

## Example File Segment Calculations

### Notation

$$\text{Spd}_1 := \frac{\sum_{j=1}^n \text{Len}_{1,j}}{\sum_{j=1}^n \frac{\text{Len}_{1,j}}{\text{Spd}_{1,j}}}$$

$$\text{Den}_1 := \frac{\sum_{j=1}^n (\text{Den}_{1,j} \cdot \text{Lns}_{1,j} \cdot \text{Len}_{1,j})}{\sum_{j=1}^n (\text{Lns}_{1,j} \cdot \text{Len}_{1,j})}$$

$\text{Spd}_i$  = Average speed in entire segment  $i$

$\text{Spd}_{i,j}$  = Average speed in subsegment  $j$  of segment  $i$

$\text{Len}_{i,j}$  = Length of subsegment  $j$  of segment  $i$

$\text{Lns}_{i,j}$  = Number of lanes in subsegment  $j$  of segment  $i$

$\text{Den}_i$  = Average density in entire segment  $i$

$\text{Den}_{i,j}$  = Average density in subsegment  $j$  of segment  $i$

$\text{NVeh}_{i,j}$  = Total number of vehicles in subsegment  $j$  of segment  $i$  (i.e., Density \* NumberLanes \* Length)

$\text{Time}_{i,j}$  = Average travel time to cover subsegment  $j$  of segment  $i$  (i.e., Length / Speed)

$i$  is the segment index,  $j$  is the subsegment index and  $n$  is the number of subsegments

### 1. Basic Segment

$$\text{Spd}_{1,1} := 65.0$$

$$\text{Spd}_1 := \text{Spd}_{1,1} = 65.000$$

$$\text{Den}_{1,1} := 16.8$$

$$\text{Den}_1 := \text{Den}_{1,1} = 16.800$$

### 2. Full Cloverleaf Segment

$\text{Spd}_{2,1} := 59.9$	$\text{Den}_{2,1} := 17.8636$	$\text{Len}_{2,1} := 1500$	$\text{Lns}_{2,1} := 3$	$\text{Time}_{2,1} := \frac{\text{Len}_{2,1}}{\text{Spd}_{2,1}}$	$\text{NVeh}_{2,1} := \text{Den}_{2,1} \cdot \text{Len}_{2,1} \cdot \text{Lns}_{2,1}$
$\text{Spd}_{2,2} := 65.0$	$\text{Den}_{2,2} := 15.16275$	$\text{Len}_{2,2} := 500$	$\text{Lns}_{2,2} := 3$	$\text{Time}_{2,2} := \frac{\text{Len}_{2,2}}{\text{Spd}_{2,2}}$	$\text{NVeh}_{2,2} := \text{Den}_{2,2} \cdot \text{Len}_{2,2} \cdot \text{Lns}_{2,2}$
$\text{Spd}_{2,3} := 53.1$	$\text{Den}_{2,3} := 17.4$	$\text{Len}_{2,3} := 3000$	$\text{Lns}_{2,3} := 4$	$\text{Time}_{2,3} := \frac{\text{Len}_{2,3}}{\text{Spd}_{2,3}}$	$\text{NVeh}_{2,3} := \text{Den}_{2,3} \cdot \text{Len}_{2,3} \cdot \text{Lns}_{2,3}$
$\text{Spd}_{2,4} := 65.0$	$\text{Den}_{2,4} := 16.4985$	$\text{Len}_{2,4} := 500$	$\text{Lns}_{2,4} := 3$	$\text{Time}_{2,4} := \frac{\text{Len}_{2,4}}{\text{Spd}_{2,4}}$	$\text{NVeh}_{2,4} := \text{Den}_{2,4} \cdot \text{Len}_{2,4} \cdot \text{Lns}_{2,4}$
$\text{Spd}_{2,5} := 59.7$	$\text{Den}_{2,5} := 18.8044$	$\text{Len}_{2,5} := 1500$	$\text{Lns}_{2,5} := 3$	$\text{Time}_{2,5} := \frac{\text{Len}_{2,5}}{\text{Spd}_{2,5}}$	$\text{NVeh}_{2,5} := \text{Den}_{2,5} \cdot \text{Len}_{2,5} \cdot \text{Lns}_{2,5}$

