04
	6	200	1	2	1.71	3.15E-05
				7	1.71	2.16E-05
				12	1.69	1.58E-05
			7	2	1.85	3.25E-05
				7	1.86	2.32E-05
				12	1.86	1.70E-05
			13	2	2.04	3.15E-05
				7	2.04	2.30E-05
				12	1.86	1.71E-05
		800	1	2	1.70	1.34E-04
				7	1.71	1.03E-04
				12	1.70	8.27E-05
			7	2	1.86	1.40E-04
				7	1.86	1.09E-04
				12	1.86	8.79E-05
			13	2	2.03	1.34E-04
				7	2.03	1.04E-04
				12	1.86	8.73E-05
		1400	1	2	1.70	2.33E-04
				7	1.70	1.80E-04
				12	1.70	1.47E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	6	1400	7	2	1.86	2.46E-04
				7	1.86	1.92E-04
				12	1.86	1.54E-04
			13	2	2.04	2.30E-04
				7	2.04	1.78E-04
				12	1.86	1.56E-04
8	0	200	1	2	1.71	2.97E-05
				7	1.71	1.98E-05
				12	1.71	1.34E-05
			7	2	1.86	3.17E-05
				7	1.87	2.17E-05
				12	1.86	1.44E-05
			13	2	2.03	2.94E-05
				7	2.03	2.13E-05
				12	2.05	1.37E-05
		800	1	2	1.70	1.16E-04
				7	1.70	9.08E-05
				12	1.71	7.19E-05
			7	2	1.86	1.21E-04
				7	1.87	9.48E-05
				12	1.86	7.53E-05
			13	2	2.04	1.12E-04
				7	2.04	8.86E-05
				12	1.85	7.66E-05
		1400	1	2	1.70	1.80E-04
				7	1.70	1.41E-04
				12	1.70	1.14E-04
			7	2	1.86	1.92E-04
				7	1.86	1.51E-04
				12	1.86	1.21E-04
			13	2	2.04	1.79E-04
				7	2.04	1.43E-04
				12	1.86	1.20E-04
	3	200	1	2	1.70	3.40E-05
				7	1.71	2.28E-05
				12	1.70	1.56E-05
			7	2	1.86	3.58E-05
				7	1.87	2.39E-05
				12	1.86	1.62E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	3	200	13	2	2.05	3.30E-05
				7	2.06	2.18E-05
				12	1.86	1.62E-05
		800	1	2	1.71	1.30E-04
				7	1.70	1.03E-04
				12	1.70	7.95E-05
			7	2	1.86	1.38E-04
				7	1.87	1.05E-04
				12	1.87	8.55E-05
			13	2	2.04	1.29E-04
				7	2.04	1.02E-04
				12	1.86	8.52E-05
		1400	1	2	1.70	2.07E-04
				7	1.71	1.59E-04
				12	1.70	1.30E-04
			7	2	1.86	2.16E-04
				7	1.86	1.70E-04
				12	1.86	1.36E-04
			13	2	2.04	2.06E-04
				7	2.04	1.60E-04
				12	1.86	1.36E-04
	6	200	1	2	1.70	4.58E-05
				7	1.69	3.19E-05
				12	1.70	2.09E-05
			7	2	1.87	4.69E-05
				7	1.87	3.26E-05
				12	1.86	2.22E-05
			13	2	2.04	4.51E-05
				7	2.04	2.92E-05
				12	1.87	2.15E-05
		800	1	2	1.70	1.73E-04
				7	1.71	1.33E-04
				12	1.70	1.08E-04
			7	2	1.86	1.81E-04
				7	1.86	1.42E-04
				12	1.86	1.13E-04
			13	2	2.04	1.73E-04
				7	2.05	1.31E-04
				12	1.86	1.14E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	6	1400	1	2	1.71	2.74E-04
				7	1.70	2.17E-04
				12	1.70	1.71E-04
			7	2	1.86	2.88E-04
				7	1.86	2.26E-04
				12	1.87	1.79E-04
			13	2	2.04	2.70E-04
				7	2.04	2.12E-04
				12	1.86	1.82E-04

Appendix O. 1V:3H Urban Local

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	2.10	4.51E-05
				7	2.10	3.24E-05
				12	2.10	2.13E-05
			7	2	2.29	4.45E-05
				7	2.29	3.08E-05
				12	2.29	2.09E-05
			13	2	2.52	3.76E-05
				7	2.51	2.74E-05
				12	2.51	1.87E-05
		800	1	2	2.10	1.69E-04
				7	2.09	1.25E-04
				12	2.09	8.92E-05
			7	2	2.29	1.50E-04
				7	2.28	1.10E-04
				12	2.29	7.83E-05
			13	2	2.51	1.33E-04
				7	2.52	9.72E-05
				12	2.51	7.03E-05
		1400	1	2	2.09	2.96E-04
				7	2.09	2.16E-04
				12	2.09	1.54E-04
			7	2	2.29	2.56E-04
				7	2.29	1.89E-04
				12	2.29	1.33E-04
			13	2	2.51	2.32E-04
				7	2.51	1.69E-04
				12	2.52	1.21E-04
	6	200	1	2	2.09	7.07E-05
				7	2.10	4.72E-05
				12	2.10	3.22E-05
			7	2	2.28	6.82E-05
				7	2.30	4.37E-05
				12	2.30	2.99E-05
			13	2	2.51	5.94E-05
				7	2.52	4.11E-05
				12	2.53	2.76E-05
		800	1	2	2.09	2.56E-04
				7	2.10	1.83E-04
				12	2.10	1.26E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	800	7	2	2.29	2.24E-04
				7	2.30	1.62E-04
				12	2.29	1.15E-04
			13	2	2.52	2.01E-04
				7	2.51	1.48E-04
				12	2.51	1.04E-04
		1400	1	2	2.09	4.42E-04
				7	2.10	3.22E-04
				12	2.09	2.31E-04
			7	2	2.29	3.86E-04
				7	2.29	2.82E-04
				12	2.29	2.04E-04
			13	2	2.51	3.50E-04
				7	2.51	2.52E-04
				12	2.51	1.81E-04
	12	200	1	2	2.09	6.81E-05
				7	2.10	4.78E-05
				12	2.08	3.25E-05
			7	2	2.29	6.46E-05
				7	2.30	4.49E-05
				12	2.29	3.16E-05
			13	2	2.51	5.86E-05
				7	2.50	4.27E-05
				12	2.50	2.86E-05
		800	1	2	2.10	2.57E-04
				7	2.09	1.84E-04
				12	2.09	1.32E-04
			7	2	2.29	2.27E-04
				7	2.29	1.62E-04
				12	2.29	1.19E-04
			13	2	2.51	1.99E-04
				7	2.51	1.44E-04
				12	2.51	1.04E-04
		1400	1	2	2.09	4.36E-04
				7	2.10	3.16E-04
				12	2.09	2.31E-04
			7	2	2.29	3.89E-04
				7	2.29	2.81E-04
				12	2.29	2.01E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	12	1400	13	2	2.51	3.52E-04
				7	2.51	2.52E-04
				12	2.51	1.80E-04
3	0	200	1	2	2.09	4.51E-05
				7	2.08	3.15E-05
				12	2.09	2.04E-05
			7	2	2.29	4.37E-05
				7	2.29	2.79E-05
				12	2.29	1.79E-05
			13	2	2.50	3.94E-05
				7	2.52	2.37E-05
				12	2.50	1.70E-05
		800	1	2	2.10	1.80E-04
				7	2.09	1.29E-04
				12	2.09	8.96E-05
			7	2	2.29	1.52E-04
				7	2.29	1.12E-04
				12	2.29	7.85E-05
			13	2	2.51	1.40E-04
				7	2.51	9.98E-05
				12	2.51	7.14E-05
		1400	1	2	2.09	3.01E-04
				7	2.09	2.19E-04
				12	2.09	1.59E-04
			7	2	2.29	2.66E-04
				7	2.29	1.88E-04
				12	2.29	1.35E-04
			13	2	2.51	2.28E-04
				7	2.51	1.72E-04
				12	2.51	1.20E-04
	6	200	1	2	2.10	7.21E-05
				7	2.10	4.66E-05
				12	2.11	3.00E-05
			7	2	2.29	6.20E-05
				7	2.28	4.03E-05
				12	2.29	2.77E-05
			13	2	2.50	5.86E-05
				7	2.52	3.74E-05
				12	2.51	2.43E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	6	800	1	2	2.09	2.66E-04
				7	2.10	1.92E-04
				12	2.09	1.38E-04
			7	2	2.28	2.34E-04
				7	2.28	1.67E-04
				12	2.30	1.15E-04
			13	2	2.51	2.02E-04
				7	2.52	1.50E-04
				12	2.51	1.05E-04
		1400	1	2	2.09	4.55E-04
				7	2.09	3.39E-04
				12	2.09	2.30E-04
			7	2	2.29	3.88E-04
				7	2.29	2.84E-04
				12	2.29	1.97E-04
			13	2	2.52	3.42E-04
				7	2.51	2.51E-04
				12	2.51	1.84E-04
	12	200	1	2	2.09	7.28E-05
				7	2.09	4.50E-05
				12	2.08	3.11E-05
			7	2	2.28	6.58E-05
				7	2.30	3.98E-05
				12	2.29	2.87E-05
			13	2	2.52	6.07E-05
				7	2.52	3.71E-05
				12	2.51	2.36E-05
		800	1	2	2.10	2.62E-04
				7	2.09	1.89E-04
				12	2.09	1.37E-04
			7	2	2.30	2.33E-04
				7	2.30	1.65E-04
				12	2.29	1.18E-04
			13	2	2.51	2.06E-04
				7	2.51	1.54E-04
				12	2.52	1.06E-04
		1400	1	2	2.10	4.56E-04
				7	2.09	3.29E-04
				12	2.10	2.29E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	12	1400	7	2	2.29	3.89E-04
				7	2.29	2.84E-04
				12	2.29	2.04E-04
			13	2	2.51	3.55E-04
				7	2.51	2.53E-04
				12	2.51	1.82E-04
6	0	200	1	2	2.08	1.40E-04
				7	2.10	9.60E-05
				12	2.09	6.25E-05
			7	2	2.29	1.19E-04
				7	2.29	8.50E-05
				12	2.28	5.56E-05
			13	2	2.50	1.15E-04
				7	2.51	7.86E-05
				12	2.49	5.14E-05
		800	1	2	2.09	5.42E-04
				7	2.09	3.89E-04
				12	2.10	2.75E-04
			7	2	2.29	4.61E-04
				7	2.29	3.34E-04
				12	2.29	2.39E-04
			13	2	2.51	4.18E-04
				7	2.51	2.97E-04
				12	2.51	2.16E-04
		1400	1	2	2.09	8.98E-04
				7	2.10	6.49E-04
				12	2.09	4.49E-04
			7	2	2.29	7.74E-04
				7	2.29	5.63E-04
				12	2.29	3.87E-04
			13	2	2.52	6.82E-04
				7	2.50	4.95E-04
				12	2.51	3.47E-04
	6	200	1	2	2.10	2.02E-04
				7	2.09	1.48E-04
				12	2.09	9.66E-05
			7	2	2.29	1.86E-04
				7	2.28	1.25E-04
				12	2.29	8.13E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	6	200	13	2	2.53	1.64E-04
				7	2.50	1.18E-04
				12	2.51	7.89E-05
		800	1	2	2.09	8.18E-04
				7	2.10	5.98E-04
				12	2.08	4.16E-04
			7	2	2.30	7.10E-04
				7	2.30	4.94E-04
				12	2.30	3.54E-04
			13	2	2.51	6.29E-04
				7	2.51	4.50E-04
				12	2.50	3.24E-04
		1400	1	2	2.09	1.33E-03
				7	2.09	9.59E-04
				12	2.09	6.78E-04
			7	2	2.30	1.16E-03
				7	2.30	8.15E-04
				12	2.29	5.99E-04
			13	2	2.51	1.01E-03
				7	2.51	7.43E-04
				12	2.51	5.23E-04
	12	200	1	2	2.09	2.18E-04
				7	2.08	1.48E-04
				12	2.09	9.51E-05
			7	2	2.29	1.91E-04
				7	2.30	1.28E-04
				12	2.28	8.72E-05
			13	2	2.50	1.78E-04
				7	2.51	1.23E-04
				12	2.49	7.52E-05
		800	1	2	2.09	8.35E-04
				7	2.09	5.83E-04
				12	2.10	3.96E-04
			7	2	2.29	7.13E-04
				7	2.29	4.97E-04
				12	2.28	3.63E-04
			13	2	2.51	6.16E-04
				7	2.51	4.60E-04
				12	2.51	3.15E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	12	1400	1	2	2.09	1.36E-03
				7	2.10	9.60E-04
				12	2.09	6.71E-04
			7	2	2.29	1.15E-03
				7	2.29	8.33E-04
				12	2.29	5.93E-04
			13	2	2.52	1.01E-03
				7	2.51	7.44E-04
				12	2.51	5.15E-04

Appendix P. 1V:4H Freeway

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	1.49	9.70E-06
				7	1.49	7.11E-06
				12	1.48	5.19E-06
			7	2	1.95	1.44E-05
				7	1.95	1.05E-05
				12	1.95	8.79E-06
			13	2	1.95	1.60E-05
				7	1.95	1.20E-05
				12	1.94	9.88E-06
		800	1	2	1.48	3.67E-05
				7	1.48	2.84E-05
				12	1.49	2.28E-05
			7	2	1.95	4.91E-05
				7	1.95	3.90E-05
				12	1.94	3.18E-05
			13	2	1.95	5.10E-05
				7	1.95	3.92E-05
				12	1.95	3.20E-05
		1400	1	2	1.49	6.43E-05
				7	1.49	5.14E-05
				12	1.49	4.17E-05
			7	2	1.95	8.36E-05
				7	1.95	6.74E-05
				12	1.95	5.41E-05
			13	2	1.94	8.57E-05
				7	1.95	6.82E-05
				12	1.95	5.49E-05
	2	200	1	2	1.49	8.94E-06
				7	1.49	6.70E-06
				12	1.48	5.18E-06
			7	2	1.96	1.42E-05
				7	1.94	1.09E-05
				12	1.95	8.73E-06
			13	2	1.95	1.59E-05
				7	1.95	1.18E-05
				12	1.94	9.64E-06
		800	1	2	1.48	3.64E-05
				7	1.49	2.90E-05
				12	1.49	2.35E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	2	800	7	2	1.95	4.89E-05
				7	1.95	3.80E-05
				12	1.94	3.13E-05
			13	2	1.95	5.09E-05
				7	1.95	3.95E-05
				12	1.95	3.26E-05
		1400	1	2	1.49	6.53E-05
				7	1.48	5.09E-05
				12	1.49	4.08E-05
			7	2	1.94	8.38E-05
				7	1.95	6.70E-05
				12	1.95	5.54E-05
			13	2	1.95	8.58E-05
				7	1.95	6.69E-05
				12	1.95	5.52E-05
	3	200	1	2	1.48	1.04E-05
				7	1.48	7.72E-06
				12	1.49	5.83E-06
			7	2	1.94	1.59E-05
				7	1.95	1.24E-05
				12	1.94	1.02E-05
			13	2	1.95	1.76E-05
				7	1.94	1.38E-05
				12	1.94	1.07E-05
		800	1	2	1.48	4.14E-05
				7	1.49	3.22E-05
				12	1.48	2.57E-05
			7	2	1.95	5.38E-05
				7	1.95	4.34E-05
				12	1.95	3.57E-05
			13	2	1.95	5.63E-05
				7	1.95	4.50E-05
				12	1.95	3.70E-05
		1400	1	2	1.48	7.08E-05
				7	1.49	5.74E-05
				12	1.49	4.69E-05
			7	2	1.95	9.46E-05
				7	1.94	7.42E-05
				12	1.95	6.14E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	1400	13	2	1.95	9.65E-05
				7	1.95	7.48E-05
				12	1.95	6.26E-05
2	0	200	1	2	1.49	7.08E-06
				7	1.49	4.87E-06
				12	1.49	3.26E-06
			7	2	1.94	9.28E-06
				7	1.94	6.33E-06
				12	1.95	4.71E-06
			13	2	1.95	1.01E-05
				7	1.95	7.22E-06
				12	1.95	5.33E-06
		800	1	2	1.49	3.30E-05
				7	1.49	2.50E-05
				12	1.49	2.03E-05
			7	2	1.95	4.17E-05
				7	1.94	3.16E-05
				12	1.95	2.55E-05
			13	2	1.95	4.25E-05
				7	1.95	3.27E-05
				12	1.95	2.59E-05
		1400	1	2	1.49	5.76E-05
				7	1.49	4.44E-05
				12	1.49	3.62E-05
			7	2	1.95	7.25E-05
				7	1.95	5.68E-05
				12	1.95	4.51E-05
			13	2	1.95	7.39E-05
				7	1.95	5.74E-05
				12	1.95	4.66E-05
	2	200	1	2	1.49	7.39E-06
				7	1.48	4.79E-06
				12	1.48	3.28E-06
			7	2	1.94	9.72E-06
				7	1.94	6.37E-06
				12	1.95	5.02E-06
			13	2	1.95	1.04E-05
				7	1.95	7.24E-06
				12	1.95	5.31E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
2	2	800	1	2	1.49	3.31E-05
				7	1.49	2.52E-05
				12	1.49	2.02E-05
			7	2	1.95	4.14E-05
				7	1.95	3.21E-05
				12	1.95	2.58E-05
			13	2	1.95	4.28E-05
				7	1.94	3.32E-05
				12	1.95	2.61E-05
		1400	1	2	1.49	5.78E-05
				7	1.49	4.46E-05
				12	1.49	3.62E-05
			7	2	1.95	7.26E-05
				7	1.95	5.70E-05
				12	1.95	4.60E-05
			13	2	1.95	7.42E-05
				7	1.94	5.68E-05
				12	1.95	4.67E-05
	3	200	1	2	1.49	7.06E-06
				7	1.48	4.91E-06
				12	1.48	3.39E-06
			7	2	1.95	9.35E-06
				7	1.94	6.46E-06
				12	1.94	4.61E-06
			13	2	1.95	1.02E-05
				7	1.94	7.47E-06
				12	1.95	5.33E-06
		800	1	2	1.48	3.31E-05
				7	1.49	2.48E-05
				12	1.48	2.03E-05
			7	2	1.95	4.28E-05
				7	1.95	3.22E-05
				12	1.94	2.55E-05
			13	2	1.95	4.24E-05
				7	1.94	3.36E-05
				12	1.95	2.66E-05
		1400	1	2	1.49	5.79E-05
				7	1.48	4.45E-05
				12	1.48	3.63E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
2	3	1400	7	2	1.94	7.25E-05
				7	1.95	5.63E-05
				12	1.95	4.57E-05
			13	2	1.95	7.33E-05
				7	1.95	5.79E-05
				12	1.95	4.64E-05
3	0	200	1	2	1.48	8.30E-06
				7	1.49	5.15E-06
				12	1.47	3.80E-06
			7	2	1.95	1.04E-05
				7	1.94	6.56E-06
				12	1.95	4.89E-06
			13	2	1.95	1.08E-05
				7	1.94	7.34E-06
				12	1.94	5.35E-06
		800	1	2	1.49	3.56E-05
				7	1.48	2.65E-05
				12	1.49	2.11E-05
			7	2	1.95	4.42E-05
				7	1.94	3.41E-05
				12	1.95	2.69E-05
			13	2	1.95	4.45E-05
				7	1.95	3.44E-05
				12	1.95	2.72E-05
		1400	1	2	1.49	5.95E-05
				7	1.49	4.64E-05
				12	1.49	3.73E-05
			7	2	1.95	7.51E-05
				7	1.94	6.63E-05
				12	1.95	4.69E-05
			13	2	1.95	7.66E-05
				7	1.95	5.92E-05
				12	1.95	4.83E-05
	2	200	1	2	1.47	8.03E-06
				7	1.49	5.43E-06
				12	1.48	3.61E-06
			7	2	1.95	1.04E-05
				7	1.94	6.75E-06
				12	1.94	4.92E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	2	200	13	2	1.95	1.12E-05
				7	1.95	6.79E-06
				12	1.95	5.27E-06
		800	1	2	1.49	3.55E-05
				7	1.49	2.75E-05
				12	1.49	2.12E-05
			7	2	1.95	4.47E-05
				7	1.95	3.41E-05
				12	1.95	2.63E-05
			13	2	1.95	4.50E-05
				7	1.95	3.43E-05
				12	1.95	2.69E-05
		1400	1	2	1.49	5.90E-05
				7	1.49	4.70E-05
				12	1.49	3.76E-05
			7	2	1.95	7.52E-05
				7	1.95	5.89E-05
				12	1.95	4.76E-05
			13	2	1.95	7.57E-05
				7	1.95	5.88E-05
				12	1.95	4.71E-05
	3	200	1	2	1.48	9.00E-06
				7	1.49	5.77E-06
				12	1.49	4.11E-06
			7	2	1.94	1.17E-05
				7	1.94	7.09E-06
				12	1.95	5.42E-06
			13	2	1.95	1.24E-05
				7	1.94	8.39E-06
				12	1.95	5.96E-06
		800	1	2	1.49	3.91E-05
				7	1.48	3.00E-05
				12	1.49	2.41E-05
			7	2	1.95	4.94E-05
				7	1.95	3.81E-05
				12	1.95	2.92E-05
			13	2	1.95	4.97E-05
				7	1.95	3.93E-05
				12	1.95	2.97E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	3	1400	1	2	1.48	6.80E-05
				7	1.49	5.29E-05
				12	1.49	4.26E-05
			7	2	1.95	8.41E-05
				7	1.95	6.61E-05
				12	1.95	5.30E-05
			13	2	1.95	8.40E-05
				7	1.95	6.61E-05
				12	1.95	5.45E-05

