Chapter 3
Roadway Geometrics

3-1 Sight Distance

The "AASHTO Green Book" contains a discussion of the factors and assumptions associated with the calculation of stopping, passing, and intersection sight distance. Stopping sight distance is a vital consideration for both urban and rural situations. Passing sight distance will likely be pertinent only in rural arterial situations. Intersection sight distance must be considered in light of the terrain in which the facility is located and in urban situations to what extent parking is permitted. Stopping Sight Distance (SSD) shall be available throughout all horizontal and vertical curves.

Minimum Stopping Sight Distance shall be designed for wet pavement; the effects of grade shall also be accounted for grades steeper than 3 percent as follows:

Stopping Sight Distance (SSD)
(feet)

		Downhill Grade				
Design Speed	**Minimum SSD**	**3%**	**6%**	**9%**	**12%**	**15%**
20 mph	**115**	**116**	**120**	**126**	**132**	**141**
25 mph	**155**	**158**	**165**	**173**	**183**	**197**
30 mph	**200**	**205**	**215**	**227**	**242**	**262**
35 mph	**250**	**257**	**271**	**287**	**308**	**335**
40 mph	**305**	**315**	**333**	**354**	**381**	**417**
45 mph	**360**	**378**	**400**	**427**	**462**	**507**

For the purpose of assessing Stopping Sight Distance, Pierce County has maintained an object height of 0.5 feet and a driver's eye height of 3.5 feet.

Stopping sight distance shall be achieved without the need for additional easements or right-of-way, unless otherwise approved by the County Engineer.

Entering Sight Distance (ESD) for a residential driveway approach to a local road within a subdivision is not required if the road has been designed and constructed to meet stopping sight distance requirements.

Entering Sight Distance (ESD)

Posted/Legal Speed (mph)	25	30	35	40	45
ESD (feet)	295	355	415	470	530

Entering Sight Distance values are based on an object height of 3.5 feet and a driver's eye height of 3.5 feet set back from the edge of the travel way at least 10 feet for residential and minor driveway approaches, and 14.5 feet for major driveway and road approaches. (See Details in Appendix "C"). Special consideration shall be given when stop bars are used, ESD shall be measured 8 feet back from such stop bars. Further, ESD must be calculated for situations that involve road approach grades in excess of 6 percent to account for the reduction in vehicle acceleration and deceleration.

In situations where the entering sight distance is questionable, the County Engineer may require the Engineer to prepare an entering sight distance diagram, together with appropriate field measurements, and submit them for review prior to the approval of the construction plans. The diagram and measurements shall be stamped and signed by the Engineer.

Locations along a through road from which vehicles are permitted to turn left across opposing traffic, including intersections and driveway approaches, should have sufficient sight distance to accommodate the left-turn maneuver. Exiting Sight Distance along the through road shall be as follows, based on a left turn by a stopped vehicle:

Exiting Sight Distance (ExSD)
Left Turns from the Through Road

Posted/Legal Speed (mph)	25	30	35	40	45
ExSD (feet)	205	245	285	325	365
For each additional opposing through lane (feet)[1]	+19	+22	+26	+30	+33

[1] Adjustment for multi-lane roads: For left-turning vehicles that cross more than one opposing lane, add distance shown for each additional lane to be crossed.

Passing Sight Distance shall be provided where determined by the County Engineer.

3-2 Horizontal

The road construction centerline must match as much as possible the right-of-way centerline, unless otherwise approved by the County Engineer. When widening existing roads, the Engineer is strongly encouraged to provide the additional widening symmetrical about the existing centerline alignment. Road curves should be designed with as large a radius curve as practical, with a minimum radius controlled by the appropriate design speed. Road alignment within plat boundaries should closely fit the existing topography to minimize cuts and fills.

On most roads, especially those classified as local roads where design speeds are in the 20 to 25 mph range, short radius curves may be tolerated and superelevation may not be necessary. On roads where design speeds may be over 35 mph, horizontal alignment becomes a most important consideration. Each individual road, however, is unique and must be carefully evaluated to ensure appropriate alignment. The computations involving curve radius and superelevation are important elements in the design process and are well detailed in the "AASHTO Green Book".