$$\text{Speed}_2 := \frac{\text{Len}_{2,1} + \text{Len}_{2,2} + \text{Len}_{2,3} + \text{Len}_{2,4} + \text{Len}_{2,5}}{\text{Time}_{2,1} + \text{Time}_{2,2} + \text{Time}_{2,3} + \text{Time}_{2,4} + \text{Time}_{2,5}}$$

$$\text{Speed}_2 = 57.354$$

$$\text{Density}_2 := \frac{\text{NVeh}_{2,1} + \text{NVeh}_{2,2} + \text{NVeh}_{2,3} + \text{NVeh}_{2,4} + \text{NVeh}_{2,5}}{\text{Lns}_{2,1} \cdot \text{Len}_{2,1} + \text{Lns}_{2,2} \cdot \text{Len}_{2,2} + \text{Lns}_{2,3} \cdot \text{Len}_{2,3} + \text{Lns}_{2,4} \cdot \text{Len}_{2,4} + \text{Lns}_{2,5} \cdot \text{Len}_{2,5}}$$

$$\text{Density}_2 = 17.554$$

### 3. Basic Segment

$$\text{Spd}_{3,1} := 65.0$$

$$\text{Spd}_3 := \text{Spd}_{3,1} = 65.000$$

$$\text{Den}_{3,1} := 19.0$$

$$\text{Den}_3 := \text{Den}_{3,1} = 19.000$$

### 4. Diamond

$\text{Spd}_{4,1} := 59.6$	$\text{Den}_{4,1} := 20.2$	$\text{Len}_{4,1} := 1500$	$\text{Lns}_{4,1} := 3$	$\text{Time}_{4,1} := \frac{\text{Len}_{4,1}}{\text{Spd}_{4,1}}$	$\text{NVeh}_{4,1} := \text{Den}_{4,1} \cdot \text{Len}_{4,1} \cdot \text{Lns}_{4,1}$
$\text{Spd}_{4,2} := 65.0$	$\text{Den}_{4,2} := 16.5$	$\text{Len}_{4,2} := 2280$	$\text{Lns}_{4,2} := 3$	$\text{Time}_{4,2} := \frac{\text{Len}_{4,2}}{\text{Spd}_{4,2}}$	$\text{NVeh}_{4,2} := \text{Den}_{4,2} \cdot \text{Len}_{4,2} \cdot \text{Lns}_{4,2}$
$\text{Spd}_{4,3} := 51.8$	$\text{Den}_{4,3} := 19.1$	$\text{Len}_{4,3} := 1500$	$\text{Lns}_{4,3} := 4$	$\text{Time}_{4,3} := \frac{\text{Len}_{4,3}}{\text{Spd}_{4,3}}$	$\text{NVeh}_{4,3} := \text{Den}_{4,3} \cdot \text{Len}_{4,3} \cdot \text{Lns}_{4,3}$

$$\text{Speed}_4 := \frac{\text{Len}_{4,1} + \text{Len}_{4,2} + \text{Len}_{4,3}}{\text{Time}_{4,1} + \text{Time}_{4,2} + \text{Time}_{4,3}}$$

$$\text{Speed}_4 = 59.191$$

$$\text{Density}_4 := \frac{\text{NVeh}_{4,1} + \text{NVeh}_{4,2} + \text{NVeh}_{4,3}}{\text{Lns}_{4,1} \cdot \text{Len}_{4,1} + \text{Lns}_{4,2} \cdot \text{Len}_{4,2} + \text{Lns}_{4,3} \cdot \text{Len}_{4,3}}$$