Appendix Q. 1V:4H Undivided Rural Arterial

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	1.01	9.03E-07
				7	1.00	6.48E-07
				12	1.00	4.55E-07
			7	2	1.31	3.10E-06
				7	1.31	2.16E-06
				12	1.31	1.56E-06
			13	2	1.31	3.21E-06
				7	1.31	2.20E-06
				12	1.31	1.52E-06
		800	1	2	1.00	3.36E-06
				7	1.00	2.44E-06
				12	1.00	1.73E-06
			7	2	1.31	1.03E-05
				7	1.31	7.38E-06
				12	1.31	5.27E-06
			13	2	1.32	1.07E-05
				7	1.31	7.64E-06
				12	1.31	5.25E-06
		1400	1	2	1.00	5.85E-06
				7	1.00	4.27E-06
				12	1.00	2.99E-06
			7	2	1.31	1.79E-05
				7	1.31	1.28E-05
				12	1.31	8.98E-06
			13	2	1.31	1.76E-05
				7	1.31	1.28E-05
				12	1.31	9.08E-06
	3	200	1	2	0.99	1.00E-06
				7	1.00	6.91E-07
				12	1.00	5.00E-07
			7	2	1.31	3.48E-06
				7	1.32	2.52E-06
				12	1.31	1.74E-06
			13	2	1.31	3.61E-06
				7	1.31	2.44E-06
				12	1.31	1.75E-06
		800	1	2	1.00	3.77E-06
				7	1.00	2.72E-06
				12	1.00	1.94E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	800	7	2	1.31	1.18E-05
				7	1.31	8.49E-06
				12	1.31	5.95E-06
			13	2	1.32	1.19E-05
				7	1.31	8.32E-06
				12	1.32	6.03E-06
		1400	1	2	1.00	6.54E-06
				7	1.00	4.77E-06
				12	1.00	3.40E-06
			7	2	1.31	1.99E-05
				7	1.31	1.42E-05
				12	1.31	1.02E-05
			13	2	1.31	1.97E-05
				7	1.31	1.43E-05
				12	1.31	1.01E-05
	6	200	1	2	1.00	1.38E-06
				7	1.01	9.46E-07
				12	1.00	6.68E-07
			7	2	1.32	4.73E-06
				7	1.31	3.20E-06
				12	1.31	2.26E-06
			13	2	1.31	4.78E-06
				7	1.32	3.46E-06
				12	1.31	2.28E-06
		800	1	2	1.00	5.08E-06
				7	1.00	3.61E-06
				12	1.00	2.56E-06
			7	2	1.31	1.56E-05
				7	1.31	1.13E-05
				12	1.31	7.83E-06
			13	2	1.31	1.54E-05
				7	1.31	1.12E-05
				12	1.31	7.87E-06
		1400	1	2	1.00	8.75E-06
				7	1.00	6.33E-06
				12	1.00	4.54E-06
			7	2	1.31	2.65E-05
				7	1.31	1.89E-05
				12	1.32	1.38E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	1400	13	2	1.31	2.66E-05
				7	1.31	1.90E-05
				12	1.31	1.38E-05
3	0	200	1	2	1.00	7.64E-07
				7	1.00	4.44E-07
				12	1.00	2.95E-07
			7	2	1.33	2.38E-06
				7	1.30	1.31E-06
				12	1.31	8.68E-07
			13	2	1.32	2.26E-06
				7	1.32	1.38E-06
				12	1.31	8.74E-07
		800	1	2	1.00	3.05E-06
				7	1.00	2.16E-06
				12	1.00	1.49E-06
			7	2	1.31	8.98E-06
				7	1.32	6.42E-06
				12	1.31	4.38E-06
			13	2	1.31	9.03E-06
				7	1.31	6.26E-06
				12	1.32	4.39E-06
		1400	1	2	1.00	5.12E-06
				7	1.00	3.65E-06
				12	1.00	2.60E-06
			7	2	1.31	1.54E-05
				7	1.32	1.08E-05
				12	1.31	7.71E-06
			13	2	1.31	1.51E-05
				7	1.32	1.11E-05
				12	1.32	7.57E-06
	3	200	1	2	1.00	8.58E-07
				7	1.00	5.08E-07
				12	1.00	3.35E-07
			7	2	1.31	2.55E-06
				7	1.31	1.49E-06
				12	1.31	9.64E-07
			13	2	1.31	2.64E-06
				7	1.31	1.52E-06
				12	1.31	1.01E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	3	800	1	2	1.00	3.47E-06
				7	1.00	2.47E-06
				12	1.00	1.67E-06
			7	2	1.31	1.00E-05
				7	1.31	7.06E-06
				12	1.31	4.98E-06
			13	2	1.31	9.98E-06
				7	1.31	7.11E-06
				12	1.31	4.95E-06
		1400	1	2	1.00	5.75E-06
				7	1.00	4.16E-06
				12	1.00	2.88E-06
			7	2	1.31	1.70E-05
				7	1.31	1.22E-05
				12	1.31	8.56E-06
			13	2	1.31	1.67E-05
				7	1.31	1.22E-05
				12	1.32	8.52E-06
	6	200	1	2	1.00	1.12E-06
				7	1.00	6.70E-07
				12	1.00	4.47E-07
			7	2	1.31	3.40E-06
				7	1.31	1.99E-06
				12	1.31	1.28E-06
			13	2	1.32	3.36E-06
				7	1.32	1.98E-06
				12	1.32	1.32E-06
		800	1	2	1.00	4.57E-06
				7	1.00	3.23E-06
				12	1.00	2.23E-06
			7	2	1.32	1.32E-05
				7	1.32	9.71E-06
				12	1.31	6.52E-06
			13	2	1.31	1.34E-05
				7	1.31	9.49E-06
				12	1.31	6.53E-06
		1400	1	2	1.00	7.70E-06
				7	1.00	5.52E-06
				12	1.00	3.88E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	6	1400	7	2	1.31	2.25E-05
				7	1.31	1.62E-05
				12	1.31	1.13E-05
			13	2	1.31	2.26E-05
				7	1.31	1.62E-05
				12	1.31	1.15E-05
6	0	200	1	2	1.00	2.23E-06
				7	1.00	1.47E-06
				12	1.00	9.36E-07
			7	2	1.31	6.72E-06
				7	1.30	4.48E-06
				12	1.31	2.80E-06
			13	2	1.32	6.66E-06
				7	1.31	4.25E-06
				12	1.31	2.71E-06
		800	1	2	1.00	8.99E-06
				7	1.00	6.42E-06
				12	1.00	4.40E-06
			7	2	1.31	2.64E-05
				7	1.31	1.85E-05
				12	1.31	1.29E-05
			13	2	1.31	2.61E-05
				7	1.32	1.87E-05
				12	1.31	1.30E-05
		1400	1	2	1.00	1.47E-05
				7	1.00	1.06E-05
				12	1.00	7.39E-06
			7	2	1.31	4.30E-05
				7	1.31	3.08E-05
				12	1.31	2.17E-05
			13	2	1.31	4.32E-05
				7	1.31	3.08E-05
				12	1.31	2.14E-05
	3	200	1	2	1.01	2.59E-06
				7	1.00	1.73E-06
				12	1.00	1.06E-06
			7	2	1.31	7.42E-06
				7	1.32	4.75E-06
				12	1.31	3.01E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	3	200	13	2	1.32	7.38E-06
				7	1.31	4.68E-06
				12	1.32	3.07E-06
		800	1	2	1.00	1.02E-05
				7	1.00	7.20E-06
				12	1.00	4.96E-06
			7	2	1.31	2.96E-05
				7	1.32	2.12E-05
				12	1.32	1.49E-05
			13	2	1.32	3.04E-05
				7	1.31	2.08E-05
				12	1.31	1.50E-05
		1400	1	2	1.00	1.64E-05
				7	1.00	1.18E-05
				12	1.00	8.29E-06
			7	2	1.31	4.78E-05
				7	1.31	3.42E-05
				12	1.31	2.44E-05
			13	2	1.31	4.78E-05
				7	1.31	3.44E-05
				12	1.31	2.45E-05
	6	200	1	2	1.00	3.32E-06
				7	1.01	2.24E-06
				12	1.00	1.45E-06
			7	2	1.32	9.89E-06
				7	1.31	6.57E-06
				12	1.31	3.74E-06
			13	2	1.31	9.84E-06
				7	1.31	6.40E-06
				12	1.31	4.09E-06
		800	1	2	1.00	1.35E-05
				7	1.01	9.66E-06
				12	1.00	6.72E-06
			7	2	1.31	3.94E-05
				7	1.31	2.79E-05
				12	1.32	1.98E-05
			13	2	1.31	3.89E-05
				7	1.32	2.82E-05
				12	1.31	1.91E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	6	1400	1	2	1.00	2.21E-05
				7	1.00	1.57E-05
				12	1.01	1.12E-05
			7	2	1.31	6.44E-05
				7	1.32	4.63E-05
				12	1.31	3.24E-05
			13	2	1.32	6.41E-05
				7	1.32	4.59E-05
				12	1.31	3.22E-05

Appendix R. 1V:4H Divided Rural Arterial

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	1.00	1.87E-06
				7	1.00	1.46E-06
				12	1.00	1.13E-06
			7	2	1.32	7.10E-06
				7	1.31	5.38E-06
				12	1.31	4.62E-06
			13	2	1.31	7.85E-06
				7	1.32	6.34E-06
				12	1.31	5.17E-06
		800	1	2	1.00	7.04E-06
				7	1.00	5.49E-06
				12	1.00	4.49E-06
			7	2	1.31	2.23E-05
				7	1.32	1.77E-05
				12	1.31	1.44E-05
			13	2	1.31	2.28E-05
				7	1.31	1.83E-05
				12	1.31	1.49E-05
		1400	1	2	1.00	1.22E-05
				7	1.00	9.74E-06
				12	1.00	8.03E-06
			7	2	1.31	3.75E-05
				7	1.31	2.97E-05
				12	1.31	2.47E-05
			13	2	1.31	3.77E-05
				7	1.31	3.05E-05
				12	1.32	2.52E-05
	3	200	1	2	1.01	2.11E-06
				7	1.00	1.51E-06
				12	1.00	1.23E-06
			7	2	1.32	8.16E-06
				7	1.31	6.36E-06
				12	1.30	5.28E-06
			13	2	1.32	9.14E-06
				7	1.31	7.03E-06
				12	1.32	5.86E-06
		800	1	2	1.00	7.89E-06
				7	1.00	6.22E-06
				12	1.00	5.11E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	800	7	2	1.31	2.49E-05
				7	1.31	1.99E-05
				12	1.32	1.64E-05
			13	2	1.31	2.54E-05
				7	1.32	2.15E-05
				12	1.31	1.70E-05
		1400	1	2	1.00	1.37E-05
				7	1.00	1.09E-05
				12	1.00	8.93E-06
			7	2	1.32	4.25E-05
				7	1.31	3.39E-05
				12	1.31	2.75E-05
			13	2	1.31	4.31E-05
				7	1.31	3.39E-05
				12	1.31	2.81E-05
	6	200	1	2	1.01	2.90E-06
				7	1.00	2.10E-06
				12	1.00	1.69E-06
			7	2	1.31	1.08E-05
				7	1.31	8.11E-06
				12	1.31	6.90E-06
			13	2	1.31	1.17E-05
				7	1.31	9.18E-06
				12	1.31	7.84E-06
		800	1	2	1.00	1.05E-05
				7	1.00	8.39E-06
				12	1.00	6.69E-06
			7	2	1.31	3.32E-05
				7	1.31	2.64E-05
				12	1.31	2.18E-05
			13	2	1.31	3.46E-05
				7	1.31	2.77E-05
				12	1.31	2.22E-05
		1400	1	2	1.01	1.85E-05
				7	1.00	1.46E-05
				12	1.00	1.21E-05
			7	2	1.31	5.57E-05
				7	1.31	4.44E-05
				12	1.31	3.72E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	1400	13	2	1.31	5.71E-05
				7	1.31	4.54E-05
				12	1.31	3.75E-05
3	0	200	1	2	1.00	1.52E-06
				7	1.01	9.42E-07
				12	1.00	6.72E-07
			7	2	1.32	4.26E-06
				7	1.32	2.86E-06
				12	1.31	1.97E-06
			13	2	1.32	4.51E-06
				7	1.31	2.85E-06
				12	1.32	2.34E-06
		800	1	2	1.00	6.14E-06
				7	1.00	4.76E-06
				12	1.00	3.77E-06
			7	2	1.31	1.81E-05
				7	1.32	1.41E-05
				12	1.31	1.08E-05
			13	2	1.32	1.83E-05
				7	1.31	1.39E-05
				12	1.31	1.09E-05
		1400	1	2	1.00	1.05E-05
				7	1.00	8.27E-06
				12	1.00	6.59E-06
			7	2	1.31	3.03E-05
				7	1.31	2.40E-05
				12	1.32	1.94E-05
			13	2	1.31	3.05E-05
				7	1.31	2.43E-05
				12	1.31	1.98E-05
	3	200	1	2	1.00	1.64E-06
				7	1.01	1.06E-06
				12	1.01	7.73E-07
			7	2	1.31	4.75E-06
				7	1.31	3.10E-06
				12	1.31	2.19E-06
			13	2	1.31	5.17E-06
				7	1.31	3.39E-06
				12	1.30	2.51E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	3	800	1	2	1.00	6.94E-06
				7	1.00	5.38E-06
				12	1.00	4.28E-06
			7	2	1.31	2.04E-05
				7	1.32	1.57E-05
				12	1.32	1.26E-05
			13	2	1.31	2.05E-05
				7	1.31	1.59E-05
				12	1.31	1.26E-05
		1400	1	2	1.00	1.17E-05
				7	1.00	9.26E-06
				12	1.00	7.41E-06
			7	2	1.31	3.45E-05
				7	1.31	2.69E-05
				12	1.31	2.17E-05
			13	2	1.32	3.52E-05
				7	1.32	2.73E-05
				12	1.31	2.22E-05
	6	200	1	2	1.00	2.19E-06
				7	1.01	1.40E-06
				12	1.00	9.88E-07
			7	2	1.31	6.49E-06
				7	1.31	4.21E-06
				12	1.31	3.06E-06
			13	2	1.31	7.10E-06
				7	1.31	4.27E-06
				12	1.31	3.22E-06
		800	1	2	1.00	9.37E-06
				7	1.00	7.21E-06
				12	1.00	5.67E-06
			7	2	1.31	2.75E-05
				7	1.31	2.07E-05
				12	1.31	1.66E-05
			13	2	1.31	2.71E-05
				7	1.31	2.13E-05
				12	1.31	1.67E-05
		1400	1	2	1.00	1.57E-05
				7	1.00	1.20E-05
				12	1.00	9.89E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	6	1400	7	2	1.31	4.62E-05
				7	1.31	3.58E-05
				12	1.31	2.84E-05
			13	2	1.31	4.56E-05
				7	1.31	3.67E-05
				12	1.32	2.93E-05
6	0	200	1	2	0.99	4.26E-06
				7	1.01	3.06E-06
				12	1.00	2.18E-06
			7	2	1.31	1.23E-05
				7	1.32	8.73E-06
				12	1.31	6.23E-06
			13	2	1.31	1.27E-05
				7	1.31	8.93E-06
				12	1.32	6.61E-06
		800	1	2	1.00	1.83E-05
				7	1.00	1.40E-05
				12	1.00	1.13E-05
			7	2	1.31	5.23E-05
				7	1.31	4.10E-05
				12	1.31	3.32E-05
			13	2	1.31	5.30E-05
				7	1.32	4.15E-05
				12	1.31	3.31E-05
		1400	1	2	1.00	2.96E-05
				7	1.00	2.37E-05
				12	1.00	1.87E-05
			7	2	1.31	8.44E-05
				7	1.31	6.74E-05
				12	1.31	5.48E-05
			13	2	1.31	8.69E-05
				7	1.31	6.85E-05
				12	1.31	5.37E-05
	3	200	1	2	1.00	4.75E-06
				7	1.00	3.23E-06
				12	1.00	2.45E-06
			7	2	1.31	1.42E-05
				7	1.32	1.00E-05
				12	1.32	7.35E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	3	200	13	2	1.31	1.49E-05
				7	1.31	9.86E-06
				12	1.31	7.40E-06
		800	1	2	1.00	2.03E-05
				7	1.00	1.58E-05
				12	1.00	1.27E-05
			7	2	1.31	5.87E-05
				7	1.32	4.63E-05
				12	1.31	3.76E-05
			13	2	1.31	5.94E-05
				7	1.31	4.61E-05
				12	1.31	3.60E-05
		1400	1	2	1.00	3.31E-05
				7	1.00	2.61E-05
				12	1.00	2.09E-05
			7	2	1.31	9.67E-05
				7	1.31	7.54E-05
				12	1.32	6.15E-05
			13	2	1.32	9.64E-05
				7	1.31	7.68E-05
				12	1.31	6.05E-05
	6	200	1	2	1.00	6.77E-06
				7	1.01	4.52E-06
				12	1.00	3.24E-06
			7	2	1.31	1.84E-05
				7	1.32	1.37E-05
				12	1.32	9.98E-06
			13	2	1.31	1.83E-05
				7	1.31	1.32E-05
				12	1.31	1.06E-05
		800	1	2	1.00	2.70E-05
				7	1.00	2.10E-05
				12	1.00	1.72E-05
			7	2	1.31	7.96E-05
				7	1.31	6.09E-05
				12	1.31	4.85E-05
			13	2	1.31	8.08E-05
				7	1.32	6.25E-05
				12	1.32	4.99E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	6	1400	1	2	1.00	4.42E-05
				7	1.00	3.48E-05
				12	1.00	2.78E-05
			7	2	1.32	1.31E-04
				7	1.31	1.00E-04
				12	1.31	8.15E-05
			13	2	1.31	1.31E-04
				7	1.31	1.00E-04
				12	1.31	8.24E-05

Appendix S. 1V:4H Rural Local

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	0.99	7.37E-06
				7	0.99	4.99E-06
				12	0.99	3.66E-06
			7	2	1.30	1.99E-05
				7	1.30	1.39E-05
				12	1.30	9.91E-06
			13	2	1.30	2.05E-05
				7	1.30	1.44E-05
				12	1.30	1.01E-05
		800	1	2	0.99	2.56E-05
				7	0.99	1.87E-05
				12	0.99	1.31E-05
			7	2	1.30	6.13E-05
				7	1.30	4.58E-05
				12	1.30	3.24E-05
			13	2	1.30	6.26E-05
				7	1.30	4.58E-05
				12	1.30	3.18E-05
		1400	1	2	0.99	4.44E-05
				7	0.99	3.18E-05
				12	0.99	2.28E-05
			7	2	1.30	1.05E-04
				7	1.30	7.69E-05
				12	1.30	5.49E-05
			13	2	1.30	1.06E-04
				7	1.30	7.67E-05
				12	1.30	5.51E-05
	4	200	1	2	0.99	8.93E-06
				7	0.99	6.34E-06
				12	0.99	4.46E-06
			7	2	1.30	2.50E-05
				7	1.30	1.72E-05
				12	1.30	1.23E-05
			13	2	1.30	2.51E-05
				7	1.30	1.77E-05
				12	1.29	1.22E-05
		800	1	2	0.99	3.16E-05
				7	0.99	2.29E-05
				12	0.99	1.65E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	4	800	7	2	1.30	7.95E-05
				7	1.30	5.70E-05
				12	1.30	4.00E-05
			13	2	1.30	7.93E-05
				7	1.30	5.69E-05
				12	1.30	4.05E-05
		1400	1	2	0.99	5.47E-05
				7	0.99	3.95E-05
				12	0.99	2.84E-05
			7	2	1.30	1.31E-04
				7	1.30	9.56E-05
				12	1.30	6.85E-05
			13	2	1.30	1.33E-04
				7	1.30	9.60E-05
				12	1.30	6.90E-05
	8	200	1	2	0.99	1.10E-05
				7	0.99	7.55E-06
				12	0.99	5.35E-06
			7	2	1.30	3.03E-05
				7	1.30	2.04E-05
				12	1.30	1.47E-05
			13	2	1.30	2.99E-05
				7	1.30	2.13E-05
				12	1.30	1.49E-05
		800	1	2	0.99	3.77E-05
				7	0.99	2.74E-05
				12	0.99	1.98E-05
			7	2	1.30	9.34E-05
				7	1.30	6.77E-05
				12	1.30	4.87E-05
			13	2	1.30	9.44E-05
				7	1.30	6.88E-05
				12	1.30	4.82E-05
		1400	1	2	0.99	6.61E-05
				7	0.99	4.76E-05
				12	0.99	3.38E-05
			7	2	1.30	1.58E-04
				7	1.30	1.17E-04
				12	1.30	8.20E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	8	1400	13	2	1.30	1.59E-04
				7	1.30	1.16E-04
				12	1.30	8.29E-05
4	0	200	1	2	0.99	1.33E-05
				7	0.99	8.66E-06
				12	0.99	6.00E-06
			7	2	1.30	3.04E-05
				7	1.30	2.20E-05
				12	1.30	1.49E-05
			13	2	1.30	3.22E-05
				7	1.30	2.23E-05
				12	1.30	1.45E-05
		800	1	2	0.99	5.03E-05
				7	0.99	3.64E-05
				12	0.99	2.59E-05
			7	2	1.30	1.19E-04
				7	1.30	8.65E-05
				12	1.30	6.12E-05
			13	2	1.30	1.20E-04
				7	1.30	8.77E-05
				12	1.30	6.11E-05
		1400	1	2	0.99	8.61E-05
				7	0.99	6.31E-05
				12	0.99	4.42E-05
			7	2	1.30	2.01E-04
				7	1.30	1.48E-04
				12	1.30	1.05E-04
			13	2	1.30	2.02E-04
				7	1.30	1.47E-04
				12	1.30	1.03E-04
	4	200	1	2	1.00	1.62E-05
				7	0.99	1.12E-05
				12	0.99	7.31E-06
			7	2	1.30	3.88E-05
				7	1.30	2.75E-05
				12	1.29	1.79E-05
			13	2	1.29	3.82E-05
				7	1.30	2.71E-05
				12	1.30	1.80E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	4	800	1	2	0.99	6.31E-05
				7	0.99	4.51E-05
				12	0.99	3.23E-05
			7	2	1.30	1.47E-04
				7	1.30	1.09E-04
				12	1.30	7.68E-05
			13	2	1.30	1.49E-04
				7	1.30	1.10E-04
				12	1.30	7.62E-05
		1400	1	2	0.99	1.08E-04
				7	0.99	7.82E-05
				12	0.99	5.56E-05
			7	2	1.30	2.53E-04
				7	1.30	1.88E-04
				12	1.30	1.30E-04
			13	2	1.30	2.58E-04
				7	1.30	1.85E-04
				12	1.30	1.31E-04
	8	200	1	2	0.99	1.89E-05
				7	0.99	1.34E-05
				12	0.99	9.03E-06
			7	2	1.30	4.78E-05
				7	1.30	3.14E-05
				12	1.30	2.15E-05
			13	2	1.30	4.75E-05
				7	1.30	3.30E-05
				12	1.30	2.22E-05
		800	1	2	0.99	7.52E-05
				7	0.99	5.44E-05
				12	0.99	3.88E-05
			7	2	1.30	1.75E-04
				7	1.30	1.31E-04
				12	1.30	9.24E-05
			13	2	1.30	1.81E-04
				7	1.30	1.29E-04
				12	1.30	9.15E-05
		1400	1	2	0.99	1.30E-04
				7	0.99	9.46E-05
				12	0.99	6.56E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	8	1400	7	2	1.30	3.06E-04
				7	1.30	2.20E-04
				12	1.30	1.55E-04
			13	2	1.30	3.03E-04
				7	1.30	2.21E-04
				12	1.30	1.57E-04
8	0	200	1	2	0.99	1.92E-05
				7	1.00	1.24E-05
				12	0.99	7.96E-06
			7	2	1.29	4.51E-05
				7	1.30	3.09E-05
				12	1.30	1.92E-05
			13	2	1.30	4.57E-05
				7	1.29	2.98E-05
				12	1.30	1.95E-05
		800	1	2	0.99	6.74E-05
				7	0.99	4.92E-05
				12	0.99	3.39E-05
			7	2	1.30	1.60E-04
				7	1.30	1.15E-04
				12	1.30	8.26E-05
			13	2	1.30	1.59E-04
				7	1.30	1.16E-04
				12	1.30	8.09E-05
		1400	1	2	0.99	1.11E-04
				7	0.99	8.01E-05
				12	0.99	5.61E-05
			7	2	1.30	2.59E-04
				7	1.30	1.87E-04
				12	1.30	1.31E-04
			13	2	1.30	2.60E-04
				7	1.30	1.86E-04
				12	1.30	1.34E-04
	4	200	1	2	0.99	2.33E-05
				7	0.99	1.57E-05
				12	0.99	9.83E-06
			7	2	1.29	5.54E-05
				7	1.30	3.72E-05
				12	1.31	2.42E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	4	200	13	2	1.29	5.38E-05
				7	1.30	3.86E-05
				12	1.30	2.32E-05
		800	1	2	0.99	8.53E-05
				7	0.99	6.03E-05
				12	0.99	4.32E-05
			7	2	1.30	1.99E-04
				7	1.30	1.44E-04
				12	1.30	1.01E-04
			13	2	1.30	1.99E-04
				7	1.30	1.47E-04
				12	1.30	1.01E-04
		1400	1	2	0.99	1.38E-04
				7	0.99	1.01E-04
				12	0.99	6.98E-05
			7	2	1.30	3.23E-04
				7	1.30	2.33E-04
				12	1.30	1.66E-04
			13	2	1.30	3.23E-04
				7	1.30	2.37E-04
				12	1.30	1.64E-04
	8	200	1	2	0.99	2.81E-05
				7	0.99	1.83E-05
				12	0.99	1.18E-05
			7	2	1.29	6.67E-05
				7	1.30	4.45E-05
				12	1.30	2.89E-05
			13	2	1.30	6.75E-05
				7	1.30	4.34E-05
				12	1.30	2.94E-05
		800	1	2	0.99	1.01E-04
				7	0.99	7.38E-05
				12	0.99	5.16E-05
			7	2	1.30	2.39E-04
				7	1.30	1.74E-04
				12	1.30	1.24E-04
			13	2	1.30	2.39E-04
				7	1.30	1.72E-04
				12	1.30	1.23E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	8	1400	1	2	0.99	1.66E-04
				7	0.99	1.20E-04
				12	0.99	8.47E-05
			7	2	1.30	3.89E-04
				7	1.30	2.84E-04
				12	1.30	1.97E-04
			13	2	1.30	3.88E-04
				7	1.30	2.82E-04
				12	1.30	1.97E-04