The design for horizontal curvature shall be determined using the following formula:

$$R_{min} = V^2/[15\ (e+f)]$$

Where: R_{min} = minimum radius
V = Design speed
e = Superelevation
f = Maximum side friction factor

The design shall conform to the use of the following maximum side friction factor values:

Design Speed (mph)	Rural "f"	Urban "f"
20	0.170	0.270
25	0.165	0.230
30	0.160	0.200
35	0.155	0.180
40	0.150	0.160
45	0.145	0.150

The normal roadway crown slope for new construction is 2 percent unless the road is in superelevation or an intersection design requires a varying slope. When widening of an existing road is being done, a maximum of 4 percent cross slope will be permitted. Grinding and/or overlaying as applicable will be required if the cross slope will exceed this amount. The maximum superelevation rates "e" are as follows:

Road Class	Max "e" (feet/foot)
Major	**0.04**
Secondary	**0.04**
Collector	**0.04**
Feeder	**0.02**
Minor	**0.02**
Cul-de-Sac and Small Lot Roads	**No Super Allowed**

Superelevation is not recommended for use on non-arterials. When superelevation is used, the required superelevation runoff length shall be provided in accordance with the "AASHTO Green Book", and distributed in accordance with Design "A", Superelevation Transitions for Highway Curves, contained in the WSDOT *Design Manual*.

The use of reverse curves and compound curves is strongly discouraged. The Engineer shall provide adequate tangent lengths between reverse curves when superelevation is used.

Curve widening shall be considered and designed, when warranted, in accordance with the "AASHTO Green Book".

3-3 Vertical

In an urban curbed, low-volume street situation, the minimum acceptable grade to assure proper drainage is an important consideration. Tolerable maximum grades will vary with road use. A steeper grade may be acceptable on an urban residential street than on a rural road serving heavy trucks. Intersections on steep grades should be avoided whenever possible, especially in areas with recurring snow and ice problems. In urban areas, ease of access for emergency vehicles is also to be considered when establishing grades. For rural projects, the "AASHTO Green Book" includes tables of maximum grades related to design speed and terrain. The design of crest and sag vertical curves is related to design speed and is important in rural projects with higher design speeds. The "AASHTO Green Book" is the best source for this process and for the integration of vertical and horizontal curvature.

3-3.1 Grade

The maximum gradient on any new or reconstructed road shall not exceed the following:

Arterials:	
Major	**8%**
Secondary	**8%**
Collector	**10%**

Local Road	
Feeder	**10%**
Minor	**12%**
Cul-de-Sac Stem	**15%**
Cul-de-Sac Turnaround	**6%**
Small Lot Design	**12%**

The centerline and gutterline gradient of any road shall not be less than 0.7 percent when an asphalt concrete gutterline is used, and not less than 0.4 percent when a cement concrete gutterline is used. The centerline gradient of any road shall not be less than 0.7 percent when drainage is not contained.

All changes in grade greater than 1 percent shall be connected by a vertical curve.

3-4 Curves

Vertical Sag Curve design shall be based on an assumed non-illuminated roadway's visibility which should be long enough so that the automobile light beam distance is nearly the same as the stopping sight distance. Vertical Crest Curve design shall be based on stopping sight distance for wet pavement. All vertical curves shall be symmetrical parabolic curves. Design speeds for vertical curves located within the area controlled by a STOP sign or on the perpendicular street approaching a "T" intersection can be reduced in accordance with the anticipated speed of the vehicle approaching the STOP control or the Yield condition of the "T" intersection.

3-5 Roadway Widening and Overlay

For roadway widening, the improvement shall be constructed to full width to the end of the required channelization of taper transitions. Additional storm drainage improvements may be required as a result of required roadway widening in order that the additional storm runoff generated by the widening will be satisfactorily controlled per County storm drainage requirements.

When the widening provided is symmetrical around the centerline of the existing roadway, then a full width overlay shall be provided. When the widening provided is on only one side of the existing roadway, then an overlay of that half of the road that has been widened shall be provided. In this case, the existing pavement shall be ground down near the old centerline where the overlay would match the untouched half of the traveled way to provide a good match without the need to feather the overlay depth. Where widening is provided for a right-turn lane and there is no relocation of the existing, adjacent through lane, no overlay should normally be required.

When a roadway is widened (such as for a turn lane construction), additional standard roadway elements (such as curbs, gutters, and sidewalks within an urban area) shall be included in the improvement unless otherwise approved by the County Engineer. In any event, existing roadway elements (i.e., paved shoulders, sidewalks, drainage, etc.) shall be replaced in kind or better.