$$\text{Density}_4 = 18.360$$

## 5. Basic Segment

$$\text{Spd}_{5,1} := 51.8$$

$$\text{Spd}_5 := \text{Spd}_{5,1} = 51.800$$

$$\text{Den}_{5,1} := 19.1$$

$$\text{Den}_5 := \text{Den}_{5,1} = 19.100$$

## 6. Partial Cloverleaf

$$\text{Spd}_{6,1} := 51.8$$

$$\text{Den}_{6,1} := 19.1$$

$$\text{Len}_{6,1} := 1500$$

$$\text{Lns}_{6,1} := 4$$

$$\text{Time}_{6,1} := \frac{\text{Len}_{6,1}}{\text{Spd}_{6,1}}$$

$$\text{NVeh}_{6,1} := \text{Den}_{6,1} \cdot \text{Len}_{6,1} \cdot \text{Lns}_{6,1}$$

$$\text{Spd}_{6,2} := 65.0$$

$$\text{Den}_{6,2} := 16.5$$

$$\text{Len}_{6,2} := 2280$$

$$\text{Lns}_{6,2} := 3$$

$$\text{Time}_{6,2} := \frac{\text{Len}_{6,2}}{\text{Spd}_{6,2}}$$

$$\text{NVeh}_{6,2} := \text{Den}_{6,2} \cdot \text{Len}_{6,2} \cdot \text{Lns}_{6,2}$$

$$\text{Spd}_{6,3} := 59.7$$

$$\text{Den}_{6,3} := 18.8$$

$$\text{Len}_{6,3} := 1500$$

$$\text{Lns}_{6,3} := 3$$

$$\text{Time}_{6,3} := \frac{\text{Len}_{6,3}}{\text{Spd}_{6,3}}$$

$$\text{NVeh}_{6,3} := \text{Den}_{6,3} \cdot \text{Len}_{6,3} \cdot \text{Lns}_{6,3}$$

$$\text{Speed}_6 := \frac{\text{Len}_{6,1} + \text{Len}_{6,2} + \text{Len}_{6,3}}{\text{Time}_{6,1} + \text{Time}_{6,2} + \text{Time}_{6,3}}$$

$$\text{Speed}_6 = 59.219$$

$$\text{Density}_6 := \frac{\text{NVeh}_{6,1} + \text{NVeh}_{6,2} + \text{NVeh}_{6,3}}{\text{Lns}_{6,1} \cdot \text{Len}_{6,1} + \text{Lns}_{6,2} \cdot \text{Len}_{6,2} + \text{Lns}_{6,3} \cdot \text{Len}_{6,3}}$$