Appendix T. 1V:4H Undivided Urban Arterial

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	0.86	7.38E-07
				7	0.86	4.99E-07
				12	0.86	8.17E-07
			7	2	1.13	1.77E-06
				7	1.13	1.21E-06
				12	1.13	1.74E-06
			13	2	1.13	1.79E-06
				7	1.13	1.22E-06
				12	1.13	1.82E-06
		800	1	2	0.86	2.80E-06
				7	0.86	2.03E-06
				12	0.86	2.87E-06
			7	2	1.13	6.00E-06
				7	1.13	4.41E-06
				12	1.13	6.06E-06
			13	2	1.13	6.05E-06
				7	1.13	4.38E-06
				12	1.13	6.08E-06
		1400	1	2	0.86	4.87E-06
				7	0.86	3.49E-06
				12	0.86	4.90E-06
			7	2	1.13	1.04E-05
				7	1.13	7.53E-06
				12	1.13	1.04E-05
			13	2	1.13	1.04E-05
				7	1.13	7.53E-06
				12	1.13	1.04E-05
	3	200	1	2	0.86	8.39E-07
				7	0.86	5.73E-07
				12	0.86	8.80E-07
			7	2	1.13	1.95E-06
				7	1.13	1.35E-06
				12	1.13	1.98E-06
			13	2	1.13	2.02E-06
				7	1.14	1.39E-06
				12	1.13	1.95E-06
		800	1	2	0.86	3.18E-06
				7	0.86	2.32E-06
				12	0.86	3.20E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	800	7	2	1.13	6.76E-06
				7	1.13	4.92E-06
				12	1.13	6.89E-06
			13	2	1.13	6.81E-06
				7	1.13	4.91E-06
				12	1.13	6.79E-06
		1400	1	2	0.86	5.52E-06
				7	0.86	3.94E-06
				12	0.86	5.47E-06
			7	2	1.13	1.18E-05
				7	1.13	8.52E-06
				12	1.13	1.17E-05
			13	2	1.13	1.17E-05
				7	1.13	8.51E-06
				12	1.13	1.16E-05
	6	200	1	2	0.86	1.12E-06
				7	0.86	7.40E-07
				12	0.86	1.17E-06
			7	2	1.13	2.59E-06
				7	1.13	1.82E-06
				12	1.13	2.64E-06
			13	2	1.13	2.66E-06
				7	1.13	1.85E-06
				12	1.13	2.66E-06
		800	1	2	0.86	4.21E-06
				7	0.86	3.02E-06
				12	0.86	4.30E-06
			7	2	1.13	9.11E-06
				7	1.13	6.55E-06
				12	1.13	9.04E-06
			13	2	1.13	9.21E-06
				7	1.13	6.54E-06
				12	1.13	9.14E-06
		1400	1	2	0.86	7.43E-06
				7	0.86	5.28E-06
				12	0.86	7.38E-06
			7	2	1.13	1.54E-05
				7	1.13	1.13E-05
				12	1.13	1.56E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	1400	13	2	1.13	1.55E-05
				7	1.13	1.13E-05
				12	1.13	1.56E-05
4	0	200	1	2	0.86	1.29E-06
				7	0.86	8.92E-07
				12	0.86	1.35E-06
			7	2	1.12	2.79E-06
				7	1.13	1.87E-06
				12	1.13	2.84E-06
			13	2	1.13	2.83E-06
				7	1.13	1.87E-06
				12	1.13	2.82E-06
		800	1	2	0.86	5.45E-06
				7	0.86	3.91E-06
				12	0.86	5.47E-06
			7	2	1.13	1.15E-05
				7	1.13	8.17E-06
				12	1.13	1.14E-05
			13	2	1.13	1.15E-05
				7	1.13	8.15E-06
				12	1.13	1.15E-05
		1400	1	2	0.86	9.51E-06
				7	0.86	6.82E-06
				12	0.86	9.56E-06
			7	2	1.13	1.99E-05
				7	1.13	1.42E-05
				12	1.13	1.98E-05
			13	2	1.13	1.98E-05
				7	1.13	1.41E-05
				12	1.13	1.98E-05
	3	200	1	2	0.86	1.48E-06
				7	0.86	9.99E-07
				12	0.86	1.46E-06
			7	2	1.12	3.16E-06
				7	1.13	2.11E-06
				12	1.13	3.18E-06
			13	2	1.13	3.20E-06
				7	1.13	2.07E-06
				12	1.13	3.10E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	3	800	1	2	0.86	6.14E-06
				7	0.86	4.47E-06
				12	0.86	6.18E-06
			7	2	1.13	1.29E-05
				7	1.13	9.14E-06
				12	1.13	1.31E-05
			13	2	1.13	1.30E-05
				7	1.13	9.31E-06
				12	1.13	1.28E-05
		1400	1	2	0.86	1.06E-05
				7	0.86	7.63E-06
				12	0.86	1.06E-05
			7	2	1.13	2.25E-05
				7	1.13	1.61E-05
				12	1.13	2.23E-05
			13	2	1.13	2.22E-05
				7	1.13	1.60E-05
				12	1.13	2.20E-05
	6	200	1	2	0.86	1.99E-06
				7	0.86	1.31E-06
				12	0.86	2.00E-06
			7	2	1.13	4.19E-06
				7	1.13	2.73E-06
				12	1.13	4.23E-06
			13	2	1.13	4.27E-06
				7	1.13	2.86E-06
				12	1.13	4.34E-06
		800	1	2	0.86	8.17E-06
				7	0.86	5.86E-06
				12	0.86	8.15E-06
			7	2	1.13	1.75E-05
				7	1.13	1.22E-05
				12	1.13	1.71E-05
			13	2	1.13	1.72E-05
				7	1.13	1.23E-05
				12	1.13	1.70E-05
		1400	1	2	0.86	1.44E-05
				7	0.86	1.02E-05
				12	0.86	1.40E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	6	1400	7	2	1.13	2.95E-05
				7	1.13	2.15E-05
				12	1.13	2.95E-05
			13	2	1.13	2.96E-05
				7	1.13	2.16E-05
				12	1.13	3.01E-05
8	0	200	1	2	0.86	1.91E-06
				7	0.86	1.21E-06
				12	0.85	1.90E-06
			7	2	1.13	3.98E-06
				7	1.13	2.54E-06
				12	1.13	4.00E-06
			13	2	1.13	3.94E-06
				7	1.13	2.61E-06
				12	1.13	4.07E-06
		800	1	2	0.86	7.19E-06
				7	0.86	5.15E-06
				12	0.86	7.25E-06
			7	2	1.13	1.50E-05
				7	1.13	1.08E-05
				12	1.13	1.50E-05
			13	2	1.13	1.51E-05
				7	1.13	1.09E-05
				12	1.13	1.53E-05
		1400	1	2	0.86	1.15E-05
				7	0.86	8.19E-06
				12	0.86	1.15E-05
			7	2	1.13	2.39E-05
				7	1.13	1.72E-05
				12	1.13	2.39E-05
			13	2	1.13	2.40E-05
				7	1.13	1.71E-05
				12	1.13	2.40E-05
	3	200	1	2	0.86	2.13E-06
				7	0.86	1.34E-06
				12	0.86	2.18E-06
			7	2	1.13	4.36E-06
				7	1.13	2.88E-06
				12	1.12	4.50E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	3	200	13	2	1.13	4.37E-06
				7	1.13	2.88E-06
				12	1.13	4.51E-06
		800	1	2	0.86	8.03E-06
				7	0.86	5.81E-06
				12	0.86	8.18E-06
			7	2	1.13	1.68E-05
				7	1.13	1.20E-05
				12	1.13	1.67E-05
			13	2	1.13	1.71E-05
				7	1.13	1.22E-05
				12	1.13	1.69E-05
		1400	1	2	0.86	1.29E-05
				7	0.86	9.21E-06
				12	0.86	1.28E-05
			7	2	1.13	2.71E-05
				7	1.13	1.94E-05
				12	1.13	2.68E-05
			13	2	1.13	2.70E-05
				7	1.13	1.94E-05
				12	1.13	2.73E-05
	6	200	1	2	0.86	2.85E-06
				7	0.86	1.81E-06
				12	0.86	2.90E-06
			7	2	1.12	5.98E-06
				7	1.14	3.84E-06
				12	1.13	6.01E-06
			13	2	1.13	6.09E-06
				7	1.13	3.75E-06
				12	1.13	6.29E-06
		800	1	2	0.86	1.09E-05
				7	0.86	7.68E-06
				12	0.86	1.10E-05
			7	2	1.13	2.27E-05
				7	1.13	1.62E-05
				12	1.13	2.26E-05
			13	2	1.13	2.27E-05
				7	1.13	1.62E-05
				12	1.13	2.27E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	6	1400	1	2	0.86	1.72E-05
				7	0.86	1.22E-05
				12	0.86	1.75E-05
			7	2	1.13	3.58E-05
				7	1.13	2.57E-05
				12	1.13	3.57E-05
			13	2	1.13	3.61E-05
				7	1.13	2.58E-05
				12	1.12	3.58E-05

Appendix U. 1V:4H Divided Urban Arterial

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	1.02	2.25E-06
				7	1.02	1.66E-06
				12	1.02	1.27E-06
			7	2	1.33	7.17E-06
				7	1.33	5.51E-06
				12	1.34	4.45E-06
			13	2	1.34	7.80E-06
				7	1.34	6.15E-06
				12	1.33	5.05E-06
		800	1	2	1.02	8.74E-06
				7	1.02	6.88E-06
				12	1.02	5.55E-06
			7	2	1.34	2.38E-05
				7	1.33	1.90E-05
				12	1.33	1.54E-05
			13	2	1.34	2.43E-05
				7	1.34	1.97E-05
				12	1.34	1.58E-05
		1400	1	2	1.01	1.51E-05
				7	1.02	1.20E-05
				12	1.02	9.83E-06
			7	2	1.34	4.06E-05
				7	1.33	3.25E-05
				12	1.33	2.66E-05
			13	2	1.34	4.14E-05
				7	1.34	3.32E-05
				12	1.33	2.73E-05
	3	200	1	2	1.02	2.52E-06
				7	1.02	1.85E-06
				12	1.02	1.48E-06
			7	2	1.33	7.88E-06
				7	1.33	6.22E-06
				12	1.33	5.06E-06
			13	2	1.34	8.80E-06
				7	1.33	6.87E-06
				12	1.34	5.73E-06
		800	1	2	1.02	9.80E-06
				7	1.02	7.67E-06
				12	1.02	6.15E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	800	7	2	1.33	2.68E-05
				7	1.34	2.13E-05
				12	1.34	1.76E-05
			13	2	1.34	2.77E-05
				7	1.34	2.22E-05
				12	1.33	1.79E-05
		1400	1	2	1.02	1.70E-05
				7	1.02	1.34E-05
				12	1.02	1.11E-05
			7	2	1.33	4.56E-05
				7	1.33	3.66E-05
				12	1.34	3.01E-05
			13	2	1.33	4.66E-05
				7	1.33	3.75E-05
				12	1.33	3.00E-05
	6	200	1	2	1.02	3.30E-06
				7	1.01	2.46E-06
				12	1.02	1.91E-06
			7	2	1.34	1.07E-05
				7	1.33	8.25E-06
				12	1.33	6.56E-06
			13	2	1.33	1.18E-05
				7	1.33	9.35E-06
				12	1.33	7.47E-06
		800	1	2	1.02	1.29E-05
				7	1.02	1.02E-05
				12	1.01	8.31E-06
			7	2	1.34	3.62E-05
				7	1.33	2.82E-05
				12	1.34	2.31E-05
			13	2	1.33	3.70E-05
				7	1.33	2.93E-05
				12	1.33	2.37E-05
		1400	1	2	1.02	2.29E-05
				7	1.02	1.81E-05
				12	1.02	1.48E-05
			7	2	1.33	6.10E-05
				7	1.33	4.85E-05
				12	1.33	3.96E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	1400	13	2	1.33	6.25E-05
				7	1.34	4.96E-05
				12	1.33	4.05E-05
4	0	200	1	2	1.01	3.77E-06
				7	1.01	2.68E-06
				12	1.02	2.01E-06
			7	2	1.34	9.99E-06
				7	1.34	7.13E-06
				12	1.34	5.22E-06
			13	2	1.34	1.02E-05
				7	1.34	7.28E-06
				12	1.33	5.26E-06
		800	1	2	1.02	1.64E-05
				7	1.02	1.29E-05
				12	1.02	1.04E-05
			7	2	1.33	4.31E-05
				7	1.33	3.38E-05
				12	1.33	2.64E-05
			13	2	1.33	4.30E-05
				7	1.34	3.40E-05
				12	1.33	2.77E-05
		1400	1	2	1.02	2.87E-05
				7	1.02	2.29E-05
				12	1.02	1.82E-05
			7	2	1.34	7.54E-05
				7	1.33	5.86E-05
				12	1.33	4.80E-05
			13	2	1.33	7.41E-05
				7	1.33	5.78E-05
				12	1.33	4.77E-05
	3	200	1	2	1.01	4.28E-06
				7	1.02	3.17E-06
				12	1.02	2.20E-06
			7	2	1.34	1.15E-05
				7	1.33	7.93E-06
				12	1.33	5.76E-06
			13	2	1.34	1.14E-05
				7	1.34	8.44E-06
				12	1.33	5.95E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	3	800	1	2	1.02	1.86E-05
				7	1.02	1.46E-05
				12	1.02	1.17E-05
			7	2	1.33	4.86E-05
				7	1.33	3.74E-05
				12	1.34	3.07E-05
			13	2	1.33	4.82E-05
				7	1.33	3.83E-05
				12	1.33	3.07E-05
		1400	1	2	1.02	3.25E-05
				7	1.02	2.54E-05
				12	1.02	2.05E-05
			7	2	1.33	8.47E-05
				7	1.34	6.67E-05
				12	1.33	5.41E-05
			13	2	1.33	8.40E-05
				7	1.33	6.68E-05
				12	1.33	5.33E-05
	6	200	1	2	1.01	5.76E-06
				7	1.01	4.16E-06
				12	1.02	2.95E-06
			7	2	1.34	1.51E-05
				7	1.35	1.05E-05
				12	1.33	7.73E-06
			13	2	1.34	1.55E-05
				7	1.33	1.11E-05
				12	1.33	7.80E-06
		800	1	2	1.02	2.46E-05
				7	1.02	1.96E-05
				12	1.02	1.55E-05
			7	2	1.34	6.49E-05
				7	1.33	4.98E-05
				12	1.34	4.05E-05
			13	2	1.33	6.47E-05
				7	1.33	5.03E-05
				12	1.33	4.04E-05
		1400	1	2	1.02	4.33E-05
				7	1.02	3.38E-05
				12	1.02	2.76E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	6	1400	7	2	1.33	1.12E-04
				7	1.33	8.82E-05
				12	1.33	7.09E-05
			13	2	1.33	1.11E-04
				7	1.33	8.76E-05
				12	1.33	7.11E-05
8	0	200	1	2	1.02	5.70E-06
				7	1.02	3.75E-06
				12	1.02	2.57E-06
			7	2	1.33	1.45E-05
				7	1.33	1.00E-05
				12	1.34	6.87E-06
			13	2	1.35	1.47E-05
				7	1.34	9.71E-06
				12	1.33	6.77E-06
		800	1	2	1.01	2.14E-05
				7	1.02	1.70E-05
				12	1.02	1.35E-05
			7	2	1.33	5.54E-05
				7	1.33	4.47E-05
				12	1.33	3.44E-05
			13	2	1.33	5.55E-05
				7	1.34	4.33E-05
				12	1.34	3.48E-05
		1400	1	2	1.02	3.37E-05
				7	1.02	2.67E-05
				12	1.02	2.16E-05
			7	2	1.34	8.97E-05
				7	1.33	6.91E-05
				12	1.34	5.54E-05
			13	2	1.33	8.75E-05
				7	1.34	6.89E-05
				12	1.34	5.56E-05
	3	200	1	2	1.02	6.11E-06
				7	1.02	4.25E-06
				12	1.01	2.83E-06
			7	2	1.33	1.63E-05
				7	1.34	1.15E-05
				12	1.33	7.61E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	3	200	13	2	1.34	1.66E-05
				7	1.33	1.09E-05
				12	1.33	7.65E-06
		800	1	2	1.02	2.44E-05
				7	1.02	1.86E-05
				12	1.02	1.51E-05
			7	2	1.33	6.27E-05
				7	1.34	4.92E-05
				12	1.34	3.90E-05
			13	2	1.34	6.29E-05
				7	1.34	4.89E-05
				12	1.33	3.85E-05
		1400	1	2	1.02	3.84E-05
				7	1.02	2.99E-05
				12	1.02	2.42E-05
			7	2	1.34	9.96E-05
				7	1.33	7.77E-05
				12	1.34	6.31E-05
			13	2	1.34	1.00E-04
				7	1.33	7.75E-05
				12	1.33	6.25E-05
	6	200	1	2	1.02	8.66E-06
				7	1.02	5.62E-06
				12	1.02	3.87E-06
			7	2	1.33	2.27E-05
				7	1.33	1.49E-05
				12	1.33	1.00E-05
			13	2	1.34	2.15E-05
				7	1.33	1.43E-05
				12	1.33	9.93E-06
		800	1	2	1.02	3.19E-05
				7	1.02	2.51E-05
				12	1.02	2.01E-05
			7	2	1.34	8.28E-05
				7	1.34	6.63E-05
				12	1.33	5.12E-05
			13	2	1.33	8.26E-05
				7	1.33	6.54E-05
				12	1.34	5.20E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	6	1400	1	2	1.01	5.18E-05
				7	1.02	4.02E-05
				12	1.02	3.25E-05
			7	2	1.34	1.32E-04
				7	1.34	1.03E-04
				12	1.33	8.31E-05
			13	2	1.34	1.35E-04
				7	1.33	1.04E-04
				12	1.33	8.30E-05

Appendix V. 1V:4H Urban Local

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	1.06	9.29E-06
				7	1.06	6.30E-06
				12	1.06	4.41E-06
			7	2	1.39	2.89E-05
				7	1.39	2.00E-05
				12	1.39	1.37E-05
			13	2	1.39	3.01E-05
				7	1.40	2.07E-05
				12	1.38	1.37E-05
		800	1	2	1.06	3.49E-05
				7	1.06	2.53E-05
				12	1.06	1.77E-05
			7	2	1.39	9.93E-05
				7	1.39	7.25E-05
				12	1.39	5.10E-05
			13	2	1.39	1.00E-04
				7	1.39	7.30E-05
				12	1.39	5.05E-05
		1400	1	2	1.06	6.05E-05
				7	1.06	4.39E-05
				12	1.06	3.09E-05
			7	2	1.39	1.72E-04
				7	1.39	1.26E-04
				12	1.39	8.77E-05
			13	2	1.39	1.72E-04
				7	1.39	1.26E-04
				12	1.39	8.88E-05
	6	200	1	2	1.06	1.38E-05
				7	1.06	1.01E-05
				12	1.06	6.47E-06
			7	2	1.39	4.33E-05
				7	1.40	3.06E-05
				12	1.39	2.10E-05
			13	2	1.38	4.36E-05
				7	1.38	3.14E-05
				12	1.40	2.10E-05
		800	1	2	1.06	5.17E-05
				7	1.06	3.80E-05
				12	1.06	2.65E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	800	7	2	1.39	1.51E-04
				7	1.39	1.08E-04
				12	1.38	7.64E-05
			13	2	1.40	1.53E-04
				7	1.39	1.08E-04
				12	1.39	7.72E-05
		1400	1	2	1.06	9.02E-05
				7	1.06	6.63E-05
				12	1.06	4.70E-05
			7	2	1.39	2.55E-04
				7	1.38	1.85E-04
				12	1.39	1.34E-04
			13	2	1.39	2.56E-04
				7	1.39	1.88E-04
				12	1.39	1.33E-04
	12	200	1	2	1.06	1.45E-05
				7	1.06	9.70E-06
				12	1.06	6.65E-06
			7	2	1.39	4.30E-05
				7	1.39	3.00E-05
				12	1.40	2.19E-05
			13	2	1.39	4.38E-05
				7	1.38	3.00E-05
				12	1.39	2.11E-05
		800	1	2	1.06	5.17E-05
				7	1.06	3.73E-05
				12	1.06	2.64E-05
			7	2	1.39	1.48E-04
				7	1.39	1.08E-04
				12	1.39	7.67E-05
			13	2	1.39	1.52E-04
				7	1.38	1.08E-04
				12	1.39	7.66E-05
		1400	1	2	1.06	8.85E-05
				7	1.06	6.59E-05
				12	1.06	4.70E-05
			7	2	1.39	2.56E-04
				7	1.39	1.88E-04
				12	1.39	1.34E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	12	1400	13	2	1.39	2.58E-04
				7	1.39	1.88E-04
				12	1.39	1.33E-04
3	0	200	1	2	1.07	9.81E-06
				7	1.05	6.07E-06
				12	1.06	4.04E-06
			7	2	1.39	2.71E-05
				7	1.39	1.81E-05
				12	1.39	1.22E-05
			13	2	1.39	2.81E-05
				7	1.39	1.77E-05
				12	1.40	1.19E-05
		800	1	2	1.06	3.68E-05
				7	1.07	2.62E-05
				12	1.06	1.84E-05
			7	2	1.39	1.03E-04
				7	1.39	7.19E-05
				12	1.39	5.17E-05
			13	2	1.39	1.04E-04
				7	1.39	7.49E-05
				12	1.39	5.18E-05
		1400	1	2	1.06	6.13E-05
				7	1.06	4.44E-05
				12	1.06	3.17E-05
			7	2	1.39	1.73E-04
				7	1.39	1.24E-04
				12	1.39	8.94E-05
			13	2	1.39	1.74E-04
				7	1.39	1.24E-04
				12	1.39	8.91E-05
	6	200	1	2	1.06	1.47E-05
				7	1.06	9.07E-06
				12	1.06	6.12E-06
			7	2	1.39	4.17E-05
				7	1.38	2.64E-05
				12	1.38	1.82E-05
			13	2	1.39	4.22E-05
				7	1.40	2.73E-05
				12	1.39	1.76E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	6	800	1	2	1.06	5.45E-05
				7	1.06	3.88E-05
				12	1.06	2.74E-05
			7	2	1.39	1.57E-04
				7	1.39	1.12E-04
				12	1.38	7.72E-05
			13	2	1.39	1.56E-04
				7	1.39	1.11E-04
				12	1.39	7.76E-05
		1400	1	2	1.06	9.30E-05
				7	1.06	6.83E-05
				12	1.06	4.69E-05
			7	2	1.39	2.61E-04
				7	1.39	1.90E-04
				12	1.39	1.35E-04
			13	2	1.39	2.60E-04
				7	1.39	1.89E-04
				12	1.38	1.34E-04
	12	200	1	2	1.06	1.42E-05
				7	1.06	9.10E-06
				12	1.05	5.91E-06
			7	2	1.39	4.01E-05
				7	1.39	2.70E-05
				12	1.39	1.82E-05
			13	2	1.39	4.12E-05
				7	1.40	2.75E-05
				12	1.39	1.80E-05
		800	1	2	1.06	5.45E-05
				7	1.06	3.94E-05
				12	1.06	2.76E-05
			7	2	1.40	1.55E-04
				7	1.39	1.11E-04
				12	1.39	7.73E-05
			13	2	1.39	1.54E-04
				7	1.39	1.11E-04
				12	1.39	7.82E-05
		1400	1	2	1.06	9.15E-05
				7	1.06	6.64E-05
				12	1.06	4.74E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	12	1400	7	2	1.39	2.63E-04
				7	1.39	1.87E-04
				12	1.39	1.33E-04
			13	2	1.39	2.61E-04
				7	1.39	1.89E-04
				12	1.38	1.33E-04
6	0	200	1	2	1.05	2.74E-05
				7	1.06	1.92E-05
				12	1.06	1.31E-05
			7	2	1.39	8.55E-05
				7	1.38	5.63E-05
				12	1.39	3.63E-05
			13	2	1.39	8.54E-05
				7	1.39	5.75E-05
				12	1.39	3.67E-05
		800	1	2	1.06	1.08E-04
				7	1.06	8.05E-05
				12	1.06	5.47E-05
			7	2	1.39	3.10E-04
				7	1.39	2.21E-04
				12	1.39	1.58E-04
			13	2	1.39	3.07E-04
				7	1.39	2.23E-04
				12	1.39	1.55E-04
		1400	1	2	1.06	1.80E-04
				7	1.06	1.31E-04
				12	1.06	9.24E-05
			7	2	1.39	5.05E-04
				7	1.39	3.61E-04
				12	1.39	2.61E-04
			13	2	1.39	5.12E-04
				7	1.39	3.58E-04
				12	1.39	2.56E-04
	6	200	1	2	1.06	4.19E-05
				7	1.07	2.88E-05
				12	1.06	1.93E-05
			7	2	1.39	1.26E-04
				7	1.39	8.25E-05
				12	1.39	5.57E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	6	200	13	2	1.40	1.23E-04
				7	1.39	8.35E-05
				12	1.38	5.51E-05
		800	1	2	1.06	1.61E-04
				7	1.06	1.18E-04
				12	1.06	8.34E-05
			7	2	1.39	4.60E-04
				7	1.39	3.38E-04
				12	1.39	2.31E-04
			13	2	1.38	4.59E-04
				7	1.39	3.39E-04
				12	1.39	2.32E-04
		1400	1	2	1.06	2.69E-04
				7	1.06	1.95E-04
				12	1.06	1.37E-04
			7	2	1.39	7.69E-04
				7	1.39	5.43E-04
				12	1.39	3.89E-04
			13	2	1.39	7.59E-04
				7	1.39	5.49E-04
				12	1.39	3.86E-04
	12	200	1	2	1.06	4.26E-05
				7	1.06	2.98E-05
				12	1.05	1.84E-05
			7	2	1.39	1.24E-04
				7	1.38	8.36E-05
				12	1.38	5.41E-05
			13	2	1.39	1.25E-04
				7	1.39	8.45E-05
				12	1.38	5.46E-05
		800	1	2	1.06	1.64E-04
				7	1.06	1.21E-04
				12	1.06	8.32E-05
			7	2	1.39	4.63E-04
				7	1.39	3.36E-04
				12	1.39	2.36E-04
			13	2	1.39	4.64E-04
				7	1.39	3.35E-04
				12	1.40	2.38E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	12	1400	1	2	1.06	2.69E-04
				7	1.06	1.97E-04
				12	1.06	1.38E-04
			7	2	1.39	7.56E-04
				7	1.39	5.52E-04
				12	1.39	3.87E-04
			13	2	1.39	7.49E-04
				7	1.39	5.49E-04
				12	1.39	3.87E-04

