4-4 Ramp Analysis Methodology
This report documents the methodology of the ramp analyses performed as part of the US-35 Corridor Study. The analysis includes the US-35 ramps throughout the corridor, from the I-75 interchange east to the I-675 interchange.

In terms of capacity analysis, ramps differ from the mainline in that:

- Ramps are roadways of limited length and width (often just one lane);
- Free-flow speed is frequently lower than that of the roadways connected, particularly the freeway mainline;
- On single-lane ramps, where passing is not possible, the adverse impact of trucks and other slow-moving vehicles is more pronounced than on multilane roadways; and
- At ramp-street junctions, queuing may develop on the ramp, particularly if the ramp-street junction is signalized.

Figure 4-26 below lists approximate criteria for the capacity of ramp roadways.

Figure 4-26 Approximate Capacity of Ramp Roadways

Free-Flow Speed of Ramp	Capacity (veh/hour)	
	Single-Lane Ramps	Two-Lane Ramps
> 50	2,200	4,400
> 40 - 50	2,100	4,100
> 30 - 40	2,000	3,800
> 20 - 30	1,900	3,500
< 20	1,800	3,200

The study analyzes the US-35 ramps in five stages:

- Year 1995 scenario (existing traffic volumes and roadway geometry)
- No Build Scenario with Design Year (2030) traffic (with no improvements to the existing roadway geometry)
- Design Year (2030) traffic with three lane continuity along the US-35 Corridor
- Design Year (2030) traffic with four lane continuity along the US-35 Corridor

In order to identify any needed improvements, the procedures and methodologies outlined in the Transportation Research Board's (TRB) Special Report 209, the Highway Capacity Manual, 2000 (HCM) were used. Levels of Service for the ramp merges and diverges were calculated using the computerized version of the Transportation Research Board's Special Report 209, the Highway Capacity Manual, 2000 (HCS).

4-4a HCS Ramps Analysis Methodology
The HCS ramp and ramp junction analysis procedures calculate a density of vehicles per mile per lane (pc/mi/ln) and then assign a Level of Service based upon the calculated density. The density of vehicles per mile calculation on each segment can be assigned a "grade" or Level of Service (LOS) ranging from LOS A, the best, to LOS F, the worst or failure. Most roadway improvement projects are designed to provide a minimum LOS C for the peak hour of operation. In highly congested urban areas, a LOS D can be used as the minimum acceptable LOS.

The density of vehicles on the highway is the primary determinant of the Level of Service. The Level of Service for merge and diverge areas is not dependant on the Free Flow Speed of the highway or ramp. The Level of Service criteria as defined by TRB for merge and diverge areas are shown in Figure 4-27 below:

Figure 4-27 Level of Service Criteria for Merge and Diverge Areas

Level of Service (LOS)	**Maximum Density (pc/mi/ln)**
A	Less than or equal to 10
B	> 10 – 20
C	>20 – 28
D	> 28 – 35
E	> 35
F	Demand exceeds capacity

As summarized above, each Level of Service is defined by a range of densities. A density of more than 35 vehicles per mile per lane results in "failure" of the ramp. In the field, ramp failure is indicated by stop and go vehicular flow, and often results in long vehicular queues that may block adjacent intersections. Ramp failure will often interfere with vehicular flow on the highway mainline, and can also interfere with progression of traffic on the adjacent roadway arterial connecting to the mainline. The Level of Service calculation for each ramp is dependant on the following factors:

- The number of lanes on the highway mainline
- The number of lanes on the ramp
- The volume of traffic on the mainline
- The volume of traffic on the ramp
- The length of the merge/diverge area
- The side of the mainline that the ramp connects to (right or left)
- The free-flow speed of the mainline and ramp
- The terrain (level, rolling, or mountainous)

The ramp calculations for the existing and No Build condition were based upon ground conditions along the US-35 corridor, and existing traffic counts. For the future proposed conditions (Alternative One, Three-Lane Continuity, and Four-Lane Continuity), the ramp calculations were based upon the proposed ramp and mainline geometries, and projected traffic volumes based upon the MVRPC travel demand model. The results of the ramp calculations are summarized in Figure 4-28 through 4-31 below.