$$\text{Density}_6 = 17.997$$

**7. Full Cloverleaf Segment**

$\text{Spd}_{7,1} := 59.3$	$\text{Den}_{7,1} := 20.2$	$\text{Len}_{7,1} := 1500$	$\text{Lns}_{7,1} := 3$	$\text{Time}_{7,1} := \frac{\text{Len}_{7,1}}{\text{Spd}_{7,1}}$	$\text{NVeh}_{7,1} := \text{Den}_{7,1} \cdot \text{Len}_{7,1} \cdot \text{Lns}_{7,1}$
$\text{Spd}_{7,2} := 65.0$	$\text{Den}_{7,2} := 16.5$	$\text{Len}_{7,2} := 1500$	$\text{Lns}_{7,2} := 3$	$\text{Time}_{7,2} := \frac{\text{Len}_{7,2}}{\text{Spd}_{7,2}}$	$\text{NVeh}_{7,2} := \text{Den}_{7,2} \cdot \text{Len}_{7,2} \cdot \text{Lns}_{7,2}$
$\text{Spd}_{7,3} := 59.5$	$\text{Den}_{7,3} := 19.5$	$\text{Len}_{7,3} := 1500$	$\text{Lns}_{7,3} := 3$	$\text{Time}_{7,3} := \frac{\text{Len}_{7,3}}{\text{Spd}_{7,3}}$	$\text{NVeh}_{7,3} := \text{Den}_{7,3} \cdot \text{Len}_{7,3} \cdot \text{Lns}_{7,3}$
$\text{Spd}_{7,4} := 65.0$	$\text{Den}_{7,4} := 19.8$	$\text{Len}_{7,4} := 1000$	$\text{Lns}_{7,4} := 3$	$\text{Time}_{7,4} := \frac{\text{Len}_{7,4}}{\text{Spd}_{7,4}}$	$\text{NVeh}_{7,4} := \text{Den}_{7,4} \cdot \text{Len}_{7,4} \cdot \text{Lns}_{7,4}$
$\text{Spd}_{7,5} := 58.7$	$\text{Den}_{7,5} := 21.1$	$\text{Len}_{7,5} := 1500$	$\text{Lns}_{7,5} := 3$	$\text{Time}_{7,5} := \frac{\text{Len}_{7,5}}{\text{Spd}_{7,5}}$	$\text{NVeh}_{7,5} := \text{Den}_{7,5} \cdot \text{Len}_{7,5} \cdot \text{Lns}_{7,5}$
$\text{Spd}_{7,6} := 65.0$	$\text{Den}_{7,6} := 16.0$	$\text{Len}_{7,6} := 1500$	$\text{Lns}_{7,6} := 3$	$\text{Time}_{7,6} := \frac{\text{Len}_{7,6}}{\text{Spd}_{7,6}}$	$\text{NVeh}_{7,6} := \text{Den}_{7,6} \cdot \text{Len}_{7,6} \cdot \text{Lns}_{7,6}$
$\text{Spd}_{7,7} := 55.0$	$\text{Den}_{7,7} := 16.3$	$\text{Len}_{7,7} := 1500$	$\text{Lns}_{7,7} := 4$	$\text{Time}_{7,7} := \frac{\text{Len}_{7,7}}{\text{Spd}_{7,7}}$	$\text{NVeh}_{7,7} := \text{Den}_{7,7} \cdot \text{Len}_{7,7} \cdot \text{Lns}_{7,7}$

$$\text{Speed}_7 := \frac{\text{Len}_{7,1} + \text{Len}_{7,2} + \text{Len}_{7,3} + \text{Len}_{7,4} + \text{Len}_{7,5} + \text{Len}_{7,6} + \text{Len}_{7,7}}{\text{Time}_{7,1} + \text{Time}_{7,2} + \text{Time}_{7,3} + \text{Time}_{7,4} + \text{Time}_{7,5} + \text{Time}_{7,6} + \text{Time}_{7,7}}$$

$$\text{Speed}_7 = 60.654$$

$$\text{Density}_7 := \frac{\text{NVeh}_{7,1} + \text{NVeh}_{7,2} + \text{NVeh}_{7,3} + \text{NVeh}_{7,4} + \text{NVeh}_{7,5} + \text{NVeh}_{7,6} + \text{NVeh}_{7,7}}{\text{Lns}_{7,1} \cdot \text{Len}_{7,1} + \text{Lns}_{7,2} \cdot \text{Len}_{7,2} + \text{Lns}_{7,3} \cdot \text{Len}_{7,3} + \text{Lns}_{7,4} \cdot \text{Len}_{7,4} + \text{Lns}_{7,5} \cdot \text{Len}_{7,5} + \text{Lns}_{7,6} \cdot \text{Len}_{7,6} + \text{Lns}_{7,7} \cdot \text{Len}_{7,7}}$$

$$\text{Density}_7 = 18.319$$

**8. Off-Ramp Segment**

$$\text{Spd}_{8,1} := 55.0$$

$$\text{Spd}_8 := \text{Spd}_{8,1} = 55.000$$

$$\text{Den}_{8,1} := 16.3$$

$$\text{Den}_8 := \text{Den}_{8,1} = 16.300$$

**9. Basic Segment**

$$\text{Spd}_{9,1} := 65.0$$

$$\text{Spd}_9 := \text{Spd}_{9,1} = 65.000$$

$$\text{Den}_{9,1} := 16.8$$

$$\text{Den}_9 := \text{Den}_{9,1} = 16.800$$

**10. Full Cloverleaf Segment**

$$\text{Spd}_{10,1} := 59.6$$

$$\text{Den}_{10,1} := 17.9$$

$$\text{Len}_{10,1} := 1500$$

$$\text{Lns}_{10,1} := 3$$

$$\text{Time}_{10,1} := \frac{\text{Len}_{10,1}}{\text{Spd}_{10,1}} \quad \text{NVeh}_{10,1} := \text{Den}_{10,1} \cdot \text{Len}_{10,1} \cdot \text{Lns}_{10,1}$$