Appendix W. 1V:6H Freeway

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	1.47	9.15E-06
				7	1.47	6.74E-06
				12	1.46	5.31E-06
			7	2	1.47	1.17E-05
				7	1.46	8.91E-06
				12	1.46	7.22E-06
			13	2	1.46	1.22E-05
				7	1.46	9.17E-06
				12	1.47	7.40E-06
		800	1	2	1.47	3.58E-05
				7	1.47	2.81E-05
				12	1.47	2.25E-05
			7	2	1.47	3.83E-05
				7	1.47	3.01E-05
				12	1.47	2.50E-05
			13	2	1.47	3.84E-05
				7	1.47	3.05E-05
				12	1.47	2.48E-05
		1400	1	2	1.47	6.31E-05
				7	1.46	4.90E-05
				12	1.47	3.99E-05
			7	2	1.47	6.47E-05
				7	1.47	5.10E-05
				12	1.47	4.27E-05
			13	2	1.47	6.54E-05
				7	1.47	5.16E-05
				12	1.47	4.25E-05
	2	200	1	2	1.47	9.14E-06
				7	1.46	6.42E-06
				12	1.46	5.08E-06
			7	2	1.47	1.20E-05
				7	1.46	9.30E-06
				12	1.46	7.28E-06
			13	2	1.46	1.22E-05
				7	1.47	9.53E-06
				12	1.47	7.53E-06
		800	1	2	1.47	3.55E-05
				7	1.47	2.79E-05
				12	1.47	2.32E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	2	800	7	2	1.47	3.79E-05
				7	1.47	3.01E-05
				12	1.47	2.47E-05
			13	2	1.46	3.87E-05
				7	1.47	3.03E-05
				12	1.47	2.50E-05
		1400	1	2	1.46	6.16E-05
				7	1.47	4.94E-05
				12	1.47	4.05E-05
			7	2	1.47	6.54E-05
				7	1.47	5.21E-05
				12	1.47	4.18E-05
			13	2	1.47	6.54E-05
				7	1.47	5.20E-05
				12	1.47	4.24E-05
	3	200	1	2	1.46	1.06E-05
				7	1.47	7.62E-06
				12	1.47	5.86E-06
			7	2	1.47	1.31E-05
				7	1.47	1.04E-05
				12	1.46	8.12E-06
			13	2	1.47	1.38E-05
				7	1.47	1.07E-05
				12	1.47	8.46E-06
		800	1	2	1.47	3.98E-05
				7	1.47	3.19E-05
				12	1.47	2.49E-05
			7	2	1.47	4.27E-05
				7	1.46	3.37E-05
				12	1.47	2.76E-05
			13	2	1.47	4.42E-05
				7	1.47	3.43E-05
				12	1.47	2.83E-05
		1400	1	2	1.47	7.09E-05
				7	1.47	5.55E-05
				12	1.46	4.44E-05
			7	2	1.47	7.27E-05
				7	1.47	5.81E-05
				12	1.47	4.72E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	1400	13	2	1.47	7.35E-05
				7	1.47	5.83E-05
				12	1.47	4.81E-05
2	0	200	1	2	1.47	7.01E-06
				7	1.47	4.70E-06
				12	1.47	3.15E-06
			7	2	1.46	7.74E-06
				7	1.47	5.44E-06
				12	1.47	4.08E-06
			13	2	1.47	8.12E-06
				7	1.47	5.73E-06
				12	1.47	4.04E-06
		800	1	2	1.46	3.19E-05
				7	1.47	2.39E-05
				12	1.47	1.99E-05
			7	2	1.46	3.25E-05
				7	1.47	2.50E-05
				12	1.47	1.99E-05
			13	2	1.46	3.26E-05
				7	1.47	2.52E-05
				12	1.47	2.02E-05
		1400	1	2	1.47	5.49E-05
				7	1.47	4.22E-05
				12	1.47	3.51E-05
			7	2	1.46	5.56E-05
				7	1.47	4.36E-05
				12	1.47	3.57E-05
			13	2	1.47	5.68E-05
				7	1.46	4.33E-05
				12	1.47	3.54E-05
	2	200	1	2	1.47	6.99E-06
				7	1.46	4.65E-06
				12	1.47	3.22E-06
			7	2	1.46	7.46E-06
				7	1.47	5.53E-06
				12	1.46	3.97E-06
			13	2	1.46	7.62E-06
				7	1.46	5.53E-06
				12	1.47	4.03E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
2	2	800	1	2	1.47	3.14E-05
				7	1.46	2.38E-05
				12	1.46	1.89E-05
			7	2	1.47	3.23E-05
				7	1.47	2.48E-05
				12	1.47	2.00E-05
			13	2	1.46	3.25E-05
				7	1.46	2.49E-05
				12	1.47	2.00E-05
		1400	1	2	1.46	5.52E-05
				7	1.46	4.34E-05
				12	1.47	3.49E-05
			7	2	1.47	5.59E-05
				7	1.47	4.41E-05
				12	1.47	3.53E-05
			13	2	1.47	5.65E-05
				7	1.47	4.37E-05
				12	1.46	3.56E-05
	3	200	1	2	1.47	7.65E-06
				7	1.47	5.31E-06
				12	1.47	3.61E-06
			7	2	1.46	8.51E-06
				7	1.47	6.08E-06
				12	1.46	4.61E-06
			13	2	1.47	9.03E-06
				7	1.47	6.38E-06
				12	1.46	4.49E-06
		800	1	2	1.47	3.61E-05
				7	1.47	2.72E-05
				12	1.47	2.14E-05
			7	2	1.47	3.67E-05
				7	1.46	2.79E-05
				12	1.46	2.22E-05
			13	2	1.46	3.68E-05
				7	1.47	2.80E-05
				12	1.46	2.22E-05
		1400	1	2	1.46	6.13E-05
				7	1.47	4.82E-05
				12	1.47	3.91E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
2	3	1400	7	2	1.47	6.30E-05
				7	1.46	4.91E-05
				12	1.47	4.02E-05
			13	2	1.46	6.22E-05
				7	1.47	4.84E-05
				12	1.46	3.96E-05
3	0	200	1	2	1.46	7.99E-06
				7	1.46	4.80E-06
				12	1.47	3.69E-06
			7	2	1.47	7.87E-06
				7	1.47	5.35E-06
				12	1.47	4.13E-06
			13	2	1.47	8.38E-06
				7	1.47	5.35E-06
				12	1.46	3.97E-06
		800	1	2	1.47	3.40E-05
				7	1.47	2.60E-05
				12	1.47	2.01E-05
			7	2	1.47	3.44E-05
				7	1.47	2.64E-05
				12	1.47	2.04E-05
			13	2	1.47	3.51E-05
				7	1.47	2.64E-05
				12	1.47	2.09E-05
		1400	1	2	1.47	5.75E-05
				7	1.47	4.41E-05
				12	1.47	3.59E-05
			7	2	1.47	5.70E-05
				7	1.47	4.60E-05
				12	1.47	3.65E-05
			13	2	1.47	5.84E-05
				7	1.46	4.44E-05
				12	1.47	3.65E-05
	2	200	1	2	1.47	8.20E-06
				7	1.47	5.03E-06
				12	1.46	3.50E-06
			7	2	1.47	8.23E-06
				7	1.47	5.22E-06
				12	1.47	4.00E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	2	200	13	2	1.47	8.53E-06
				7	1.47	5.46E-06
				12	1.48	4.24E-06
		800	1	2	1.46	3.37E-05
				7	1.46	2.51E-05
				12	1.47	2.04E-05
			7	2	1.46	3.41E-05
				7	1.47	2.56E-05
				12	1.47	2.05E-05
			13	2	1.46	3.36E-05
				7	1.46	2.60E-05
				12	1.47	2.09E-05
		1400	1	2	1.46	5.71E-05
				7	1.47	4.46E-05
				12	1.47	3.61E-05
			7	2	1.46	5.72E-05
				7	1.46	4.50E-05
				12	1.46	3.61E-05
			13	2	1.47	5.74E-05
				7	1.47	4.46E-05
				12	1.47	3.66E-05
	3	200	1	2	1.46	8.51E-06
				7	1.48	5.70E-06
				12	1.47	3.98E-06
			7	2	1.46	9.16E-06
				7	1.47	6.07E-06
				12	1.47	4.39E-06
			13	2	1.47	9.66E-06
				7	1.46	5.97E-06
				12	1.47	4.51E-06
		800	1	2	1.47	3.77E-05
				7	1.47	2.91E-05
				12	1.46	2.24E-05
			7	2	1.47	3.80E-05
				7	1.47	2.97E-05
				12	1.46	2.37E-05
			13	2	1.47	3.92E-05
				7	1.47	3.00E-05
				12	1.46	2.29E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	3	1400	1	2	1.46	6.50E-05
				7	1.46	5.05E-05
				12	1.47	4.07E-05
			7	2	1.47	6.43E-05
				7	1.47	5.08E-05
				12	1.46	4.11E-05
			13	2	1.46	6.60E-05
				7	1.47	5.10E-05
				12	1.46	4.06E-05

Appendix X. 1V:6H Undivided Rural Arterial

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	0.98	9.29E-07
				7	0.99	6.19E-07
				12	0.99	4.56E-07
			7	2	0.99	1.07E-06
				7	0.99	7.42E-07
				12	0.98	5.16E-07
			13	2	0.99	1.10E-06
				7	0.98	7.53E-07
				12	0.99	5.24E-07
		800	1	2	0.99	3.36E-06
				7	0.99	2.40E-06
				12	0.99	1.68E-06
			7	2	0.99	3.46E-06
				7	0.99	2.49E-06
				12	0.99	1.75E-06
			13	2	0.99	3.46E-06
				7	0.99	2.49E-06
				12	0.99	1.74E-06
		1400	1	2	0.99	5.77E-06
				7	0.99	4.18E-06
				12	0.99	2.95E-06
			7	2	0.99	5.82E-06
				7	0.99	4.24E-06
				12	0.99	3.00E-06
			13	2	0.99	5.89E-06
				7	0.99	4.26E-06
				12	0.99	2.99E-06
	3	200	1	2	0.99	1.04E-06
				7	0.99	7.18E-07
				12	0.99	5.16E-07
			7	2	0.99	1.20E-06
				7	0.99	8.38E-07
				12	0.99	5.77E-07
			13	2	0.99	1.19E-06
				7	0.99	8.43E-07
				12	0.99	5.83E-07
		800	1	2	0.99	3.75E-06
				7	0.99	2.69E-06
				12	0.99	1.90E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	800	7	2	0.99	3.91E-06
				7	0.99	2.80E-06
				12	0.99	1.97E-06
			13	2	0.99	3.88E-06
				7	0.99	2.78E-06
				12	0.99	1.99E-06
		1400	1	2	0.99	6.43E-06
				7	0.99	4.70E-06
				12	0.99	3.34E-06
			7	2	0.99	6.64E-06
				7	0.99	4.77E-06
				12	0.99	3.41E-06
			13	2	0.99	6.61E-06
				7	0.99	4.80E-06
				12	0.99	3.39E-06
	6	200	1	2	0.99	1.41E-06
				7	0.99	9.63E-07
				12	0.99	6.85E-07
			7	2	0.98	1.61E-06
				7	0.99	1.12E-06
				12	0.99	7.83E-07
			13	2	0.99	1.61E-06
				7	0.99	1.13E-06
				12	0.99	7.78E-07
		800	1	2	0.99	4.99E-06
				7	0.99	3.59E-06
				12	0.99	2.55E-06
			7	2	0.99	5.19E-06
				7	0.99	3.75E-06
				12	0.99	2.66E-06
			13	2	0.99	5.21E-06
				7	0.99	3.73E-06
				12	0.99	2.65E-06
		1400	1	2	0.99	8.69E-06
				7	0.99	6.24E-06
				12	0.99	4.38E-06
			7	2	0.99	8.79E-06
				7	0.99	6.41E-06
				12	0.99	4.53E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	1400	13	2	0.99	8.80E-06
				7	0.99	6.44E-06
				12	0.99	4.52E-06
3	0	200	1	2	0.99	7.29E-07
				7	0.99	4.38E-07
				12	0.98	2.89E-07
			7	2	0.99	7.45E-07
				7	0.99	4.50E-07
				12	0.98	2.77E-07
			13	2	0.99	7.70E-07
				7	0.98	4.45E-07
				12	0.99	2.90E-07
		800	1	2	0.99	2.98E-06
				7	0.99	2.08E-06
				12	0.99	1.43E-06
			7	2	0.99	2.98E-06
				7	0.99	2.12E-06
				12	0.99	1.44E-06
			13	2	0.99	2.97E-06
				7	0.99	2.14E-06
				12	0.99	1.45E-06
		1400	1	2	0.99	4.98E-06
				7	0.99	3.61E-06
				12	0.99	2.50E-06
			7	2	0.99	5.02E-06
				7	0.99	3.56E-06
				12	0.99	2.52E-06
			13	2	0.99	5.02E-06
				7	0.99	3.57E-06
				12	0.99	2.54E-06
	3	200	1	2	0.99	8.39E-07
				7	0.99	4.98E-07
				12	0.99	3.23E-07
			7	2	0.99	8.60E-07
				7	0.99	5.13E-07
				12	0.98	3.20E-07
			13	2	0.99	8.78E-07
				7	0.99	5.07E-07
				12	0.99	3.22E-07

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	3	800	1	2	0.99	3.32E-06
				7	0.99	2.35E-06
				12	0.99	1.61E-06
			7	2	0.99	3.34E-06
				7	0.99	2.39E-06
				12	0.99	1.64E-06
			13	2	0.99	3.34E-06
				7	0.99	2.37E-06
				12	0.99	1.62E-06
		1400	1	2	0.99	5.62E-06
				7	0.99	4.01E-06
				12	0.99	2.78E-06
			7	2	0.99	5.64E-06
				7	0.99	4.04E-06
				12	0.99	2.89E-06
			13	2	0.99	5.67E-06
				7	0.99	4.04E-06
				12	0.99	2.85E-06
	6	200	1	2	0.99	1.11E-06
				7	0.99	6.60E-07
				12	0.98	4.16E-07
			7	2	0.99	1.11E-06
				7	0.98	6.55E-07
				12	0.99	4.21E-07
			13	2	0.99	1.14E-06
				7	0.99	6.55E-07
				12	0.99	4.24E-07
		800	1	2	0.99	4.51E-06
				7	0.99	3.13E-06
				12	0.99	2.15E-06
			7	2	0.98	4.45E-06
				7	0.99	3.12E-06
				12	0.99	2.19E-06
			13	2	0.99	4.50E-06
				7	0.99	3.18E-06
				12	0.99	2.20E-06
		1400	1	2	0.98	7.47E-06
				7	0.99	5.32E-06
				12	0.99	3.78E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	6	1400	7	2	0.99	7.56E-06
				7	0.99	5.36E-06
				12	0.99	3.80E-06
			13	2	0.99	7.50E-06
				7	0.99	5.38E-06
				12	0.99	3.77E-06
6	0	200	1	2	0.98	2.21E-06
				7	0.99	1.44E-06
				12	0.98	9.05E-07
			7	2	0.98	2.14E-06
				7	0.99	1.46E-06
				12	0.98	8.89E-07
			13	2	0.99	2.19E-06
				7	0.99	1.47E-06
				12	0.99	9.10E-07
		800	1	2	0.99	8.75E-06
				7	0.99	6.32E-06
				12	0.98	4.37E-06
			7	2	0.99	8.80E-06
				7	0.99	6.30E-06
				12	0.99	4.39E-06
			13	2	0.99	9.01E-06
				7	0.99	6.26E-06
				12	0.99	4.40E-06
		1400	1	2	0.99	1.44E-05
				7	0.99	1.02E-05
				12	0.99	7.24E-06
			7	2	0.99	1.42E-05
				7	0.99	1.03E-05
				12	0.99	7.21E-06
			13	2	0.99	1.42E-05
				7	0.99	1.02E-05
				12	0.99	7.21E-06
	3	200	1	2	0.98	2.40E-06
				7	0.99	1.68E-06
				12	0.99	1.12E-06
			7	2	0.99	2.69E-06
				7	0.99	1.71E-06
				12	0.99	1.13E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	3	200	13	2	0.99	2.64E-06
				7	0.99	1.67E-06
				12	0.99	1.09E-06
		800	1	2	0.99	1.07E-05
				7	0.98	7.49E-06
				12	0.99	5.22E-06
			7	2	0.99	1.05E-05
				7	0.99	7.50E-06
				12	0.99	5.30E-06
			13	2	0.98	1.06E-05
				7	0.99	7.52E-06
				12	0.99	5.25E-06
		1400	1	2	0.99	1.73E-05
				7	0.99	1.25E-05
				12	0.99	8.60E-06
			7	2	0.99	1.73E-05
				7	0.99	1.24E-05
				12	0.99	8.63E-06
			13	2	0.99	1.71E-05
				7	0.99	1.25E-05
				12	0.99	8.65E-06
	6	200	1	2	0.99	3.45E-06
				7	0.99	2.36E-06
				12	0.99	1.48E-06
			7	2	0.99	3.58E-06
				7	0.99	2.35E-06
				12	0.99	1.49E-06
			13	2	0.99	3.70E-06
				7	0.99	2.34E-06
				12	0.99	1.50E-06
		800	1	2	0.99	1.41E-05
				7	0.99	1.02E-05
				12	0.99	6.98E-06
			7	2	0.99	1.40E-05
				7	0.99	1.01E-05
				12	0.99	7.04E-06
			13	2	0.99	1.41E-05
				7	0.99	1.01E-05
				12	0.99	6.96E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	6	1400	1	2	0.99	2.32E-05
				7	0.99	1.64E-05
				12	0.99	1.16E-05
			7	2	0.99	2.33E-05
				7	0.99	1.65E-05
				12	0.99	1.15E-05
			13	2	0.99	2.29E-05
				7	0.99	1.65E-05
				12	0.99	1.17E-05

Appendix Y. 1V:6H Divided Rural Arterial

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	0.98	1.93E-06
				7	0.99	1.40E-06
				12	0.99	1.15E-06
			7	2	0.99	2.53E-06
				7	0.99	1.98E-06
				12	0.98	1.65E-06
			13	2	0.99	2.66E-06
				7	0.99	2.12E-06
				12	0.99	1.72E-06
		800	1	2	0.99	6.87E-06
				7	0.99	5.50E-06
				12	0.99	4.38E-06
			7	2	0.99	7.62E-06
				7	0.99	6.07E-06
				12	0.98	5.00E-06
			13	2	0.99	7.75E-06
				7	0.99	6.12E-06
				12	0.99	4.99E-06
		1400	1	2	0.99	1.20E-05
				7	0.99	9.58E-06
				12	0.99	7.85E-06
			7	2	0.99	1.28E-05
				7	0.99	1.02E-05
				12	0.99	8.34E-06
			13	2	0.99	1.30E-05
				7	0.99	1.02E-05
				12	0.99	8.44E-06
	3	200	1	2	0.99	2.06E-06
				7	0.99	1.57E-06
				12	0.99	1.27E-06
			7	2	0.99	2.87E-06
				7	0.99	2.25E-06
				12	0.99	1.89E-06
			13	2	0.99	3.00E-06
				7	0.99	2.41E-06
				12	0.99	2.01E-06
		800	1	2	0.99	7.75E-06
				7	0.99	6.04E-06
				12	0.99	5.02E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	800	7	2	0.99	8.39E-06
				7	0.99	6.77E-06
				12	0.99	5.57E-06
			13	2	0.99	8.71E-06
				7	0.99	6.90E-06
				12	0.99	5.57E-06
		1400	1	2	0.99	1.35E-05
				7	0.99	1.08E-05
				12	0.99	8.73E-06
			7	2	0.99	1.41E-05
				7	0.99	1.14E-05
				12	0.99	9.36E-06
			13	2	0.99	1.45E-05
				7	0.99	1.14E-05
				12	0.99	9.39E-06
	6	200	1	2	0.99	2.76E-06
				7	0.98	2.08E-06
				12	0.99	1.68E-06
			7	2	0.99	3.78E-06
				7	0.99	2.96E-06
				12	0.99	2.53E-06
			13	2	0.99	4.00E-06
				7	0.99	3.19E-06
				12	0.98	2.55E-06
		800	1	2	0.99	1.04E-05
				7	0.99	8.16E-06
				12	0.99	6.57E-06
			7	2	0.99	1.13E-05
				7	0.99	9.01E-06
				12	0.99	7.47E-06
			13	2	0.99	1.15E-05
				7	0.99	9.22E-06
				12	0.99	7.49E-06
		1400	1	2	0.99	1.82E-05
				7	0.99	1.42E-05
				12	0.99	1.14E-05
			7	2	0.99	1.89E-05
				7	0.99	1.52E-05
				12	0.99	1.24E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	1400	13	2	0.99	1.91E-05
				7	0.99	1.52E-05
				12	0.99	1.25E-05
3	0	200	1	2	0.99	1.44E-06
				7	1.00	9.28E-07
				12	0.99	6.73E-07
			7	2	0.99	1.49E-06
				7	0.99	9.24E-07
				12	0.98	7.21E-07
			13	2	0.99	1.53E-06
				7	0.99	9.82E-07
				12	0.99	7.46E-07
		800	1	2	0.99	6.12E-06
				7	0.99	4.66E-06
				12	0.99	3.60E-06
			7	2	0.99	6.18E-06
				7	0.99	4.79E-06
				12	0.99	3.75E-06
			13	2	0.99	6.13E-06
				7	0.99	4.76E-06
				12	0.99	3.74E-06
		1400	1	2	0.99	1.01E-05
				7	0.99	8.08E-06
				12	0.99	6.51E-06
			7	2	0.99	1.01E-05
				7	0.99	7.97E-06
				12	0.98	6.37E-06
			13	2	0.99	1.00E-05
				7	0.99	8.14E-06
				12	0.99	6.47E-06
	3	200	1	2	0.99	1.64E-06
				7	0.99	9.98E-07
				12	0.99	7.34E-07
			7	2	0.98	1.66E-06
				7	0.99	1.04E-06
				12	0.99	8.05E-07
			13	2	0.99	1.75E-06
				7	0.99	1.09E-06
				12	0.99	8.47E-07

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	3	800	1	2	0.99	6.83E-06
				7	0.99	5.27E-06
				12	0.99	4.21E-06
			7	2	0.99	6.91E-06
				7	0.99	5.21E-06
				12	0.99	4.15E-06
			13	2	0.99	7.01E-06
				7	0.99	5.35E-06
				12	0.99	4.20E-06
		1400	1	2	0.99	1.16E-05
				7	0.99	8.85E-06
				12	0.99	7.26E-06
			7	2	0.99	1.15E-05
				7	0.99	9.10E-06
				12	0.99	7.26E-06
			13	2	0.99	1.15E-05
				7	0.99	9.14E-06
				12	0.99	7.28E-06
	6	200	1	2	0.99	2.11E-06
				7	0.99	1.31E-06
				12	0.98	9.56E-07
			7	2	0.99	2.28E-06
				7	0.99	1.44E-06
				12	0.99	1.05E-06
			13	2	0.99	2.34E-06
				7	0.99	1.44E-06
				12	0.99	1.08E-06
		800	1	2	0.99	8.82E-06
				7	0.99	6.88E-06
				12	0.98	5.50E-06
			7	2	0.99	9.17E-06
				7	0.99	7.03E-06
				12	0.99	5.61E-06
			13	2	0.99	9.13E-06
				7	0.99	7.01E-06
				12	0.99	5.62E-06
		1400	1	2	0.99	1.52E-05
				7	0.99	1.21E-05
				12	0.99	9.59E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	6	1400	7	2	0.99	1.51E-05
				7	0.99	1.21E-05
				12	0.99	9.73E-06
			13	2	0.99	1.55E-05
				7	0.99	1.19E-05
				12	0.99	9.70E-06
6	0	200	1	2	0.99	4.24E-06
				7	0.99	2.93E-06
				12	0.99	2.16E-06
			7	2	0.99	4.25E-06
				7	0.98	3.05E-06
				12	0.99	2.11E-06
			13	2	0.99	4.42E-06
				7	0.99	2.99E-06
				12	0.98	2.09E-06
		800	1	2	0.98	1.76E-05
				7	0.99	1.37E-05
				12	0.99	1.10E-05
			7	2	0.98	1.74E-05
				7	0.99	1.39E-05
				12	0.99	1.12E-05
			13	2	0.99	1.76E-05
				7	0.99	1.40E-05
				12	0.99	1.09E-05
		1400	1	2	0.99	2.90E-05
				7	0.99	2.25E-05
				12	0.99	1.82E-05
			7	2	0.99	2.89E-05
				7	0.99	2.27E-05
				12	0.99	1.81E-05
			13	2	0.99	2.92E-05
				7	0.99	2.24E-05
				12	0.99	1.82E-05
	3	200	1	2	0.99	5.01E-06
				7	0.98	3.33E-06
				12	0.99	2.37E-06
			7	2	0.99	4.63E-06
				7	0.99	3.41E-06
				12	0.99	2.44E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	3	200	13	2	0.99	4.85E-06
				7	0.99	3.41E-06
				12	0.99	2.44E-06
		800	1	2	0.98	1.97E-05
				7	0.99	1.55E-05
				12	0.99	1.24E-05
			7	2	0.99	2.00E-05
				7	0.99	1.55E-05
				12	0.99	1.22E-05
			13	2	0.99	2.00E-05
				7	0.99	1.54E-05
				12	0.98	1.22E-05
		1400	1	2	0.99	3.25E-05
				7	0.99	2.54E-05
				12	0.99	2.06E-05
			7	2	0.99	3.24E-05
				7	0.99	2.53E-05
				12	0.99	2.03E-05
			13	2	0.99	3.28E-05
				7	0.99	2.54E-05
				12	0.99	2.03E-05
	6	200	1	2	0.98	6.45E-06
				7	0.99	4.28E-06
				12	0.99	3.23E-06
			7	2	0.99	6.57E-06
				7	1.00	4.55E-06
				12	0.99	3.23E-06
			13	2	0.99	6.20E-06
				7	0.99	4.50E-06
				12	0.98	3.07E-06
		800	1	2	0.99	2.65E-05
				7	0.99	2.08E-05
				12	0.99	1.63E-05
			7	2	0.99	2.65E-05
				7	0.99	2.04E-05
				12	0.99	1.62E-05
			13	2	0.99	2.64E-05
				7	0.99	2.05E-05
				12	0.99	1.66E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	6	1400	1	2	0.99	4.26E-05
				7	0.99	3.39E-05
				12	0.99	2.73E-05
			7	2	0.99	4.33E-05
				7	0.99	3.40E-05
				12	0.99	2.71E-05
			13	2	0.99	4.34E-05
				7	0.99	3.39E-05
				12	0.99	2.71E-05

Appendix Z. 1V:6H Rural Local

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	0.98	7.17E-06
				7	0.98	5.05E-06
				12	0.98	3.57E-06
			7	2	0.98	8.33E-06
				7	0.98	5.98E-06
				12	0.98	4.09E-06
			13	2	0.98	8.34E-06
				7	0.98	5.72E-06
				12	0.98	4.05E-06
		800	1	2	0.98	2.49E-05
				7	0.98	1.80E-05
				12	0.98	1.28E-05
			7	2	0.98	2.56E-05
				7	0.98	1.92E-05
				12	0.98	1.34E-05
			13	2	0.98	2.63E-05
				7	0.98	1.86E-05
				12	0.98	1.33E-05
		1400	1	2	0.98	4.28E-05
				7	0.98	3.12E-05
				12	0.98	2.20E-05
			7	2	0.98	4.34E-05
				7	0.98	3.20E-05
				12	0.98	2.28E-05
			13	2	0.98	4.35E-05
				7	0.98	3.19E-05
				12	0.98	2.28E-05
	4	200	1	2	0.98	9.19E-06
				7	0.98	6.25E-06
				12	0.98	4.46E-06
			7	2	0.98	1.03E-05
				7	0.98	7.29E-06
				12	0.98	5.16E-06
			13	2	0.98	1.05E-05
				7	0.98	7.40E-06
				12	0.98	5.24E-06
		800	1	2	0.98	3.09E-05
				7	0.98	2.26E-05
				12	0.98	1.60E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	4	800	7	2	0.98	3.22E-05
				7	0.98	2.34E-05
				12	0.98	1.69E-05
			13	2	0.98	3.24E-05
				7	0.98	2.33E-05
				12	0.98	1.67E-05
		1400	1	2	0.98	5.29E-05
				7	0.98	3.91E-05
				12	0.98	2.79E-05
			7	2	0.98	5.43E-05
				7	0.98	4.01E-05
				12	0.98	2.82E-05
			13	2	0.98	5.43E-05
				7	0.98	4.00E-05
				12	0.98	2.85E-05
	8	200	1	2	0.98	1.09E-05
				7	0.98	7.31E-06
				12	0.98	5.26E-06
			7	2	0.98	1.25E-05
				7	0.97	8.87E-06
				12	0.98	6.07E-06
			13	2	0.98	1.28E-05
				7	0.98	8.80E-06
				12	0.98	6.15E-06
		800	1	2	0.98	3.70E-05
				7	0.98	2.71E-05
				12	0.98	1.90E-05
			7	2	0.98	3.91E-05
				7	0.98	2.84E-05
				12	0.98	2.01E-05
			13	2	0.98	3.91E-05
				7	0.98	2.84E-05
				12	0.98	2.00E-05
		1400	1	2	0.98	6.34E-05
				7	0.98	4.65E-05
				12	0.98	3.30E-05
			7	2	0.98	6.49E-05
				7	0.98	4.78E-05
				12	0.98	3.40E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	8	1400	13	2	0.98	6.55E-05
				7	0.98	4.82E-05
				12	0.98	3.39E-05
4	0	200	1	2	0.98	1.29E-05
				7	0.98	8.77E-06
				12	0.98	5.80E-06
			7	2	0.98	1.30E-05
				7	0.98	9.13E-06
				12	0.98	6.22E-06
			13	2	0.98	1.29E-05
				7	0.98	9.08E-06
				12	0.98	5.96E-06
		800	1	2	0.98	4.93E-05
				7	0.98	3.59E-05
				12	0.98	2.51E-05
			7	2	0.98	4.91E-05
				7	0.98	3.57E-05
				12	0.98	2.52E-05
			13	2	0.98	4.92E-05
				7	0.98	3.59E-05
				12	0.98	2.49E-05
		1400	1	2	0.98	8.39E-05
				7	0.98	6.11E-05
				12	0.98	4.26E-05
			7	2	0.98	8.44E-05
				7	0.98	6.13E-05
				12	0.98	4.32E-05
			13	2	0.98	8.47E-05
				7	0.98	6.14E-05
				12	0.98	4.32E-05
	4	200	1	2	0.98	1.57E-05
				7	0.98	1.11E-05
				12	0.98	7.13E-06
			7	2	0.97	1.62E-05
				7	0.97	1.11E-05
				12	0.98	7.65E-06
			13	2	0.98	1.68E-05
				7	0.98	1.14E-05
				12	0.98	7.51E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	4	800	1	2	0.98	6.11E-05
				7	0.97	4.39E-05
				12	0.98	3.10E-05
			7	2	0.98	6.28E-05
				7	0.97	4.42E-05
				12	0.98	3.16E-05
			13	2	0.98	6.20E-05
				7	0.98	4.47E-05
				12	0.98	3.16E-05
		1400	1	2	0.98	1.04E-04
				7	0.98	7.61E-05
				12	0.98	5.39E-05
			7	2	0.98	1.05E-04
				7	0.98	7.61E-05
				12	0.98	5.47E-05
			13	2	0.98	1.06E-04
				7	0.98	7.64E-05
				12	0.98	5.36E-05
	8	200	1	2	0.97	1.85E-05
				7	0.98	1.30E-05
				12	0.98	8.59E-06
			7	2	0.98	1.96E-05
				7	0.97	1.35E-05
				12	0.98	9.12E-06
			13	2	0.98	1.94E-05
				7	0.98	1.37E-05
				12	0.98	8.83E-06
		800	1	2	0.98	7.35E-05
				7	0.98	5.38E-05
				12	0.98	3.73E-05
			7	2	0.98	7.50E-05
				7	0.98	5.46E-05
				12	0.98	3.83E-05
			13	2	0.98	7.43E-05
				7	0.98	5.38E-05
				12	0.98	3.76E-05
		1400	1	2	0.98	1.25E-04
				7	0.98	9.08E-05
				12	0.98	6.47E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	8	1400	7	2	0.98	1.27E-04
				7	0.98	9.23E-05
				12	0.98	6.36E-05
			13	2	0.98	1.26E-04
				7	0.98	9.20E-05
				12	0.98	6.48E-05
8	0	200	1	2	0.98	1.78E-05
				7	0.99	1.22E-05
				12	0.98	7.61E-06
			7	2	0.98	1.88E-05
				7	0.98	1.23E-05
				12	0.98	7.98E-06
			13	2	0.98	1.88E-05
				7	0.98	1.27E-05
				12	0.98	7.95E-06
		800	1	2	0.98	6.58E-05
				7	0.98	4.80E-05
				12	0.98	3.38E-05
			7	2	0.98	6.58E-05
				7	0.98	4.83E-05
				12	0.98	3.32E-05
			13	2	0.98	6.64E-05
				7	0.98	4.79E-05
				12	0.98	3.36E-05
		1400	1	2	0.98	1.07E-04
				7	0.98	7.68E-05
				12	0.98	5.46E-05
			7	2	0.98	1.07E-04
				7	0.98	7.78E-05
				12	0.98	5.50E-05
			13	2	0.98	1.08E-04
				7	0.98	7.67E-05
				12	0.98	5.50E-05
	4	200	1	2	0.98	2.28E-05
				7	0.98	1.53E-05
				12	0.97	9.63E-06
			7	2	0.98	2.35E-05
				7	0.97	1.49E-05
				12	0.97	9.54E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	4	200	13	2	0.98	2.35E-05
				7	0.98	1.53E-05
				12	0.98	1.02E-05
		800	1	2	0.98	8.27E-05
				7	0.98	5.90E-05
				12	0.98	4.17E-05
			7	2	0.98	8.29E-05
				7	0.98	6.01E-05
				12	0.98	4.29E-05
			13	2	0.98	8.16E-05
				7	0.98	5.96E-05
				12	0.98	4.25E-05
		1400	1	2	0.98	1.35E-04
				7	0.98	9.55E-05
				12	0.98	6.74E-05
			7	2	0.98	1.33E-04
				7	0.98	9.63E-05
				12	0.98	6.81E-05
			13	2	0.98	1.34E-04
				7	0.98	9.69E-05
				12	0.98	6.83E-05
	8	200	1	2	0.98	2.64E-05
				7	0.98	1.77E-05
				12	0.98	1.18E-05
			7	2	0.97	2.78E-05
				7	0.98	1.84E-05
				12	0.98	1.24E-05
			13	2	0.98	2.89E-05
				7	0.98	1.85E-05
				12	0.98	1.18E-05
		800	1	2	0.98	9.70E-05
				7	0.98	7.05E-05
				12	0.98	5.06E-05
			7	2	0.98	1.01E-04
				7	0.98	7.14E-05
				12	0.98	5.04E-05
			13	2	0.98	9.91E-05
				7	0.98	7.14E-05
				12	0.98	5.05E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	8	1400	1	2	0.98	1.59E-04
				7	0.98	1.16E-04
				12	0.98	8.21E-05
			7	2	0.98	1.62E-04
				7	0.98	1.16E-04
				12	0.98	8.07E-05
			13	2	0.98	1.60E-04
				7	0.98	1.16E-04
				12	0.98	8.11E-05

Appendix AA. 1V:6H Undivided Urban Arterial

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	0.85	7.22E-07
				7	0.85	5.05E-07
				12	0.85	3.52E-07
			7	2	0.85	8.25E-07
				7	0.85	5.72E-07
				12	0.85	3.95E-07
			13	2	0.85	8.34E-07
				7	0.85	5.67E-07
				12	0.85	3.94E-07
		800	1	2	0.85	2.76E-06
				7	0.85	1.99E-06
				12	0.85	1.39E-06
			7	2	0.85	2.83E-06
				7	0.85	2.03E-06
				12	0.85	1.45E-06
			13	2	0.85	2.84E-06
				7	0.85	2.03E-06
				12	0.85	1.44E-06
		1400	1	2	0.85	4.80E-06
				7	0.85	3.47E-06
				12	0.85	2.45E-06
			7	2	0.85	4.87E-06
				7	0.85	3.50E-06
				12	0.85	2.53E-06
			13	2	0.85	4.89E-06
				7	0.85	3.54E-06
				12	0.85	2.47E-06
	3	200	1	2	0.85	8.11E-07
				7	0.86	5.71E-07
				12	0.85	3.93E-07
			7	2	0.85	9.39E-07
				7	0.85	6.40E-07
				12	0.85	4.43E-07
			13	2	0.85	9.48E-07
				7	0.85	6.44E-07
				12	0.85	4.49E-07
		800	1	2	0.85	3.09E-06
				7	0.85	2.22E-06
				12	0.85	1.57E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	800	7	2	0.85	3.16E-06
				7	0.85	2.26E-06
				12	0.85	1.61E-06
			13	2	0.85	3.19E-06
				7	0.85	2.30E-06
				12	0.85	1.60E-06
		1400	1	2	0.85	5.37E-06
				7	0.85	3.87E-06
				12	0.85	2.79E-06
			7	2	0.85	5.46E-06
				7	0.85	3.96E-06
				12	0.85	2.84E-06
			13	2	0.85	5.40E-06
				7	0.85	3.95E-06
				12	0.85	2.80E-06
	6	200	1	2	0.85	1.09E-06
				7	0.85	7.56E-07
				12	0.85	5.17E-07
			7	2	0.85	1.24E-06
				7	0.85	8.59E-07
				12	0.85	5.86E-07
			13	2	0.85	1.22E-06
				7	0.85	8.55E-07
				12	0.85	5.87E-07
		800	1	2	0.85	4.12E-06
				7	0.85	2.96E-06
				12	0.85	2.07E-06
			7	2	0.85	4.27E-06
				7	0.85	3.06E-06
				12	0.85	2.15E-06
			13	2	0.85	4.30E-06
				7	0.85	3.08E-06
				12	0.85	2.14E-06
		1400	1	2	0.85	7.21E-06
				7	0.85	5.22E-06
				12	0.85	3.70E-06
			7	2	0.85	7.26E-06
				7	0.85	5.31E-06
				12	0.85	3.76E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	1400	13	2	0.85	7.29E-06
				7	0.85	5.25E-06
				12	0.85	3.76E-06
4	0	200	1	2	0.85	1.30E-06
				7	0.85	8.42E-07
				12	0.85	5.52E-07
			7	2	0.85	1.30E-06
				7	0.85	8.54E-07
				12	0.85	5.61E-07
			13	2	0.85	1.30E-06
				7	0.85	8.77E-07
				12	0.85	5.55E-07
		800	1	2	0.85	5.33E-06
				7	0.85	3.86E-06
				12	0.85	2.68E-06
			7	2	0.85	5.29E-06
				7	0.85	3.83E-06
				12	0.85	2.65E-06
			13	2	0.85	5.32E-06
				7	0.85	3.75E-06
				12	0.85	2.66E-06
		1400	1	2	0.85	9.18E-06
				7	0.85	6.64E-06
				12	0.85	4.67E-06
			7	2	0.85	9.18E-06
				7	0.85	6.73E-06
				12	0.85	4.66E-06
			13	2	0.85	9.22E-06
				7	0.85	6.59E-06
				12	0.85	4.64E-06
	3	200	1	2	0.85	1.47E-06
				7	0.86	9.68E-07
				12	0.85	6.29E-07
			7	2	0.85	1.47E-06
				7	0.85	9.65E-07
				12	0.85	6.30E-07
			13	2	0.85	1.46E-06
				7	0.85	9.72E-07
				12	0.85	6.27E-07

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	3	800	1	2	0.85	6.02E-06
				7	0.85	4.26E-06
				12	0.85	3.00E-06
			7	2	0.85	5.99E-06
				7	0.85	4.33E-06
				12	0.85	3.02E-06
			13	2	0.85	6.00E-06
				7	0.85	4.27E-06
				12	0.85	2.97E-06
		1400	1	2	0.85	1.04E-05
				7	0.85	7.52E-06
				12	0.85	5.24E-06
			7	2	0.85	1.05E-05
				7	0.85	7.49E-06
				12	0.85	5.22E-06
			13	2	0.85	1.04E-05
				7	0.85	7.45E-06
				12	0.85	5.23E-06
	6	200	1	2	0.85	1.94E-06
				7	0.85	1.27E-06
				12	0.85	8.29E-07
			7	2	0.85	1.95E-06
				7	0.85	1.30E-06
				12	0.85	8.21E-07
			13	2	0.85	2.02E-06
				7	0.85	1.31E-06
				12	0.86	8.52E-07
		800	1	2	0.85	7.99E-06
				7	0.85	5.74E-06
				12	0.85	4.00E-06
			7	2	0.85	8.18E-06
				7	0.85	5.81E-06
				12	0.85	4.05E-06
			13	2	0.85	8.00E-06
				7	0.85	5.75E-06
				12	0.85	3.97E-06
		1400	1	2	0.85	1.38E-05
				7	0.85	9.99E-06
				12	0.85	6.93E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	6	1400	7	2	0.85	1.39E-05
				7	0.85	1.00E-05
				12	0.85	7.02E-06
			13	2	0.85	1.38E-05
				7	0.85	1.00E-05
				12	0.85	7.00E-06
8	0	200	1	2	0.85	1.85E-06
				7	0.85	1.19E-06
				12	0.85	7.08E-07
			7	2	0.85	1.89E-06
				7	0.85	1.19E-06
				12	0.85	7.46E-07
			13	2	0.85	1.86E-06
				7	0.85	1.20E-06
				12	0.85	7.21E-07
		800	1	2	0.85	6.92E-06
				7	0.85	5.05E-06
				12	0.85	3.52E-06
			7	2	0.85	7.10E-06
				7	0.85	5.01E-06
				12	0.85	3.50E-06
			13	2	0.85	7.06E-06
				7	0.85	5.02E-06
				12	0.85	3.56E-06
		1400	1	2	0.85	1.12E-05
				7	0.85	7.97E-06
				12	0.85	5.63E-06
			7	2	0.85	1.12E-05
				7	0.85	8.02E-06
				12	0.85	5.68E-06
			13	2	0.85	1.11E-05
				7	0.85	8.05E-06
				12	0.85	5.64E-06
	3	200	1	2	0.85	2.06E-06
				7	0.85	1.34E-06
				12	0.85	8.03E-07
			7	2	0.86	2.11E-06
				7	0.85	1.37E-06
				12	0.84	8.19E-07

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	3	200	13	2	0.85	2.11E-06
				7	0.85	1.32E-06
				12	0.85	8.32E-07
		800	1	2	0.85	7.95E-06
				7	0.85	5.62E-06
				12	0.85	3.96E-06
			7	2	0.85	7.90E-06
				7	0.85	5.63E-06
				12	0.85	3.91E-06
			13	2	0.85	7.93E-06
				7	0.85	5.73E-06
				12	0.85	3.94E-06
		1400	1	2	0.85	1.26E-05
				7	0.85	9.02E-06
				12	0.85	6.28E-06
			7	2	0.85	1.26E-05
				7	0.85	8.93E-06
				12	0.85	6.34E-06
			13	2	0.85	1.25E-05
				7	0.85	8.94E-06
				12	0.85	6.31E-06
	6	200	1	2	0.85	2.80E-06
				7	0.85	1.79E-06
				12	0.84	1.08E-06
			7	2	0.85	2.80E-06
				7	0.86	1.80E-06
				12	0.85	1.10E-06
			13	2	0.85	2.88E-06
				7	0.85	1.81E-06
				12	0.85	1.07E-06
		800	1	2	0.85	1.04E-05
				7	0.85	7.55E-06
				12	0.86	5.24E-06
			7	2	0.85	1.05E-05
				7	0.85	7.59E-06
				12	0.85	5.28E-06
			13	2	0.85	1.06E-05
				7	0.85	7.51E-06
				12	0.85	5.19E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	6	1400	1	2	0.85	1.68E-05
				7	0.85	1.20E-05
				12	0.85	8.39E-06
			7	2	0.85	1.68E-05
				7	0.85	1.20E-05
				12	0.85	8.46E-06
			13	2	0.85	1.68E-05
				7	0.85	1.21E-05
				12	0.85	8.42E-06

Appendix BB. 1V:6H Divided Urban Arterial

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	0.85	1.45E-06
				7	0.85	1.07E-06
				12	0.85	8.79E-07
			7	2	0.85	1.87E-06
				7	0.85	1.48E-06
				12	0.85	1.23E-06
			13	2	0.85	1.92E-06
				7	0.85	1.55E-06
				12	0.85	1.21E-06
		800	1	2	0.85	5.57E-06
				7	0.85	4.45E-06
				12	0.85	3.57E-06
			7	2	0.85	6.05E-06
				7	0.85	4.85E-06
				12	0.85	3.92E-06
			13	2	0.85	6.13E-06
				7	0.85	4.83E-06
				12	0.85	3.94E-06
		1400	1	2	0.85	9.84E-06
				7	0.85	7.81E-06
				12	0.85	6.36E-06
			7	2	0.85	1.02E-05
				7	0.85	8.18E-06
				12	0.85	6.65E-06
			13	2	0.85	1.04E-05
				7	0.85	8.20E-06
				12	0.85	6.65E-06
	3	200	1	2	0.85	1.64E-06
				7	0.85	1.24E-06
				12	0.85	9.85E-07
			7	2	0.85	2.11E-06
				7	0.85	1.61E-06
				12	0.85	1.38E-06
			13	2	0.85	2.20E-06
				7	0.85	1.74E-06
				12	0.85	1.42E-06
		800	1	2	0.85	6.20E-06
				7	0.85	4.96E-06
				12	0.85	4.03E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	800	7	2	0.85	6.81E-06
				7	0.85	5.43E-06
				12	0.85	4.41E-06
			13	2	0.85	6.82E-06
				7	0.85	5.51E-06
				12	0.85	4.48E-06
		1400	1	2	0.85	1.10E-05
				7	0.85	8.77E-06
				12	0.85	7.13E-06
			7	2	0.85	1.16E-05
				7	0.85	9.17E-06
				12	0.85	7.55E-06
			13	2	0.85	1.16E-05
				7	0.85	9.35E-06
				12	0.85	7.62E-06
	6	200	1	2	0.85	2.16E-06
				7	0.85	1.64E-06
				12	0.85	1.25E-06
			7	2	0.85	2.82E-06
				7	0.85	2.16E-06
				12	0.85	1.83E-06
			13	2	0.85	3.05E-06
				7	0.85	2.34E-06
				12	0.85	1.90E-06
		800	1	2	0.85	8.42E-06
				7	0.85	6.67E-06
				12	0.85	5.34E-06
			7	2	0.85	9.00E-06
				7	0.85	7.19E-06
				12	0.85	5.84E-06
			13	2	0.85	9.19E-06
				7	0.85	7.30E-06
				12	0.85	5.91E-06
		1400	1	2	0.85	1.48E-05
				7	0.85	1.17E-05
				12	0.85	9.58E-06
			7	2	0.85	1.53E-05
				7	0.85	1.23E-05
				12	0.85	9.98E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	1400	13	2	0.85	1.53E-05
				7	0.85	1.23E-05
				12	0.85	1.01E-05
4	0	200	1	2	0.85	2.37E-06
				7	0.85	1.74E-06
				12	0.85	1.28E-06
			7	2	0.85	2.57E-06
				7	0.85	1.79E-06
				12	0.85	1.31E-06
			13	2	0.85	2.58E-06
				7	0.85	1.83E-06
				12	0.85	1.35E-06
		800	1	2	0.85	1.06E-05
				7	0.85	8.33E-06
				12	0.85	6.73E-06
			7	2	0.85	1.08E-05
				7	0.85	8.31E-06
				12	0.85	6.73E-06
			13	2	0.85	1.07E-05
				7	0.85	8.44E-06
				12	0.85	6.71E-06
		1400	1	2	0.85	1.85E-05
				7	0.85	1.46E-05
				12	0.85	1.18E-05
			7	2	0.85	1.86E-05
				7	0.85	1.45E-05
				12	0.85	1.18E-05
			13	2	0.85	1.86E-05
				7	0.85	1.47E-05
				12	0.85	1.18E-05
	3	200	1	2	0.85	2.85E-06
				7	0.85	1.98E-06
				12	0.85	1.44E-06
			7	2	0.85	2.81E-06
				7	0.85	2.00E-06
				12	0.85	1.53E-06
			13	2	0.85	2.84E-06
				7	0.85	1.99E-06
				12	0.85	1.50E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	3	800	1	2	0.85	1.19E-05
				7	0.85	9.45E-06
				12	0.85	7.40E-06
			7	2	0.85	1.20E-05
				7	0.85	9.35E-06
				12	0.85	7.52E-06
			13	2	0.85	1.21E-05
				7	0.85	9.49E-06
				12	0.85	7.66E-06
		1400	1	2	0.85	2.08E-05
				7	0.85	1.64E-05
				12	0.85	1.32E-05
			7	2	0.85	2.09E-05
				7	0.85	1.64E-05
				12	0.85	1.33E-05
			13	2	0.85	2.10E-05
				7	0.85	1.66E-05
				12	0.85	1.32E-05
	6	200	1	2	0.86	3.76E-06
				7	0.85	2.70E-06
				12	0.86	1.91E-06
			7	2	0.85	3.80E-06
				7	0.85	2.67E-06
				12	0.85	2.02E-06
			13	2	0.85	3.81E-06
				7	0.85	2.74E-06
				12	0.85	1.95E-06
		800	1	2	0.85	1.55E-05
				7	0.85	1.25E-05
				12	0.85	1.00E-05
			7	2	0.85	1.59E-05
				7	0.85	1.24E-05
				12	0.85	1.02E-05
			13	2	0.85	1.62E-05
				7	0.85	1.25E-05
				12	0.85	1.00E-05
		1400	1	2	0.85	2.82E-05
				7	0.85	2.20E-05
				12	0.85	1.76E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	6	1400	7	2	0.85	2.76E-05
				7	0.85	2.18E-05
				12	0.85	1.77E-05
			13	2	0.85	2.83E-05
				7	0.85	2.20E-05
				12	0.85	1.77E-05
8	0	200	1	2	0.85	3.60E-06
				7	0.85	2.46E-06
				12	0.85	1.61E-06
			7	2	0.85	3.64E-06
				7	0.85	2.47E-06
				12	0.85	1.67E-06
			13	2	0.85	3.65E-06
				7	0.85	2.44E-06
				12	0.85	1.66E-06
		800	1	2	0.85	1.40E-05
				7	0.85	1.07E-05
				12	0.85	8.62E-06
			7	2	0.85	1.40E-05
				7	0.85	1.07E-05
				12	0.85	8.68E-06
			13	2	0.85	1.37E-05
				7	0.85	1.08E-05
				12	0.85	8.72E-06
		1400	1	2	0.85	2.19E-05
				7	0.85	1.71E-05
				12	0.85	1.40E-05
			7	2	0.85	2.20E-05
				7	0.85	1.72E-05
				12	0.85	1.37E-05
			13	2	0.85	2.19E-05
				7	0.85	1.71E-05
				12	0.85	1.38E-05
	3	200	1	2	0.85	4.13E-06
				7	0.85	2.84E-06
				12	0.85	1.86E-06
			7	2	0.85	4.05E-06
				7	0.85	2.78E-06
				12	0.85	1.92E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	3	200	13	2	0.85	3.93E-06
				7	0.85	2.73E-06
				12	0.85	1.87E-06
		800	1	2	0.85	1.56E-05
				7	0.85	1.20E-05
				12	0.85	9.83E-06
			7	2	0.85	1.56E-05
				7	0.85	1.23E-05
				12	0.85	9.79E-06
			13	2	0.85	1.58E-05
				7	0.85	1.22E-05
				12	0.85	9.75E-06
		1400	1	2	0.85	2.47E-05
				7	0.85	1.93E-05
				12	0.85	1.56E-05
			7	2	0.85	2.44E-05
				7	0.85	1.94E-05
				12	0.85	1.56E-05
			13	2	0.85	2.45E-05
				7	0.85	1.93E-05
				12	0.85	1.55E-05
	6	200	1	2	0.85	5.61E-06
				7	0.84	3.75E-06
				12	0.85	2.44E-06
			7	2	0.85	5.23E-06
				7	0.85	3.68E-06
				12	0.85	2.47E-06
			13	2	0.85	5.34E-06
				7	0.85	3.65E-06
				12	0.85	2.50E-06
		800	1	2	0.85	2.05E-05
				7	0.85	1.63E-05
				12	0.85	1.30E-05
			7	2	0.85	2.08E-05
				7	0.85	1.62E-05
				12	0.85	1.27E-05
			13	2	0.85	2.12E-05
				7	0.85	1.62E-05
				12	0.85	1.29E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	6	1400	1	2	0.85	3.30E-05
				7	0.85	2.59E-05
				12	0.85	2.07E-05
			7	2	0.85	3.30E-05
				7	0.85	2.57E-05
				12	0.85	2.07E-05
			13	2	0.85	3.31E-05
				7	0.85	2.56E-05
				12	0.85	2.06E-05