$$\text{Spd}_{10,2} := 65.0$$

$$\text{Den}_{10,2} := 14.6$$

$$\text{Len}_{10,2} := 1000$$

$$\text{Lns}_{10,2} := 3$$

$$\text{Time}_{10,2} := \frac{\text{Len}_{10,2}}{\text{Spd}_{10,2}} \quad \text{NVeh}_{10,2} := \text{Den}_{10,2} \cdot \text{Len}_{10,2} \cdot \text{Lns}_{10,2}$$

$$\text{Spd}_{10,3} := 57.4$$

$$\text{Den}_{10,3} := 20.8$$

$$\text{Len}_{10,3} := 900$$

$$\text{Lns}_{10,3} := 3$$

$$\text{Time}_{10,3} := \frac{\text{Len}_{10,3}}{\text{Spd}_{10,3}} \quad \text{NVeh}_{10,3} := \text{Den}_{10,3} \cdot \text{Len}_{10,3} \cdot \text{Lns}_{10,3}$$

$$\text{Spd}_{10,4} := 57.4$$

$$\text{Den}_{10,4} := 20.8$$

$$\text{Len}_{10,4} := 900$$

$$\text{Lns}_{10,4} := 3$$

$$\text{Time}_{10,4} := \frac{\text{Len}_{10,4}}{\text{Spd}_{10,4}} \quad \text{NVeh}_{10,4} := \text{Den}_{10,4} \cdot \text{Len}_{10,4} \cdot \text{Lns}_{10,4}$$

$$\text{Spd}_{10,5} := 65.0$$

$$\text{Den}_{10,5} := 15.7$$

$$\text{Len}_{10,5} := 1000$$

$$\text{Lns}_{10,5} := 3$$

$$\text{Time}_{10,5} := \frac{\text{Len}_{10,5}}{\text{Spd}_{10,5}} \quad \text{NVeh}_{10,5} := \text{Den}_{10,5} \cdot \text{Len}_{10,5} \cdot \text{Lns}_{10,5}$$

$$\text{Spd}_{10,6} := 59.5$$

$$\text{Den}_{10,6} := 19.2$$

$$\text{Len}_{10,6} := 1500$$

$$\text{Lns}_{10,6} := 3$$

$$\text{Time}_{10,6} := \frac{\text{Len}_{10,6}}{\text{Spd}_{10,6}} \quad \text{NVeh}_{10,6} := \text{Den}_{10,6} \cdot \text{Len}_{10,6} \cdot \text{Lns}_{10,6}$$

$$\text{Speed}_{10} := \frac{\text{Len}_{10.1} + \text{Len}_{10.2} + \text{Len}_{10.3} + \text{Len}_{10.4} + \text{Len}_{10.5} + \text{Len}_{10.6}}{\text{Time}_{10.1} + \text{Time}_{10.2} + \text{Time}_{10.3} + \text{Time}_{10.4} + \text{Time}_{10.5} + \text{Time}_{10.6}}$$

$$\text{Speed}_{10} = 60.441$$

$$\text{Density}_{10} := \frac{\text{NVeh}_{10.1} + \text{NVeh}_{10.2} + \text{NVeh}_{10.3} + \text{NVeh}_{10.4} + \text{NVeh}_{10.5} + \text{NVeh}_{10.6}}{\text{Lns}_{10.1} \cdot \text{Len}_{10.1} + \text{Lns}_{10.2} \cdot \text{Len}_{10.2} + \text{Lns}_{10.3} \cdot \text{Len}_{10.3} + \text{Lns}_{10.4} \cdot \text{Len}_{10.4} + \text{Lns}_{10.5} \cdot \text{Len}_{10.5} + \text{Lns}_{10.6} \cdot \text{Len}_{10.6}}$$