Appendix CC. 1V:6H Urban Local

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	1.05	9.38E-06
				7	1.05	6.14E-06
				12	1.05	4.26E-06
			7	2	1.05	1.00E-05
				7	1.06	7.22E-06
				12	1.04	4.70E-06
			13	2	1.05	1.01E-05
				7	1.04	7.00E-06
				12	1.05	4.77E-06
		800	1	2	1.05	3.37E-05
				7	1.05	2.42E-05
				12	1.05	1.74E-05
			7	2	1.05	3.47E-05
				7	1.05	2.46E-05
				12	1.05	1.77E-05
			13	2	1.05	3.43E-05
				7	1.05	2.48E-05
				12	1.04	1.76E-05
		1400	1	2	1.05	5.77E-05
				7	1.05	4.22E-05
				12	1.04	2.95E-05
			7	2	1.05	5.80E-05
				7	1.05	4.25E-05
				12	1.05	3.06E-05
			13	2	1.05	5.84E-05
				7	1.05	4.29E-05
				12	1.05	3.12E-05
	6	200	1	2	1.05	1.39E-05
				7	1.05	9.59E-06
				12	1.05	6.55E-06
			7	2	1.04	1.50E-05
				7	1.05	1.05E-05
				12	1.05	7.03E-06
			13	2	1.04	1.54E-05
				7	1.04	1.07E-05
				12	1.05	7.20E-06
		800	1	2	1.05	5.04E-05
				7	1.04	3.58E-05
				12	1.05	2.57E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	800	7	2	1.05	5.10E-05
				7	1.05	3.68E-05
				12	1.05	2.64E-05
			13	2	1.05	5.14E-05
				7	1.05	3.77E-05
				12	1.04	2.63E-05
		1400	1	2	1.05	8.70E-05
				7	1.05	6.32E-05
				12	1.05	4.55E-05
			7	2	1.05	8.70E-05
				7	1.05	6.42E-05
				12	1.04	4.60E-05
			13	2	1.05	8.83E-05
				7	1.05	6.42E-05
				12	1.04	4.57E-05
	12	200	1	2	1.05	1.39E-05
				7	1.05	9.70E-06
				12	1.05	6.63E-06
			7	2	1.05	1.53E-05
				7	1.04	1.03E-05
				12	1.05	7.01E-06
			13	2	1.04	1.48E-05
				7	1.04	1.04E-05
				12	1.05	7.18E-06
		800	1	2	1.05	5.01E-05
				7	1.05	3.57E-05
				12	1.04	2.55E-05
			7	2	1.05	5.12E-05
				7	1.05	3.75E-05
				12	1.05	2.63E-05
			13	2	1.04	5.07E-05
				7	1.05	3.75E-05
				12	1.05	2.63E-05
		1400	1	2	1.05	8.69E-05
				7	1.05	6.38E-05
				12	1.05	4.51E-05
			7	2	1.05	8.70E-05
				7	1.05	6.39E-05
				12	1.05	4.57E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	12	1400	13	2	1.04	8.76E-05
				7	1.05	6.42E-05
				12	1.05	4.56E-05
3	0	200	1	2	1.05	9.49E-06
				7	1.05	5.96E-06
				12	1.05	3.99E-06
			7	2	1.05	9.75E-06
				7	1.04	6.03E-06
				12	1.05	4.25E-06
			13	2	1.05	9.60E-06
				7	1.04	6.14E-06
				12	1.05	3.99E-06
		800	1	2	1.04	3.49E-05
				7	1.05	2.47E-05
				12	1.04	1.76E-05
			7	2	1.05	3.51E-05
				7	1.04	2.56E-05
				12	1.05	1.78E-05
			13	2	1.05	3.52E-05
				7	1.04	2.55E-05
				12	1.04	1.76E-05
		1400	1	2	1.04	5.89E-05
				7	1.05	4.32E-05
				12	1.05	3.04E-05
			7	2	1.04	5.92E-05
				7	1.04	4.31E-05
				12	1.05	3.07E-05
			13	2	1.04	5.89E-05
				7	1.05	4.30E-05
				12	1.05	3.06E-05
	6	200	1	2	1.05	1.32E-05
				7	1.05	8.61E-06
				12	1.05	6.09E-06
			7	2	1.04	1.43E-05
				7	1.05	9.28E-06
				12	1.04	6.20E-06
			13	2	1.05	1.40E-05
				7	1.04	9.26E-06
				12	1.05	5.99E-06

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	6	800	1	2	1.04	5.17E-05
				7	1.05	3.78E-05
				12	1.05	2.65E-05
			7	2	1.04	5.28E-05
				7	1.05	3.83E-05
				12	1.05	2.67E-05
			13	2	1.05	5.30E-05
				7	1.05	3.84E-05
				12	1.05	2.66E-05
		1400	1	2	1.05	8.88E-05
				7	1.05	6.45E-05
				12	1.05	4.56E-05
			7	2	1.04	8.97E-05
				7	1.05	6.42E-05
				12	1.05	4.59E-05
			13	2	1.05	8.95E-05
				7	1.04	6.50E-05
				12	1.04	4.57E-05
	12	200	1	2	1.05	1.40E-05
				7	1.05	8.95E-06
				12	1.05	6.11E-06
			7	2	1.04	1.42E-05
				7	1.04	9.21E-06
				12	1.04	6.06E-06
			13	2	1.05	1.44E-05
				7	1.05	9.23E-06
				12	1.05	6.24E-06
		800	1	2	1.05	5.28E-05
				7	1.05	3.81E-05
				12	1.04	2.56E-05
			7	2	1.05	5.25E-05
				7	1.05	3.83E-05
				12	1.04	2.70E-05
			13	2	1.05	5.36E-05
				7	1.05	3.78E-05
				12	1.05	2.68E-05
		1400	1	2	1.05	8.89E-05
				7	1.05	6.49E-05
				12	1.04	4.54E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	12	1400	7	2	1.04	8.94E-05
				7	1.05	6.39E-05
				12	1.04	4.57E-05
			13	2	1.05	8.80E-05
				7	1.05	6.53E-05
				12	1.05	4.56E-05
6	0	200	1	2	1.05	2.77E-05
				7	1.05	1.90E-05
				12	1.05	1.27E-05
			7	2	1.05	2.88E-05
				7	1.04	1.96E-05
				12	1.04	1.27E-05
			13	2	1.05	2.85E-05
				7	1.05	1.98E-05
				12	1.05	1.28E-05
		800	1	2	1.04	1.06E-04
				7	1.04	7.56E-05
				12	1.05	5.42E-05
			7	2	1.04	1.06E-04
				7	1.04	7.67E-05
				12	1.05	5.46E-05
			13	2	1.05	1.06E-04
				7	1.04	7.60E-05
				12	1.05	5.47E-05
		1400	1	2	1.04	1.74E-04
				7	1.05	1.24E-04
				12	1.05	8.76E-05
			7	2	1.04	1.71E-04
				7	1.05	1.27E-04
				12	1.05	8.80E-05
			13	2	1.05	1.72E-04
				7	1.05	1.24E-04
				12	1.05	8.83E-05
	6	200	1	2	1.05	4.13E-05
				7	1.05	2.86E-05
				12	1.05	1.86E-05
			7	2	1.05	4.42E-05
				7	1.04	2.88E-05
				12	1.05	1.90E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	6	200	13	2	1.04	4.29E-05
				7	1.04	2.95E-05
				12	1.06	1.95E-05
		800	1	2	1.04	1.58E-04
				7	1.04	1.13E-04
				12	1.05	8.00E-05
			7	2	1.05	1.58E-04
				7	1.04	1.16E-04
				12	1.05	8.01E-05
			13	2	1.05	1.58E-04
				7	1.05	1.14E-04
				12	1.04	7.91E-05
		1400	1	2	1.05	2.57E-04
				7	1.05	1.85E-04
				12	1.05	1.31E-04
			7	2	1.05	2.59E-04
				7	1.05	1.87E-04
				12	1.04	1.29E-04
			13	2	1.05	2.58E-04
				7	1.05	1.88E-04
				12	1.04	1.30E-04
	12	200	1	2	1.05	4.17E-05
				7	1.05	2.86E-05
				12	1.06	1.89E-05
			7	2	1.04	4.23E-05
				7	1.05	2.84E-05
				12	1.05	1.93E-05
			13	2	1.04	4.18E-05
				7	1.04	2.93E-05
				12	1.05	1.93E-05
		800	1	2	1.04	1.57E-04
				7	1.05	1.13E-04
				12	1.05	8.09E-05
			7	2	1.05	1.61E-04
				7	1.04	1.15E-04
				12	1.04	7.98E-05
			13	2	1.05	1.58E-04
				7	1.05	1.14E-04
				12	1.05	8.04E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	12	1400	1	2	1.05	2.55E-04
				7	1.05	1.90E-04
				12	1.05	1.32E-04
			7	2	1.05	2.61E-04
				7	1.05	1.89E-04
				12	1.05	1.31E-04
			13	2	1.05	2.61E-04
				7	1.05	1.88E-04
				12	1.05	1.32E-04

Appendix DD. Guardrail Freeway

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	2.47	9.01E-05
				7	2.49	7.85E-05
				12	2.45	6.33E-05
			7	2	2.70	8.57E-05
				7	2.71	6.67E-05
				12	2.72	5.34E-05
			13	2	2.96	6.77E-05
				7	2.97	4.92E-05
				12	2.95	3.69E-05
		800	1	2	2.49	3.08E-04
				7	2.49	2.30E-04
				12	2.49	1.94E-04
			7	2	2.71	2.38E-04
				7	2.71	1.74E-04
				12	2.71	1.46E-04
			13	2	2.97	1.67E-04
				7	2.97	1.22E-04
				12	2.97	1.02E-04
		1400	1	2	2.49	5.10E-04
				7	2.48	4.01E-04
				12	2.48	3.41E-04
			7	2	2.72	3.74E-04
				7	2.70	2.95E-04
				12	2.71	2.40E-04
			13	2	2.98	2.66E-04
				7	2.98	1.98E-04
				12	2.97	1.62E-04
	2	200	1	2	2.48	9.60E-05
				7	2.47	7.23E-05
				12	2.45	5.27E-05
			7	2	2.69	9.17E-05
				7	2.70	7.04E-05
				12	2.70	5.24E-05
			13	2	2.96	6.71E-05
				7	2.96	4.41E-05
				12	2.96	3.92E-05
		800	1	2	2.49	3.16E-04
				7	2.47	2.51E-04
				12	2.47	2.02E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	2	800	7	2	2.71	2.39E-04
				7	2.69	1.91E-04
				12	2.71	1.43E-04
			13	2	2.98	1.63E-04
				7	2.98	1.28E-04
				12	2.98	1.03E-04
		1400	1	2	2.48	5.25E-04
				7	2.47	4.21E-04
				12	2.48	3.30E-04
			7	2	2.71	3.89E-04
				7	2.71	2.97E-04
				12	2.72	2.43E-04
			13	2	2.98	2.56E-04
				7	2.98	2.07E-04
				12	2.98	1.57E-04
	3	200	1	2	2.50	1.09E-04
				7	2.50	7.49E-05
				12	2.47	5.99E-05
			7	2	2.67	1.08E-04
				7	2.70	7.51E-05
				12	2.72	5.63E-05
			13	2	2.95	8.10E-05
				7	2.95	5.73E-05
				12	2.95	4.34E-05
		800	1	2	2.49	3.45E-04
				7	2.49	2.63E-04
				12	2.50	2.20E-04
			7	2	2.72	2.58E-04
				7	2.73	1.98E-04
				12	2.70	1.66E-04
			13	2	2.98	1.87E-04
				7	2.98	1.41E-04
				12	2.97	1.07E-04
		1400	1	2	2.48	5.99E-04
				7	2.49	4.60E-04
				12	2.48	3.86E-04
			7	2	2.72	4.31E-04
				7	2.72	3.29E-04
				12	2.72	2.64E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	1400	13	2	2.98	2.91E-04
				7	2.97	2.25E-04
				12	2.97	1.93E-04
2	0	200	1	2	2.48	8.86E-05
				7	2.49	6.37E-05
				12	2.48	4.96E-05
			7	2	2.72	8.14E-05
				7	2.70	6.21E-05
				12	2.71	4.48E-05
			13	2	2.94	6.35E-05
				7	2.96	4.45E-05
				12	2.95	3.55E-05
		800	1	2	2.47	2.93E-04
				7	2.49	2.26E-04
				12	2.47	1.86E-04
			7	2	2.71	2.21E-04
				7	2.71	1.63E-04
				12	2.72	1.40E-04
			13	2	2.97	1.55E-04
				7	2.97	1.14E-04
				12	2.97	9.42E-05
		1400	1	2	2.48	4.77E-04
				7	2.48	3.75E-04
				12	2.48	3.07E-04
			7	2	2.72	3.61E-04
				7	2.71	2.80E-04
				12	2.71	2.26E-04
			13	2	2.98	2.47E-04
				7	2.96	1.90E-04
				12	2.98	1.51E-04
	2	200	1	2	2.46	8.97E-05
				7	2.49	6.09E-05
				12	2.48	5.27E-05
			7	2	2.71	8.48E-05
				7	2.69	5.91E-05
				12	2.71	4.82E-05
			13	2	2.97	6.28E-05
				7	2.96	4.56E-05
				12	3.00	3.39E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
2	2	800	1	2	2.48	2.91E-04
				7	2.49	2.27E-04
				12	2.48	1.80E-04
			7	2	2.71	2.22E-04
				7	2.71	1.66E-04
				12	2.72	1.32E-04
			13	2	2.97	1.57E-04
				7	2.98	1.17E-04
				12	2.96	9.49E-05
		1400	1	2	2.48	4.93E-04
				7	2.49	3.92E-04
				12	2.48	3.19E-04
			7	2	2.71	3.54E-04
				7	2.71	2.71E-04
				12	2.71	2.34E-04
			13	2	2.97	2.46E-04
				7	2.97	1.83E-04
				12	2.97	1.55E-04
	3	200	1	2	2.49	9.54E-05
				7	2.48	7.58E-05
				12	2.48	5.88E-05
			7	2	2.69	9.48E-05
				7	2.69	7.03E-05
				12	2.70	5.10E-05
			13	2	2.95	7.28E-05
				7	2.95	4.83E-05
				12	2.96	3.68E-05
		800	1	2	2.48	3.30E-04
				7	2.48	2.62E-04
				12	2.48	1.99E-04
			7	2	2.73	2.48E-04
				7	2.71	1.86E-04
				12	2.71	1.54E-04
			13	2	2.97	1.80E-04
				7	2.98	1.30E-04
				12	2.96	1.07E-04
		1400	1	2	2.49	5.49E-04
				7	2.48	4.30E-04
				12	2.48	3.42E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
2	3	1400	7	2	2.71	4.08E-04
				7	2.71	3.09E-04
				12	2.72	2.44E-04
			13	2	2.97	2.76E-04
				7	2.98	2.16E-04
				12	2.97	1.71E-04
3	0	200	1	2	2.50	1.03E-04
				7	2.46	7.96E-05
				12	2.46	6.21E-05
			7	2	2.69	1.04E-04
				7	2.70	6.66E-05
				12	2.68	5.62E-05
			13	2	2.95	7.07E-05
				7	2.93	5.27E-05
				12	2.97	3.78E-05
		800	1	2	2.48	3.34E-04
				7	2.49	2.54E-04
				12	2.47	2.12E-04
			7	2	2.71	2.56E-04
				7	2.71	1.94E-04
				12	2.71	1.51E-04
			13	2	2.98	1.76E-04
				7	2.97	1.35E-04
				12	2.97	1.08E-04
		1400	1	2	2.48	5.77E-04
				7	2.47	4.32E-04
				12	2.48	3.77E-04
			7	2	2.72	4.00E-04
				7	2.71	3.05E-04
				12	2.72	2.50E-04
			13	2	2.98	2.79E-04
				7	2.97	2.15E-04
				12	2.96	1.81E-04
	2	200	1	2	2.46	1.06E-04
				7	2.49	7.66E-05
				12	2.48	5.83E-05
			7	2	2.69	1.04E-04
				7	2.70	6.73E-05
				12	2.70	5.32E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	2	200	13	2	2.96	7.24E-05
				7	2.94	5.45E-05
				12	2.97	3.62E-05
		800	1	2	2.47	3.42E-04
				7	2.49	2.49E-04
				12	2.49	2.09E-04
			7	2	2.72	2.52E-04
				7	2.72	1.83E-04
				12	2.71	1.56E-04
			13	2	2.96	1.77E-04
				7	2.97	1.30E-04
				12	2.98	1.03E-04
		1400	1	2	2.48	5.62E-04
				7	2.49	4.37E-04
				12	2.48	3.61E-04
			7	2	2.72	4.15E-04
				7	2.72	3.12E-04
				12	2.72	2.51E-04
			13	2	2.98	2.76E-04
				7	2.97	2.15E-04
				12	2.98	1.70E-04
	3	200	1	2	2.47	1.38E-04
				7	2.46	8.13E-05
				12	2.45	6.61E-05
			7	2	2.71	1.13E-04
				7	2.72	7.76E-05
				12	2.70	5.61E-05
			13	2	2.96	7.99E-05
				7	2.95	5.68E-05
				12	2.97	4.12E-05
		800	1	2	2.49	3.84E-04
				7	2.48	3.03E-04
				12	2.48	2.37E-04
			7	2	2.72	2.81E-04
				7	2.70	2.15E-04
				12	2.72	1.76E-04
			13	2	2.99	2.01E-04
				7	2.97	1.49E-04
				12	2.97	1.21E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	3	1400	1	2	2.48	6.39E-04
				7	2.49	4.78E-04
				12	2.48	4.06E-04
			7	2	2.72	4.52E-04
				7	2.72	3.58E-04
				12	2.72	2.81E-04
			13	2	2.98	3.18E-04
				7	2.97	2.46E-04
				12	2.97	2.00E-04

Appendix EE. Guardrail Undivided Rural Arterial

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	1.96	6.39E-05
				7	1.99	3.99E-05
				12	1.97	2.73E-05
			7	2	2.19	5.36E-05
				7	2.16	3.55E-05
				12	2.16	2.42E-05
			13	2	2.38	3.96E-05
				7	2.37	2.57E-05
				12	2.36	1.88E-05
		800	1	2	1.98	1.87E-04
				7	1.99	1.31E-04
				12	1.98	9.42E-05
			7	2	2.17	1.39E-04
				7	2.18	9.65E-05
				12	2.16	7.11E-05
			13	2	2.36	9.55E-05
				7	2.38	6.69E-05
				12	2.38	4.68E-05
		1400	1	2	1.98	3.24E-04
				7	1.98	2.27E-04
				12	1.98	1.54E-04
			7	2	2.16	2.29E-04
				7	2.16	1.65E-04
				12	2.17	1.12E-04
			13	2	2.37	1.50E-04
				7	2.37	1.08E-04
				12	2.37	7.54E-05
	3	200	1	2	2.00	6.09E-05
				7	1.98	4.67E-05
				12	2.02	2.97E-05
			7	2	2.16	5.89E-05
				7	2.16	4.12E-05
				12	2.16	2.53E-05
			13	2	2.35	4.61E-05
				7	2.35	3.26E-05
				12	2.37	1.97E-05
		800	1	2	1.98	2.08E-04
				7	1.98	1.44E-04
				12	1.97	1.09E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	800	7	2	2.18	1.52E-04
				7	2.15	1.17E-04
				12	2.17	8.12E-05
			13	2	2.38	1.08E-04
				7	2.36	8.03E-05
				12	2.37	5.15E-05
		1400	1	2	1.98	3.65E-04
				7	1.98	2.48E-04
				12	1.97	1.87E-04
			7	2	2.15	2.62E-04
				7	2.17	1.80E-04
				12	2.17	1.28E-04
			13	2	2.36	1.84E-04
				7	2.38	1.25E-04
				12	2.36	9.01E-05
	6	200	1	2	1.97	8.94E-05
				7	1.96	5.31E-05
				12	1.94	4.51E-05
			7	2	2.16	8.68E-05
				7	2.19	5.50E-05
				12	2.16	3.92E-05
			13	2	2.36	6.12E-05
				7	2.37	4.00E-05
				12	2.34	2.85E-05
		800	1	2	1.98	2.83E-04
				7	1.97	1.91E-04
				12	1.98	1.49E-04
			7	2	2.18	2.13E-04
				7	2.18	1.35E-04
				12	2.16	1.10E-04
			13	2	2.38	1.42E-04
				7	2.38	1.03E-04
				12	2.38	7.17E-05
		1400	1	2	1.99	4.79E-04
				7	1.98	3.41E-04
				12	1.99	2.35E-04
			7	2	2.18	3.39E-04
				7	2.16	2.43E-04
				12	2.17	1.74E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	1400	13	2	2.37	2.31E-04
				7	2.37	1.59E-04
				12	2.36	1.23E-04
3	0	200	1	2	2.01	5.83E-05
				7	1.95	4.21E-05
				12	1.94	3.07E-05
			7	2	2.15	6.36E-05
				7	2.13	4.14E-05
				12	2.16	2.81E-05
			13	2	2.37	4.61E-05
				7	2.36	3.10E-05
				12	2.40	1.89E-05
		800	1	2	1.99	2.03E-04
				7	1.98	1.46E-04
				12	2.14	6.86E-05
			7	2	2.46	9.02E-05
				7	2.47	6.26E-05
				12	2.47	4.43E-05
			13	2	2.61	7.38E-05
				7	2.59	5.39E-05
				12	2.61	3.78E-05
		1400	1	2	2.24	2.14E-04
				7	2.25	1.53E-04
				12	2.23	1.11E-04
			7	2	2.46	1.50E-04
				7	2.46	1.05E-04
				12	2.46	7.34E-05
			13	2	2.62	1.15E-04
				7	2.62	8.36E-05
				12	2.61	6.04E-05
	3	200	1	2	2.23	5.03E-05
				7	2.26	3.10E-05
				12	2.28	2.14E-05
			7	2	2.46	4.20E-05
				7	2.45	2.67E-05
				12	2.49	1.71E-05
			13	2	2.61	3.32E-05
				7	2.60	2.41E-05
				12	2.63	1.54E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	3	800	1	2	2.24	1.41E-04
				7	2.24	1.09E-04
				12	2.23	7.19E-05
			7	2	2.46	1.03E-04
				7	2.47	7.03E-05
				12	2.47	5.18E-05
			13	2	2.63	8.25E-05
				7	2.62	5.75E-05
				12	2.61	4.24E-05
		1400	1	2	2.24	2.46E-04
				7	2.25	1.69E-04
				12	2.24	1.20E-04
			7	2	2.46	1.65E-04
				7	2.47	1.16E-04
				12	2.47	8.19E-05
			13	2	2.61	1.32E-04
				7	2.62	9.43E-05
				12	2.62	6.54E-05
	6	200	1	2	2.27	5.76E-05
				7	2.23	3.74E-05
				12	2.25	2.80E-05
			7	2	2.48	5.46E-05
				7	2.46	3.33E-05
				12	2.46	2.33E-05
			13	2	2.64	4.39E-05
				7	2.60	3.03E-05
				12	2.61	1.97E-05
		800	1	2	2.23	1.97E-04
				7	2.24	1.37E-04
				12	2.24	9.35E-05
			7	2	2.47	1.37E-04
				7	2.46	9.65E-05
				12	2.49	6.36E-05
			13	2	2.63	1.08E-04
				7	2.62	7.61E-05
				12	2.60	5.75E-05
		1400	1	2	2.25	3.24E-04
				7	2.24	2.33E-04
				12	2.24	1.61E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	6	1400	7	2	2.47	2.22E-04
				7	2.47	1.62E-04
				12	2.46	1.13E-04
			13	2	2.61	1.77E-04
				7	2.61	1.26E-04
				12	2.61	8.87E-05
6	0	200	1	2	2.24	1.49E-04
				7	2.24	1.02E-04
				12	2.24	7.03E-05
			7	2	2.42	1.46E-04
				7	2.47	9.05E-05
				12	2.43	6.42E-05
			13	2	2.60	1.18E-04
				7	2.64	7.21E-05
				12	2.61	4.65E-05
		800	1	2	2.23	4.83E-04
				7	2.24	3.35E-04
				12	2.26	2.29E-04
			7	2	2.45	3.48E-04
				7	2.44	2.37E-04
				12	2.48	1.68E-04
			13	2	2.59	2.84E-04
				7	2.60	1.93E-04
				12	2.63	1.28E-04
		1400	1	2	2.25	7.97E-04
				7	2.25	5.54E-04
				12	2.24	4.10E-04
			7	2	2.46	5.62E-04
				7	2.46	3.89E-04
				12	2.46	2.69E-04
			13	2	2.60	4.47E-04
				7	2.61	3.05E-04
				12	2.63	2.10E-04
	3	200	1	2	2.26	1.62E-04
				7	2.25	1.18E-04
				12	2.25	8.12E-05
			7	2	2.48	1.58E-04
				7	2.46	1.02E-04
				12	2.46	6.72E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	3	200	13	2	2.59	1.25E-04
				7	2.65	7.83E-05
				12	2.62	5.51E-05
		800	1	2	2.25	5.23E-04
				7	2.23	3.68E-04
				12	2.22	2.70E-04
			7	2	2.46	4.07E-04
				7	2.47	2.62E-04
				12	2.47	1.85E-04
			13	2	2.63	3.20E-04
				7	2.61	2.20E-04
				12	2.62	1.46E-04
		1400	1	2	2.25	9.24E-04
				7	2.24	6.68E-04
				12	2.24	4.55E-04
			7	2	2.47	6.30E-04
				7	2.47	4.26E-04
				12	2.47	3.08E-04
			13	2	2.64	4.69E-04
				7	2.61	3.50E-04
				12	2.63	2.40E-04
	6	200	1	2	2.24	2.37E-04
				7	2.23	1.55E-04
				12	2.23	1.11E-04
			7	2	2.48	2.04E-04
				7	2.50	1.34E-04
				12	2.47	8.85E-05
			13	2	2.59	1.73E-04
				7	2.63	1.19E-04
				12	2.62	7.20E-05
		800	1	2	2.24	7.12E-04
				7	2.25	5.10E-04
				12	2.25	3.36E-04
			7	2	2.46	5.04E-04
				7	2.45	3.61E-04
				12	2.46	2.57E-04
			13	2	2.62	4.02E-04
				7	2.61	2.93E-04
				12	2.61	2.03E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	6	1400	1	2	2.24	1.22E-03
				7	2.25	8.50E-04
				12	2.23	6.06E-04
			7	2	2.46	8.52E-04
				7	2.46	6.16E-04
				12	2.47	4.07E-04
			13	2	2.61	6.66E-04
				7	2.61	4.71E-04
				12	2.61	3.21E-04

Appendix FF. Guardrail Divided Rural Arterial

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	1.99	1.22E-04
				7	1.97	9.46E-05
				12	1.98	6.83E-05
			7	2	2.17	1.16E-04
				7	2.16	7.85E-05
				12	2.20	5.91E-05
			13	2	2.36	8.26E-05
				7	2.36	6.30E-05
				12	2.36	4.71E-05
		800	1	2	1.97	4.05E-04
				7	1.98	3.15E-04
				12	1.99	2.42E-04
			7	2	2.16	3.01E-04
				7	2.17	2.27E-04
				12	2.17	1.88E-04
			13	2	2.38	1.97E-04
				7	2.36	1.68E-04
				12	2.38	1.22E-04
		1400	1	2	1.97	6.88E-04
				7	1.98	5.18E-04
				12	1.97	4.35E-04
			7	2	2.17	4.68E-04
				7	2.17	3.65E-04
				12	2.17	3.11E-04
			13	2	2.37	3.21E-04
				7	2.39	2.47E-04
				12	2.38	2.05E-04
	3	200	1	2	1.99	1.46E-04
				7	1.97	9.28E-05
				12	2.01	7.72E-05
			7	2	2.13	1.33E-04
				7	2.17	9.49E-05
				12	2.15	7.25E-05
			13	2	2.34	1.04E-04
				7	2.37	6.41E-05
				12	2.37	5.38E-05
		800	1	2	1.99	4.52E-04
				7	1.97	3.34E-04
				12	1.99	2.63E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	800	7	2	2.16	3.45E-04
				7	2.16	2.60E-04
				12	2.16	1.99E-04
			13	2	2.38	2.13E-04
				7	2.36	1.79E-04
				12	2.38	1.43E-04
		1400	1	2	1.97	7.42E-04
				7	1.99	5.99E-04
				12	1.97	4.95E-04
			7	2	2.16	5.55E-04
				7	2.16	4.26E-04
				12	2.17	3.38E-04
			13	2	2.37	3.62E-04
				7	2.37	2.85E-04
				12	2.37	2.32E-04
	6	200	1	2	1.97	1.84E-04
				7	1.99	1.36E-04
				12	1.97	1.04E-04
			7	2	2.18	1.73E-04
				7	2.17	1.26E-04
				12	2.15	9.96E-05
			13	2	2.38	1.22E-04
				7	2.36	8.82E-05
				12	2.36	6.93E-05
		800	1	2	1.99	5.93E-04
				7	1.96	4.77E-04
				12	1.96	3.67E-04
			7	2	2.17	4.27E-04
				7	2.16	3.47E-04
				12	2.17	2.71E-04
			13	2	2.39	2.88E-04
				7	2.37	2.32E-04
				12	2.37	1.89E-04
		1400	1	2	1.98	1.01E-03
				7	1.98	8.26E-04
				12	1.99	6.19E-04
			7	2	2.17	7.19E-04
				7	2.17	5.63E-04
				12	2.18	4.73E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	1400	13	2	2.37	4.92E-04
				7	2.37	3.79E-04
				12	2.37	3.06E-04
3	0	200	1	2	1.97	1.36E-04
				7	1.95	9.58E-05
				12	1.96	7.67E-05
			7	2	2.18	1.27E-04
				7	2.15	9.65E-05
				12	2.12	7.49E-05
			13	2	2.37	9.18E-05
				7	2.40	5.97E-05
				12	2.39	4.82E-05
		800	1	2	1.99	4.28E-04
				7	1.98	3.40E-04
				12	1.97	2.71E-04
			7	2	2.18	3.14E-04
				7	2.17	2.36E-04
				12	2.16	2.07E-04
			13	2	2.36	2.13E-04
				7	2.39	1.65E-04
				12	2.37	1.34E-04
		1400	1	2	1.97	7.05E-04
				7	1.98	5.71E-04
				12	1.99	4.60E-04
			7	2	2.15	5.15E-04
				7	2.16	3.99E-04
				12	2.17	3.31E-04
			13	2	2.38	3.37E-04
				7	2.38	2.67E-04
				12	2.37	2.17E-04
	3	200	1	2	1.98	1.46E-04
				7	1.97	1.05E-04
				12	1.97	8.35E-05
			7	2	2.16	1.45E-04
				7	2.18	9.20E-05
				12	2.17	7.91E-05
			13	2	2.38	9.43E-05
				7	2.39	7.14E-05
				12	2.35	5.24E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	3	800	1	2	1.98	4.71E-04
				7	1.98	3.77E-04
				12	1.97	2.98E-04
			7	2	2.16	3.58E-04
				7	2.17	2.80E-04
				12	2.17	2.24E-04
			13	2	2.37	2.42E-04
				7	2.36	1.85E-04
				12	2.37	1.53E-04
		1400	1	2	1.98	8.00E-04
				7	1.97	6.13E-04
				12	1.96	5.10E-04
			7	2	2.17	5.69E-04
				7	2.16	4.50E-04
				12	2.17	3.56E-04
			13	2	2.37	3.94E-04
				7	2.37	3.00E-04
				12	2.38	2.43E-04
	6	200	1	2	1.95	2.12E-04
				7	1.97	1.44E-04
				12	1.97	1.16E-04
			7	2	2.16	2.02E-04
				7	2.17	1.22E-04
				12	2.14	1.03E-04
			13	2	2.38	1.32E-04
				7	2.38	8.65E-05
				12	2.37	6.66E-05
		800	1	2	1.97	6.47E-04
				7	1.97	4.59E-04
				12	1.96	3.93E-04
			7	2	2.15	4.97E-04
				7	2.17	3.60E-04
				12	2.17	2.84E-04
			13	2	2.38	3.24E-04
				7	2.37	2.58E-04
				12	2.37	1.90E-04
		1400	1	2	1.98	1.07E-03
				7	1.98	8.06E-04
				12	1.97	6.96E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	6	1400	7	2	2.17	7.70E-04
				7	2.17	6.04E-04
				12	2.17	4.84E-04
			13	2	2.38	4.88E-04
				7	2.37	3.92E-04
				12	2.38	3.24E-04
6	0	200	1	2	2.00	4.70E-04
				7	1.97	3.44E-04
				12	1.98	2.59E-04
			7	2	2.18	4.20E-04
				7	2.17	3.03E-04
				12	2.17	2.54E-04
			13	2	2.37	3.06E-04
				7	2.39	2.08E-04
				12	2.37	1.62E-04
		800	1	2	1.99	1.47E-03
				7	1.98	1.17E-03
				12	1.97	9.60E-04
			7	2	2.15	1.12E-03
				7	2.17	8.64E-04
				12	2.18	6.79E-04
			13	2	2.39	7.31E-04
				7	2.39	5.51E-04
				12	2.37	4.65E-04
		1400	1	2	1.97	2.57E-03
				7	1.98	2.05E-03
				12	1.98	1.60E-03
			7	2	2.16	1.86E-03
				7	2.17	1.40E-03
				12	2.17	1.12E-03
			13	2	2.38	1.20E-03
				7	2.37	9.66E-04
				12	2.38	7.59E-04
	3	200	1	2	1.97	5.13E-04
				7	1.98	3.66E-04
				12	1.98	3.01E-04
			7	2	2.16	4.89E-04
				7	2.17	3.15E-04
				12	2.15	2.67E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	3	200	13	2	2.39	3.49E-04
				7	2.32	2.85E-04
				12	2.37	1.84E-04
		800	1	2	1.98	1.62E-03
				7	1.98	1.24E-03
				12	1.97	9.46E-04
			7	2	2.14	1.28E-03
				7	2.15	9.69E-04
				12	2.16	7.82E-04
			13	2	2.37	8.43E-04
				7	2.37	6.64E-04
				12	2.38	4.98E-04
		1400	1	2	1.97	2.95E-03
				7	1.98	2.22E-03
				12	1.99	1.80E-03
			7	2	2.17	2.03E-03
				7	2.17	1.58E-03
				12	2.17	1.28E-03
			13	2	2.37	1.40E-03
				7	2.39	1.02E-03
				12	2.38	8.40E-04
	6	200	1	2	1.96	7.48E-04
				7	2.00	4.75E-04
				12	1.98	4.22E-04
			7	2	2.18	6.25E-04
				7	2.19	4.20E-04
				12	2.16	3.45E-04
			13	2	2.35	4.70E-04
				7	2.39	3.29E-04
				12	2.38	2.45E-04
		800	1	2	1.97	2.27E-03
				7	1.97	1.75E-03
				12	1.98	1.37E-03
			7	2	2.17	1.62E-03
				7	2.17	1.33E-03
				12	2.17	1.01E-03
			13	2	2.39	1.07E-03
				7	2.38	8.50E-04
				12	2.36	7.16E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	6	1400	1	2	1.98	3.88E-03
				7	1.99	2.84E-03
				12	1.99	2.39E-03
			7	2	2.17	2.76E-03
				7	2.17	2.05E-03
				12	2.17	1.72E-03
			13	2	2.37	1.79E-03
				7	2.38	1.36E-03
				12	2.38	1.12E-03

Appendix GG. Guardrail Rural Local

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	1.95	3.69E-04
				7	1.94	2.93E-04
				12	1.96	1.70E-04
			7	2	2.15	3.85E-04
				7	2.15	2.62E-04
				12	2.13	1.72E-04
			13	2	2.34	2.79E-04
				7	2.31	1.83E-04
				12	2.35	1.38E-04
		800	1	2	1.95	1.19E-03
				7	1.95	8.85E-04
				12	1.96	6.32E-04
			7	2	2.14	8.94E-04
				7	2.14	6.48E-04
				12	2.14	4.67E-04
			13	2	2.34	6.43E-04
				7	2.35	4.79E-04
				12	2.35	3.08E-04
		1400	1	2	1.95	2.01E-03
				7	1.97	1.39E-03
				12	1.95	1.03E-03
			7	2	2.14	1.47E-03
				7	2.15	1.03E-03
				12	2.15	7.28E-04
			13	2	2.36	9.48E-04
				7	2.35	7.05E-04
				12	2.36	5.05E-04
	4	200	1	2	1.95	4.90E-04
				7	1.96	3.39E-04
				12	1.96	2.46E-04
			7	2	2.12	4.64E-04
				7	2.13	3.27E-04
				12	2.13	2.31E-04
			13	2	2.32	3.75E-04
				7	2.33	2.28E-04
				12	2.34	1.53E-04
		800	1	2	1.95	1.49E-03
				7	1.96	9.84E-04
				12	1.96	7.46E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	4	800	7	2	2.15	1.13E-03
				7	2.15	7.75E-04
				12	2.13	5.78E-04
			13	2	2.36	7.45E-04
				7	2.35	5.48E-04
				12	2.36	4.03E-04
		1400	1	2	1.96	2.52E-03
				7	1.95	1.83E-03
				12	1.95	1.28E-03
			7	2	2.14	1.83E-03
				7	2.16	1.31E-03
				12	2.13	9.42E-04
			13	2	2.34	1.22E-03
				7	2.33	9.20E-04
				12	2.34	6.55E-04
	8	200	1	2	1.97	5.96E-04
				7	1.97	3.98E-04
				12	1.99	2.73E-04
			7	2	2.12	5.72E-04
				7	2.16	3.88E-04
				12	2.15	2.36E-04
			13	2	2.35	4.05E-04
				7	2.33	3.00E-04
				12	2.32	2.01E-04
		800	1	2	1.95	1.72E-03
				7	1.97	1.25E-03
				12	1.97	8.52E-04
			7	2	2.14	1.36E-03
				7	2.14	9.51E-04
				12	2.15	7.10E-04
			13	2	2.34	9.46E-04
				7	2.35	6.99E-04
				12	2.35	4.84E-04
		1400	1	2	1.95	2.99E-03
				7	1.96	2.07E-03
				12	1.97	1.44E-03
			7	2	2.14	2.20E-03
				7	2.13	1.62E-03
				12	2.13	1.12E-03

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	8	1400	13	2	2.35	1.49E-03
				7	2.35	1.07E-03
				12	2.35	7.38E-04
4	0	200	1	2	1.95	9.68E-04
				7	1.95	7.13E-04
				12	1.97	4.72E-04
			7	2	2.13	1.10E-03
				7	2.16	7.39E-04
				12	2.14	4.70E-04
			13	2	2.33	7.71E-04
				7	2.36	4.84E-04
				12	2.35	3.57E-04
		800	1	2	1.95	3.26E-03
				7	1.96	2.29E-03
				12	1.96	1.61E-03
			7	2	2.14	2.44E-03
				7	2.13	1.82E-03
				12	2.14	1.27E-03
			13	2	2.34	1.63E-03
				7	2.34	1.20E-03
				12	2.37	8.08E-04
		1400	1	2	1.97	5.31E-03
				7	1.96	3.83E-03
				12	1.96	2.76E-03
			7	2	2.14	3.80E-03
				7	2.15	2.75E-03
				12	2.14	2.00E-03
			13	2	2.35	2.67E-03
				7	2.36	1.86E-03
				12	2.34	1.32E-03
	4	200	1	2	1.95	1.35E-03
				7	1.95	8.57E-04
				12	1.95	5.97E-04
			7	2	2.15	1.28E-03
				7	2.16	8.67E-04
				12	2.13	6.00E-04
			13	2	2.34	9.47E-04
				7	2.34	6.73E-04
				12	2.34	4.42E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	4	800	1	2	1.95	3.75E-03
				7	1.97	2.86E-03
				12	1.97	1.98E-03
			7	2	2.16	2.91E-03
				7	2.14	2.22E-03
				12	2.14	1.50E-03
			13	2	2.35	2.10E-03
				7	2.35	1.49E-03
				12	2.33	1.05E-03
		1400	1	2	1.96	6.63E-03
				7	1.95	4.95E-03
				12	1.96	3.44E-03
			7	2	2.13	5.07E-03
				7	2.14	3.55E-03
				12	2.14	2.45E-03
			13	2	2.33	3.14E-03
				7	2.35	2.30E-03
				12	2.34	1.68E-03
	8	200	1	2	1.95	1.60E-03
				7	1.96	9.83E-04
				12	1.94	7.16E-04
			7	2	2.15	1.52E-03
				7	2.15	1.02E-03
				12	2.14	6.92E-04
			13	2	2.36	1.17E-03
				7	2.35	7.33E-04
				12	2.36	5.16E-04
		800	1	2	1.96	4.73E-03
				7	1.96	3.50E-03
				12	1.96	2.36E-03
			7	2	2.15	3.67E-03
				7	2.14	2.70E-03
				12	2.14	1.78E-03
			13	2	2.35	2.64E-03
				7	2.35	1.72E-03
				12	2.34	1.28E-03
		1400	1	2	1.96	8.18E-03
				7	1.97	5.67E-03
				12	1.96	3.96E-03

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	8	1400	7	2	2.15	5.69E-03
				7	2.13	4.27E-03
				12	2.14	2.97E-03
			13	2	2.34	4.06E-03
				7	2.35	2.73E-03
				12	2.35	1.98E-03
8	0	200	1	2	1.95	1.93E-03
				7	1.96	1.34E-03
				12	1.95	9.37E-04
			7	2	2.17	2.10E-03
				7	2.13	1.36E-03
				12	2.14	9.49E-04
			13	2	2.34	1.59E-03
				7	2.34	1.08E-03
				12	2.35	7.05E-04
		800	1	2	1.96	6.09E-03
				7	1.96	4.30E-03
				12	1.97	3.02E-03
			7	2	2.14	4.84E-03
				7	2.15	3.36E-03
				12	2.14	2.29E-03
			13	2	2.35	3.26E-03
				7	2.33	2.35E-03
				12	2.35	1.68E-03
		1400	1	2	1.96	9.94E-03
				7	1.97	7.30E-03
				12	1.96	5.32E-03
			7	2	2.15	7.49E-03
				7	2.14	5.49E-03
				12	2.14	3.90E-03
			13	2	2.34	5.26E-03
				7	2.34	3.85E-03
				12	2.34	2.63E-03
	4	200	1	2	1.97	2.65E-03
				7	1.96	1.76E-03
				12	1.93	1.24E-03
			7	2	2.15	2.55E-03
				7	2.13	1.81E-03
				12	2.16	1.14E-03

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	4	200	13	2	2.36	1.82E-03
				7	2.35	1.25E-03
				12	2.34	8.73E-04
		800	1	2	1.96	7.69E-03
				7	1.96	4.91E-03
				12	1.96	3.84E-03
			7	2	2.15	6.02E-03
				7	2.14	4.34E-03
				12	2.15	3.06E-03
			13	2	2.34	4.12E-03
				7	2.34	2.86E-03
				12	2.35	1.99E-03
		1400	1	2	1.96	1.29E-02
				7	1.94	9.87E-03
				12	1.96	6.28E-03
			7	2	2.14	9.75E-03
				7	2.14	6.83E-03
				12	2.15	4.80E-03
			13	2	2.35	6.49E-03
				7	2.35	4.51E-03
				12	2.35	3.27E-03
	8	200	1	2	1.95	3.10E-03
				7	1.95	2.04E-03
				12	1.96	1.47E-03
			7	2	2.16	2.91E-03
				7	2.14	2.12E-03
				12	2.13	1.43E-03
			13	2	2.36	2.31E-03
				7	2.31	1.63E-03
				12	2.33	1.15E-03
		800	1	2	1.97	9.29E-03
				7	1.94	6.66E-03
				12	1.96	4.72E-03
			7	2	2.15	7.30E-03
				7	2.14	5.11E-03
				12	2.14	3.64E-03
			13	2	2.34	4.85E-03
				7	2.33	3.47E-03
				12	2.35	2.41E-03

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	8	1400	1	2	1.96	1.57E-02
				7	1.97	1.08E-02
				12	1.96	8.07E-03
			7	2	2.14	1.15E-02
				7	2.15	8.03E-03
				12	2.14	5.83E-03
			13	2	2.35	7.60E-03
				7	2.35	5.55E-03
				12	2.34	3.78E-03

Appendix HH. Guardrail Undivided Urban Arterial

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	1.71	6.14E-05
				7	1.72	4.37E-05
				12	1.68	3.04E-05
			7	2	1.85	7.29E-05
				7	1.88	4.36E-05
				12	1.85	3.37E-05
			13	2	2.06	5.00E-05
				7	2.04	3.41E-05
				12	2.05	2.27E-05
		800	1	2	1.70	2.00E-04
				7	1.69	1.48E-04
				12	1.69	1.05E-04
			7	2	1.86	1.83E-04
				7	1.87	1.28E-04
				12	1.86	9.10E-05
			13	2	2.03	1.33E-04
				7	2.05	8.99E-05
				12	2.05	6.21E-05
		1400	1	2	1.70	3.35E-04
				7	1.70	2.40E-04
				12	1.71	1.72E-04
			7	2	1.86	2.86E-04
				7	1.86	2.05E-04
				12	1.86	1.54E-04
			13	2	2.04	2.09E-04
				7	2.05	1.49E-04
				12	2.04	1.06E-04
	3	200	1	2	1.70	7.33E-05
				7	1.70	5.09E-05
				12	1.72	3.01E-05
			7	2	1.86	7.63E-05
				7	1.88	5.19E-05
				12	1.88	3.41E-05
			13	2	2.05	5.64E-05
				7	2.04	3.98E-05
				12	2.03	2.87E-05
		800	1	2	1.70	2.33E-04
				7	1.70	1.63E-04
				12	1.71	1.12E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	800	7	2	1.85	2.08E-04
				7	1.86	1.42E-04
				12	1.86	9.76E-05
			13	2	2.04	1.49E-04
				7	2.03	1.07E-04
				12	2.05	7.00E-05
		1400	1	2	1.70	3.75E-04
				7	1.69	2.76E-04
				12	1.71	1.95E-04
			7	2	1.86	3.23E-04
				7	1.86	2.39E-04
				12	1.87	1.63E-04
			13	2	2.04	2.37E-04
				7	2.04	1.71E-04
				12	2.04	1.17E-04
	6	200	1	2	1.71	9.24E-05
				7	1.69	6.33E-05
				12	1.73	4.47E-05
			7	2	1.86	1.06E-04
				7	1.84	6.92E-05
				12	1.88	4.99E-05
			13	2	2.03	8.13E-05
				7	2.05	5.49E-05
				12	2.06	3.54E-05
		800	1	2	1.71	3.02E-04
				7	1.70	2.22E-04
				12	1.71	1.53E-04
			7	2	1.85	2.79E-04
				7	1.86	1.86E-04
				12	1.87	1.34E-04
			13	2	2.04	2.00E-04
				7	2.04	1.36E-04
				12	2.05	9.57E-05
		1400	1	2	1.71	5.02E-04
				7	1.71	3.61E-04
				12	1.72	2.62E-04
			7	2	1.86	4.38E-04
				7	1.86	3.15E-04
				12	1.87	2.19E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	1400	13	2	2.03	3.19E-04
0	6	1400	13	7	2.05	2.27E-04
0	6	1400	13	12	2.03	1.62E-04
4	0	200	1	2	1.72	1.58E-04
4	0	200	1	7	1.71	9.76E-05
4	0	200	1	12	1.70	7.07E-05
4	0	200	7	2	1.87	1.82E-04
4	0	200	7	7	1.87	1.16E-04
4	0	200	7	12	1.86	7.85E-05
4	0	200	13	2	2.06	1.29E-04
4	0	200	13	7	2.05	8.83E-05
4	0	200	13	12	2.03	6.00E-05
4	0	800	1	2	1.71	4.98E-04
4	0	800	1	7	1.70	3.49E-04
4	0	800	1	12	1.70	2.50E-04
4	0	800	7	2	1.86	4.33E-04
4	0	800	7	7	1.86	3.08E-04
4	0	800	7	12	1.86	2.15E-04
4	0	800	13	2	2.04	3.30E-04
4	0	800	13	7	2.04	2.26E-04
4	0	800	13	12	2.05	1.56E-04
4	0	1400	1	2	1.70	8.43E-04
4	0	1400	1	7	1.72	5.94E-04
4	0	1400	1	12	1.71	4.32E-04
4	0	1400	7	2	1.86	7.12E-04
4	0	1400	7	7	1.87	4.95E-04
4	0	1400	7	12	1.87	3.59E-04
4	0	1400	13	2	2.04	5.18E-04
4	0	1400	13	7	2.03	3.70E-04
4	0	1400	13	12	2.03	2.56E-04
4	3	200	1	2	1.70	1.73E-04
4	3	200	1	7	1.72	1.14E-04
4	3	200	1	12	1.73	8.05E-05
4	3	200	7	2	1.86	2.07E-04
4	3	200	7	7	1.87	1.26E-04
4	3	200	7	12	1.87	8.58E-05
4	3	200	13	2	2.07	1.35E-04
4	3	200	13	7	2.05	1.02E-04
4	3	200	13	12	2.04	6.53E-05