$$\text{Density}_{10} = 18.146$$

### 11. Basic Segment

$$\text{Spd}_{11.1} := 65.0$$

$$\text{Spd}_{11} := \text{Spd}_{11.1} = 65.000$$

$$\text{Den}_{11.1} := 19.5$$

$$\text{Den}_{11} := \text{Den}_{11.1} = 19.500$$

### 12. On-Ramp Segment

$$\text{Spd}_{12.1} := 52.9$$

$$\text{Spd}_{12} := \text{Spd}_{12.1} = 52.900$$

$$\text{Den}_{12.1} := 21.0$$

$$\text{Den}_{12} := \text{Den}_{12.1} = 21.000$$

### 13. Basic Segment

$$\text{Spd}_{13.1} := 52.9$$

$$\text{Spd}_{13} := \text{Spd}_{13.1} = 52.900$$

$$\text{Den}_{13.1} := 21.0$$

$$\text{Den}_{13} := \text{Den}_{13.1} = 21.000$$

**14. Full Cloverleaf**

$Spd_{14,1} := 52.9$	$Den_{14,1} := 21.0$	$Len_{14,1} := 1500$	$Lns_{14,1} := 4$	$Time_{14,1} := \frac{Len_{14,1}}{Spd_{14,1}}$	$NVeh_{14,1} := Den_{14,1} \cdot Len_{14,1} \cdot Lns_{14,1}$
$Spd_{14,2} := 65.0$	$Den_{14,2} := 20.3$	$Len_{14,2} := 1140$	$Lns_{14,2} := 3$	$Time_{14,2} := \frac{Len_{14,2}}{Spd_{14,2}}$	$NVeh_{14,2} := Den_{14,2} \cdot Len_{14,2} \cdot Lns_{14,2}$
$Spd_{14,3} := 53.2$	$Den_{14,3} := 20.9$	$Len_{14,3} := 2000$	$Lns_{14,3} := 4$	$Time_{14,3} := \frac{Len_{14,3}}{Spd_{14,3}}$	$NVeh_{14,3} := Den_{14,3} \cdot Len_{14,3} \cdot Lns_{14,3}$
$Spd_{14,4} := 65.0$	$Den_{14,4} := 20.3$	$Len_{14,4} := 1140$	$Lns_{14,4} := 3$	$Time_{14,4} := \frac{Len_{14,4}}{Spd_{14,4}}$	$NVeh_{14,4} := Den_{14,4} \cdot Len_{14,4} \cdot Lns_{14,4}$
$Spd_{14,5} := 59.0$	$Den_{14,5} := 22.8$	$Len_{14,5} := 1500$	$Lns_{14,5} := 3$	$Time_{14,5} := \frac{Len_{14,5}}{Spd_{14,5}}$	$NVeh_{14,5} := Den_{14,5} \cdot Len_{14,5} \cdot Lns_{14,5}$

$$Speed_{14} := \frac{Len_{14,1} + Len_{14,2} + Len_{14,3} + Len_{14,4} + Len_{14,5}}{Time_{14,1} + Time_{14,2} + Time_{14,3} + Time_{14,4} + Time_{14,5}}$$

$$Speed_{14} = 57.572$$

$$Density_{14} := \frac{NVeh_{14,1} + NVeh_{14,2} + NVeh_{14,3} + NVeh_{14,4} + NVeh_{14,5}}{Lns_{14,1} \cdot Len_{14,1} + Lns_{14,2} \cdot Len_{14,2} + Lns_{14,3} \cdot Len_{14,3} + Lns_{14,4} \cdot Len_{14,4} + Lns_{14,5} \cdot Len_{14,5}}$$

$$Density_{14} = 21.099$$