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	3	800	1	2	1.70	5.63E-04
				7	1.71	4.18E-04
				12	1.69	2.81E-04
			7	2	1.87	5.02E-04
				7	1.87	3.53E-04
				12	1.86	2.49E-04
			13	2	2.04	3.68E-04
				7	2.04	2.61E-04
				12	2.03	1.83E-04
		1400	1	2	1.70	9.25E-04
				7	1.70	6.82E-04
				12	1.70	4.90E-04
			7	2	1.86	8.30E-04
				7	1.86	5.63E-04
				12	1.86	4.09E-04
			13	2	2.05	5.65E-04
				7	2.03	4.11E-04
				12	2.04	2.88E-04
	6	200	1	2	1.70	2.32E-04
				7	1.71	1.67E-04
				12	1.70	1.07E-04
			7	2	1.86	2.66E-04
				7	1.85	1.79E-04
				12	1.87	1.16E-04
			13	2	2.04	1.98E-04
				7	2.05	1.32E-04
				12	2.06	8.49E-05
		800	1	2	1.71	7.48E-04
				7	1.69	5.45E-04
				12	1.67	3.74E-04
			7	2	1.86	6.91E-04
				7	1.87	4.56E-04
				12	1.86	3.22E-04
			13	2	2.05	4.68E-04
				7	2.04	3.39E-04
				12	2.04	2.37E-04
		1400	1	2	1.70	1.30E-03
				7	1.70	9.15E-04
				12	1.70	6.42E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	6	1400	7	2	1.86	1.08E-03
				7	1.87	7.57E-04
				12	1.86	5.48E-04
			13	2	2.04	7.89E-04
				7	2.03	5.64E-04
				12	2.04	3.81E-04
8	0	200	1	2	1.69	2.88E-04
				7	1.71	1.83E-04
				12	1.69	1.21E-04
			7	2	1.89	3.02E-04
				7	1.87	1.99E-04
				12	1.87	1.36E-04
			13	2	2.05	2.42E-04
				7	2.07	1.46E-04
				12	2.04	1.04E-04
		800	1	2	1.69	8.85E-04
				7	1.70	6.01E-04
				12	1.70	4.29E-04
			7	2	1.87	7.78E-04
				7	1.87	5.37E-04
				12	1.86	3.74E-04
			13	2	2.04	5.55E-04
				7	2.03	4.01E-04
				12	2.05	2.67E-04
		1400	1	2	1.70	1.47E-03
				7	1.70	1.05E-03
				12	1.70	7.42E-04
			7	2	1.86	1.25E-03
				7	1.86	8.86E-04
				12	1.86	6.32E-04
			13	2	2.04	9.01E-04
				7	2.03	6.52E-04
				12	2.05	4.39E-04
	3	200	1	2	1.71	3.13E-04
				7	1.72	2.00E-04
				12	1.70	1.38E-04
			7	2	1.86	3.56E-04
				7	1.88	2.21E-04
				12	1.85	1.59E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	3	200	13	2	2.06	2.59E-04
				7	2.01	1.83E-04
				12	2.07	1.04E-04
		800	1	2	1.70	9.67E-04
				7	1.69	7.07E-04
				12	1.71	4.76E-04
			7	2	1.85	9.17E-04
				7	1.85	6.14E-04
				12	1.86	4.25E-04
			13	2	2.03	6.81E-04
				7	2.04	4.58E-04
				12	2.04	3.04E-04
		1400	1	2	1.70	1.66E-03
				7	1.70	1.16E-03
				12	1.69	8.37E-04
			7	2	1.86	1.43E-03
				7	1.87	9.84E-04
				12	1.86	7.02E-04
			13	2	2.05	9.97E-04
				7	2.03	7.11E-04
				12	2.04	5.02E-04
	6	200	1	2	1.72	4.00E-04
				7	1.71	2.72E-04
				12	1.70	1.89E-04
			7	2	1.89	4.51E-04
				7	1.87	3.03E-04
				12	1.88	1.97E-04
			13	2	2.08	3.37E-04
				7	2.05	2.30E-04
				12	2.02	1.65E-04
		800	1	2	1.70	1.35E-03
				7	1.70	9.06E-04
				12	1.70	6.39E-04
			7	2	1.87	1.15E-03
				7	1.86	8.17E-04
				12	1.86	5.68E-04
			13	2	2.05	8.28E-04
				7	2.05	5.74E-04
				12	2.04	4.06E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	6	1400	1	2	1.71	2.19E-03
				7	1.70	1.58E-03
				12	1.70	1.13E-03
			7	2	1.86	1.88E-03
				7	1.87	1.33E-03
				12	1.87	9.16E-04
			13	2	2.04	1.35E-03
				7	2.04	9.83E-04
				12	2.05	6.44E-04

Appendix II. Guardrail Divided Urban Arterial

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	1.72	1.23E-04
				7	1.71	9.74E-05
				12	1.71	7.42E-05
			7	2	1.86	1.45E-04
				7	1.88	9.57E-05
				12	1.85	8.43E-05
			13	2	2.04	1.06E-04
				7	2.05	7.80E-05
				12	2.04	6.07E-05
		800	1	2	1.71	4.18E-04
				7	1.70	3.37E-04
				12	1.71	2.51E-04
			7	2	1.85	3.73E-04
				7	1.87	2.84E-04
				12	1.86	2.23E-04
			13	2	2.04	2.73E-04
				7	2.04	2.01E-04
				12	2.04	1.73E-04
		1400	1	2	1.71	7.09E-04
				7	1.70	5.55E-04
				12	1.70	4.39E-04
			7	2	1.86	6.12E-04
				7	1.87	4.63E-04
				12	1.87	3.72E-04
			13	2	2.04	4.29E-04
				7	2.05	3.44E-04
				12	2.03	2.85E-04
	3	200	1	2	1.70	1.52E-04
				7	1.69	9.94E-05
				12	1.70	8.04E-05
			7	2	1.87	1.57E-04
				7	1.86	1.17E-04
				12	1.86	8.79E-05
			13	2	2.07	1.07E-04
				7	2.04	8.86E-05
				12	2.04	6.96E-05
		800	1	2	1.70	4.71E-04
				7	1.70	3.81E-04
				12	1.69	3.13E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	3	800	7	2	1.87	4.21E-04
				7	1.86	3.23E-04
				12	1.87	2.57E-04
			13	2	2.05	2.94E-04
				7	2.04	2.39E-04
				12	2.05	1.88E-04
		1400	1	2	1.70	7.96E-04
				7	1.70	6.25E-04
				12	1.69	4.94E-04
			7	2	1.87	6.72E-04
				7	1.85	5.29E-04
				12	1.86	4.37E-04
			13	2	2.04	4.84E-04
				7	2.04	3.77E-04
				12	2.04	3.00E-04
	6	200	1	2	1.71	1.96E-04
				7	1.71	1.36E-04
				12	1.71	1.13E-04
			7	2	1.85	2.20E-04
				7	1.89	1.48E-04
				12	1.88	1.11E-04
			13	2	2.07	1.57E-04
				7	2.05	1.13E-04
				12	2.04	8.98E-05
		800	1	2	1.71	6.16E-04
				7	1.69	4.98E-04
				12	1.70	3.79E-04
			7	2	1.87	5.61E-04
				7	1.86	4.17E-04
				12	1.86	3.43E-04
			13	2	2.04	3.94E-04
				7	2.03	3.17E-04
				12	2.04	2.51E-04
		1400	1	2	1.70	1.04E-03
				7	1.71	8.19E-04
				12	1.71	6.95E-04
			7	2	1.87	9.08E-04
				7	1.87	6.96E-04
				12	1.86	5.78E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	1400	13	2	2.03	6.42E-04
				7	2.04	5.02E-04
				12	2.04	4.19E-04
4	0	200	1	2	1.71	3.01E-04
				7	1.69	2.19E-04
				12	1.72	1.79E-04
			7	2	1.86	3.37E-04
				7	1.88	2.33E-04
				12	1.86	1.88E-04
			13	2	2.04	2.57E-04
				7	2.02	1.91E-04
				12	2.03	1.36E-04
		800	1	2	1.70	9.82E-04
				7	1.71	7.55E-04
				12	1.70	6.15E-04
			7	2	1.88	8.43E-04
				7	1.87	6.56E-04
				12	1.86	5.51E-04
			13	2	2.04	6.25E-04
				7	2.03	4.89E-04
				12	2.05	3.82E-04
		1400	1	2	1.70	1.69E-03
				7	1.69	1.28E-03
				12	1.70	1.06E-03
			7	2	1.86	1.43E-03
				7	1.87	1.11E-03
				12	1.86	8.94E-04
			13	2	2.04	1.02E-03
				7	2.03	7.86E-04
				12	2.04	6.31E-04
	3	200	1	2	1.71	3.56E-04
				7	1.72	2.58E-04
				12	1.69	1.94E-04
			7	2	1.87	3.89E-04
				7	1.85	2.75E-04
				12	1.85	2.19E-04
			13	2	2.06	2.68E-04
				7	2.04	2.01E-04
				12	2.03	1.61E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	3	800	1	2	1.70	1.13E-03
				7	1.70	8.60E-04
				12	1.71	6.99E-04
			7	2	1.87	9.95E-04
				7	1.88	7.47E-04
				12	1.86	6.01E-04
			13	2	2.04	7.07E-04
				7	2.05	5.37E-04
				12	2.04	4.31E-04
		1400	1	2	1.70	1.84E-03
				7	1.70	1.47E-03
				12	1.70	1.11E-03
			7	2	1.86	1.60E-03
				7	1.86	1.24E-03
				12	1.86	1.00E-03
			13	2	2.05	1.08E-03
				7	2.05	8.68E-04
				12	2.04	7.23E-04
	6	200	1	2	1.70	4.48E-04
				7	1.69	3.32E-04
				12	1.71	2.72E-04
			7	2	1.87	4.60E-04
				7	1.86	3.66E-04
				12	1.87	2.77E-04
			13	2	2.05	3.76E-04
				7	2.07	2.51E-04
				12	2.02	2.14E-04
		800	1	2	1.69	1.51E-03
				7	1.70	1.14E-03
				12	1.70	9.29E-04
			7	2	1.86	1.31E-03
				7	1.86	1.02E-03
				12	1.87	8.15E-04
			13	2	2.04	1.01E-03
				7	2.04	7.34E-04
				12	2.04	5.78E-04
		1400	1	2	1.70	2.53E-03
				7	1.70	1.98E-03
				12	1.70	1.56E-03

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
4	6	1400	7	2	1.86	2.13E-03
				7	1.86	1.64E-03
				12	1.86	1.30E-03
			13	2	2.04	1.51E-03
				7	2.04	1.18E-03
				12	2.05	9.21E-04
8	0	200	1	2	1.71	5.09E-04
				7	1.69	3.39E-04
				12	1.70	2.63E-04
			7	2	1.87	5.50E-04
				7	1.87	3.80E-04
				12	1.87	2.90E-04
			13	2	2.07	3.77E-04
				7	2.05	2.76E-04
				12	2.02	2.23E-04
		800	1	2	1.69	1.60E-03
				7	1.71	1.23E-03
				12	1.70	1.01E-03
			7	2	1.87	1.41E-03
				7	1.86	1.12E-03
				12	1.86	9.02E-04
			13	2	2.03	1.03E-03
				7	2.05	7.49E-04
				12	2.05	6.30E-04
		1400	1	2	1.70	2.77E-03
				7	1.71	2.13E-03
				12	1.71	1.76E-03
			7	2	1.86	2.32E-03
				7	1.87	1.77E-03
				12	1.86	1.47E-03
			13	2	2.04	1.68E-03
				7	2.05	1.23E-03
				12	2.04	1.00E-03
	3	200	1	2	1.69	5.83E-04
				7	1.70	4.08E-04
				12	1.71	3.06E-04
			7	2	1.85	6.22E-04
				7	1.87	4.57E-04
				12	1.86	3.33E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	3	200	13	2	2.02	5.01E-04
				7	2.06	3.31E-04
				12	2.04	2.54E-04
		800	1	2	1.71	1.78E-03
				7	1.71	1.41E-03
				12	1.71	1.11E-03
			7	2	1.87	1.59E-03
				7	1.86	1.23E-03
				12	1.85	9.81E-04
			13	2	2.04	1.19E-03
				7	2.03	9.19E-04
				12	2.03	7.26E-04
		1400	1	2	1.69	3.10E-03
				7	1.70	2.42E-03
				12	1.70	1.97E-03
			7	2	1.86	2.59E-03
				7	1.87	1.96E-03
				12	1.87	1.61E-03
			13	2	2.05	1.80E-03
				7	2.05	1.38E-03
				12	2.03	1.15E-03
	6	200	1	2	1.69	7.39E-04
				7	1.70	5.49E-04
				12	1.73	3.80E-04
			7	2	1.88	8.54E-04
				7	1.86	6.03E-04
				12	1.87	4.30E-04
			13	2	2.09	5.76E-04
				7	2.06	4.27E-04
				12	2.04	3.40E-04
		800	1	2	1.71	2.38E-03
				7	1.69	1.92E-03
				12	1.70	1.47E-03
			7	2	1.86	2.16E-03
				7	1.86	1.63E-03
				12	1.86	1.33E-03
			13	2	2.04	1.55E-03
				7	2.06	1.12E-03
				12	2.05	9.43E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
8	6	1400	1	2	1.71	4.15E-03
				7	1.70	3.20E-03
				12	1.70	2.59E-03
			7	2	1.86	3.61E-03
				7	1.86	2.69E-03
				12	1.86	2.16E-03
			13	2	2.04	2.58E-03
				7	2.04	1.94E-03
				12	2.04	1.52E-03

Appendix JJ. Guardrail Urban Local

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	0	200	1	2	2.11	3.56E-04
				7	2.09	2.88E-04
				12	2.06	2.05E-04
			7	2	2.30	3.71E-04
				7	2.29	2.46E-04
				12	2.29	1.78E-04
			13	2	2.54	2.51E-04
				7	2.53	1.78E-04
				12	2.52	1.22E-04
		800	1	2	2.11	1.24E-03
				7	2.11	8.23E-04
				12	2.08	6.06E-04
			7	2	2.28	9.06E-04
				7	2.29	6.61E-04
				12	2.30	4.42E-04
			13	2	2.53	5.97E-04
				7	2.51	4.34E-04
				12	2.52	3.12E-04
		1400	1	2	2.09	2.06E-03
				7	2.09	1.47E-03
				12	2.09	1.03E-03
			7	2	2.28	1.50E-03
				7	2.28	1.08E-03
				12	2.29	7.35E-04
			13	2	2.50	9.67E-04
				7	2.51	7.05E-04
				12	2.51	4.99E-04
	6	200	1	2	2.07	6.63E-04
				7	2.09	3.67E-04
				12	2.09	2.95E-04
			7	2	2.29	5.52E-04
				7	2.31	3.58E-04
				12	2.29	2.63E-04
			13	2	2.52	3.40E-04
				7	2.52	2.49E-04
				12	2.51	2.02E-04
		800	1	2	2.09	1.88E-03
				7	2.10	1.31E-03
				12	2.08	9.73E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	6	800	7	2	2.30	1.29E-03
				7	2.28	9.41E-04
				12	2.29	6.60E-04
			13	2	2.50	9.41E-04
				7	2.51	6.52E-04
				12	2.50	4.92E-04
		1400	1	2	2.09	3.13E-03
				7	2.09	2.37E-03
				12	2.11	1.53E-03
			7	2	2.29	2.15E-03
				7	2.29	1.60E-03
				12	2.29	1.11E-03
			13	2	2.53	1.44E-03
				7	2.51	1.03E-03
				12	2.52	7.37E-04
	12	200	1	2	2.13	5.16E-04
				7	2.07	3.99E-04
				12	2.12	2.92E-04
			7	2	2.34	5.90E-04
				7	2.32	3.46E-04
				12	2.29	2.83E-04
			13	2	2.58	3.55E-04
				7	2.54	2.48E-04
				12	2.53	1.89E-04
		800	1	2	2.09	1.85E-03
				7	2.08	1.40E-03
				12	2.09	9.54E-04
			7	2	2.31	1.34E-03
				7	2.28	9.67E-04
				12	2.27	7.26E-04
			13	2	2.51	8.93E-04
				7	2.51	6.68E-04
				12	2.52	4.43E-04
		1400	1	2	2.10	3.03E-03
				7	2.10	2.24E-03
				12	2.10	1.64E-03
			7	2	2.29	2.25E-03
				7	2.29	1.59E-03
				12	2.30	1.11E-03

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
0	12	1400	13	2	2.48	1.42E-03
				7	2.52	1.08E-03
				12	2.52	7.30E-04
3	0	200	1	2	2.09	5.28E-04
				7	2.13	2.42E-04
				12	2.08	2.55E-04
			7	2	2.29	4.60E-04
				7	2.30	2.92E-04
				12	2.30	1.91E-04
			13	2	2.53	3.15E-04
				7	2.51	2.24E-04
				12	2.55	1.29E-04
		800	1	2	2.10	1.34E-03
				7	2.10	9.25E-04
				12	2.08	7.17E-04
			7	2	2.30	1.06E-03
				7	2.30	7.45E-04
				12	2.30	5.18E-04
			13	2	2.52	7.12E-04
				7	2.52	5.05E-04
				12	2.50	3.74E-04
		1400	1	2	2.09	2.38E-03
				7	2.09	1.57E-03
				12	2.08	1.23E-03
			7	2	2.30	1.61E-03
				7	2.29	1.24E-03
				12	2.30	8.66E-04
			13	2	2.52	1.16E-03
				7	2.52	7.90E-04
				12	2.51	5.65E-04
	6	200	1	2	2.11	6.33E-04
				7	2.07	4.68E-04
				12	2.10	3.15E-04
			7	2	2.28	6.98E-04
				7	2.29	4.13E-04
				12	2.32	2.76E-04
			13	2	2.53	4.87E-04
				7	2.50	3.36E-04
				12	2.53	2.13E-04

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	6	800	1	2	2.10	1.97E-03
				7	2.10	1.46E-03
				12	2.08	1.06E-03
			7	2	2.30	1.53E-03
				7	2.30	1.17E-03
				12	2.28	7.84E-04
			13	2	2.53	1.07E-03
				7	2.51	7.60E-04
				12	2.52	5.12E-04
		1400	1	2	2.10	3.42E-03
				7	2.10	2.39E-03
				12	2.10	1.87E-03
			7	2	2.29	2.63E-03
				7	2.29	1.87E-03
				12	2.29	1.26E-03
			13	2	2.51	1.66E-03
				7	2.51	1.25E-03
				12	2.51	8.92E-04
	12	200	1	2	2.12	6.38E-04
				7	2.10	4.63E-04
				12	2.10	3.07E-04
			7	2	2.25	6.79E-04
				7	2.31	4.42E-04
				12	2.32	2.83E-04
			13	2	2.51	4.81E-04
				7	2.51	3.24E-04
				12	2.51	2.39E-04
		800	1	2	2.10	2.09E-03
				7	2.09	1.42E-03
				12	2.09	1.05E-03
			7	2	2.27	1.69E-03
				7	2.30	1.11E-03
				12	2.29	7.90E-04
			13	2	2.51	1.08E-03
				7	2.51	7.74E-04
				12	2.53	5.22E-04
		1400	1	2	2.09	3.54E-03
				7	2.08	2.50E-03
				12	2.10	1.79E-03

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
3	12	1400	7	2	2.29	2.58E-03
				7	2.29	1.81E-03
				12	2.28	1.28E-03
			13	2	2.52	1.66E-03
				7	2.52	1.21E-03
				12	2.52	8.51E-04
6	0	200	1	2	2.13	1.48E-03
				7	2.11	1.12E-03
				12	2.12	7.59E-04
			7	2	2.28	1.70E-03
				7	2.30	1.19E-03
				12	2.30	7.25E-04
			13	2	2.50	1.01E-03
				7	2.49	9.50E-04
				12	2.55	4.68E-04
		800	1	2	2.08	5.49E-03
				7	2.10	3.61E-03
				12	2.07	2.78E-03
			7	2	2.29	3.82E-03
				7	2.29	2.85E-03
				12	2.30	1.94E-03
			13	2	2.53	2.56E-03
				7	2.50	1.84E-03
				12	2.51	1.30E-03
		1400	1	2	2.09	8.77E-03
				7	2.09	6.49E-03
				12	2.10	4.32E-03
			7	2	2.29	6.18E-03
				7	2.30	4.43E-03
				12	2.28	3.05E-03
			13	2	2.51	4.11E-03
				7	2.52	2.88E-03
				12	2.52	2.01E-03
	6	200	1	2	2.07	2.80E-03
				7	2.14	1.65E-03
				12	2.11	1.06E-03
			7	2	2.32	2.47E-03
				7	2.27	1.75E-03
				12	2.31	1.11E-03

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	6	200	13	2	2.58	1.46E-03
				7	2.57	1.17E-03
				12	2.50	8.75E-04
		800	1	2	2.08	8.03E-03
				7	2.08	5.48E-03
				12	2.09	3.79E-03
			7	2	2.28	5.90E-03
				7	2.28	4.27E-03
				12	2.30	2.92E-03
			13	2	2.51	4.26E-03
				7	2.51	2.91E-03
				12	2.50	2.04E-03
		1400	1	2	2.09	1.33E-02
				7	2.07	9.78E-03
				12	2.09	6.93E-03
			7	2	2.29	9.31E-03
				7	2.29	6.64E-03
				12	2.30	4.61E-03
			13	2	2.51	6.10E-03
				7	2.51	4.21E-03
				12	2.50	3.03E-03
	12	200	1	2	2.10	2.46E-03
				7	2.10	1.63E-03
				12	2.09	1.26E-03
			7	2	2.31	2.43E-03
				7	2.29	1.63E-03
				12	2.28	1.13E-03
			13	2	2.54	1.61E-03
				7	2.50	1.28E-03
				12	2.51	7.62E-04
		800	1	2	2.09	7.87E-03
				7	2.09	5.55E-03
				12	2.08	4.15E-03
			7	2	2.29	5.75E-03
				7	2.30	4.64E-03
				12	2.29	3.08E-03
			13	2	2.51	4.06E-03
				7	2.52	2.84E-03
				12	2.52	1.99E-03

Degree of Curvature	Grade (%)	Length of Feature (ft)	Height of Feature (ft)	Offset (ft)	SI	b
6	12	1400	1	2	2.09	1.34E-02
				7	2.10	8.76E-03
				12	2.09	6.64E-03
			7	2	2.28	9.41E-03
				7	2.28	6.80E-03
				12	2.29	4.65E-03
			13	2	2.52	5.88E-03
				7	2.53	4.64E-03
				12	2.50	3.05E-03

END OF DOCUMENT