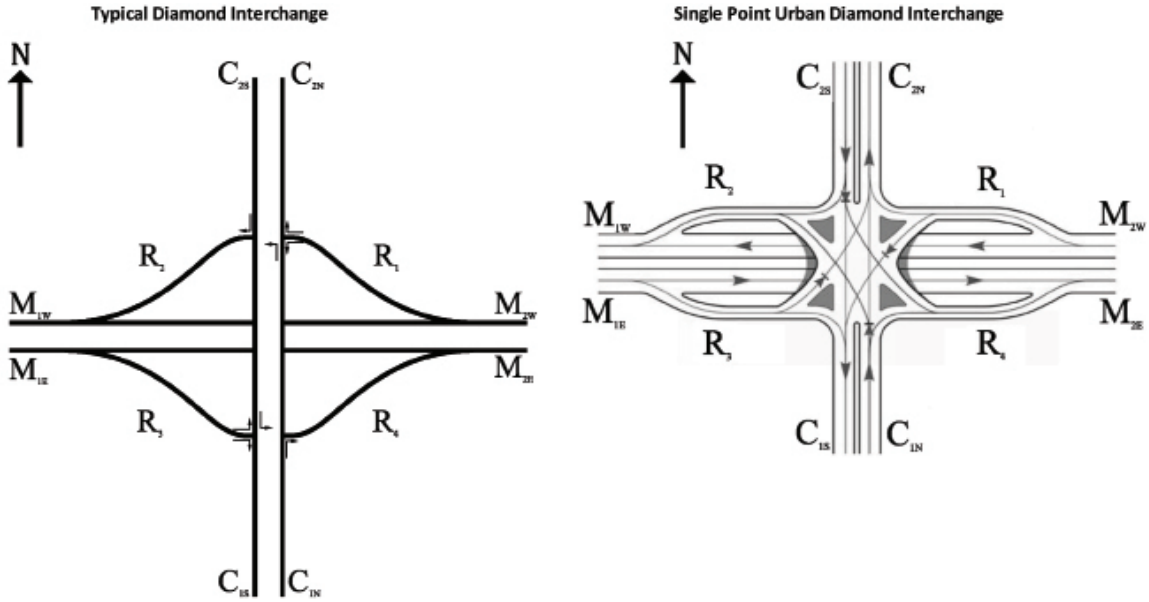
Appendix K –

Typical Interchange AADT Estimation

Appendix K. TYPICAL INTERCHANGE AADT ESTIMATION

The following are equations and example computations of using relevant data to compute unknowns rather than field counting for the most common interchange configurations.



Source: Federal Highway Administration.

FIGURE K-1. TYPICAL DIAMOND INTERCHANGES

Mathematical Formulas

$$R_1 = \left(\frac{C_{1S}+C_{2S}}{C_{1S}}\right)[C_{1S} - C_{2S}] + \left(\frac{C_{2S}}{C_{1S}}\right)[R_2 - R_4] - R_3 \quad (1)$$

$$R_2 = (M_{1W} - M_{2W}) + R_1 \quad (2)$$

$$R_3 = \left(\frac{C_{1N}+C_{2N}}{C_{2N}}\right)[C_{2N} - C_{1N}] + \left(\frac{C_{1N}}{C_{2N}}\right)[R_2 + R_4] - R_1 \quad (3)$$

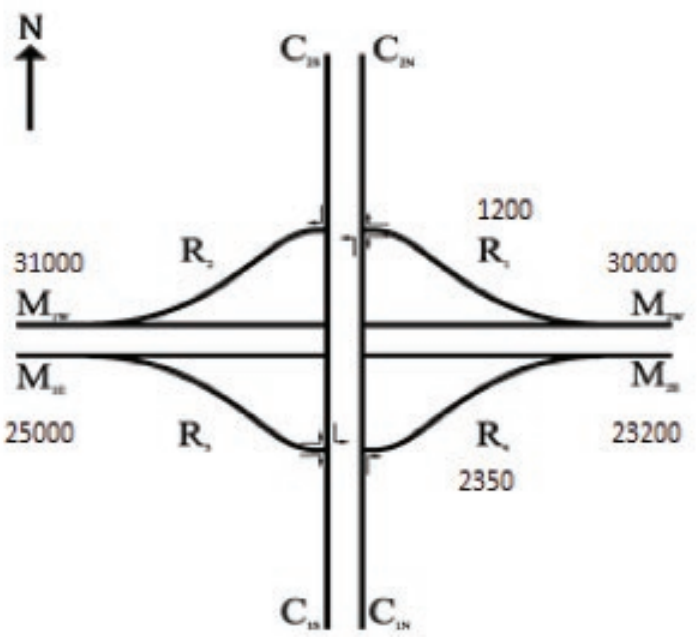
$$R_4 = (M_{2E} - M_{1E}) + R_3 \quad (4)$$

While formulas 1 and 3 require cross street data, ramps 1 and 3 can be counted and formulas 2 and 4 can be used to estimate ramps 2 and 4.

Example

A diamond interchange located on an E/W freeway has directional mainline data both upstream and downstream of the interchange. Two ramps need to be counted in order to use formulas (3) and (5). Ramps R_1 and R_4 were counted and the following data are now known:

M_{1E}	=	25,000	R_1	=	1,200
M_{2E}	=	23,200	R_4	=	2,350
M_{1W}	=	31,000			
M_{2W}	=	30,000			



Source: Federal Highway Administration.

FIGURE K-2. DIAMOND INTERCHANGE RAMP ESTIMATION PROBLEM

R_2 = $(M_{1W} - M_{2W}) + R_1$

R_2 = (31,000 - 30,000) + 1,200

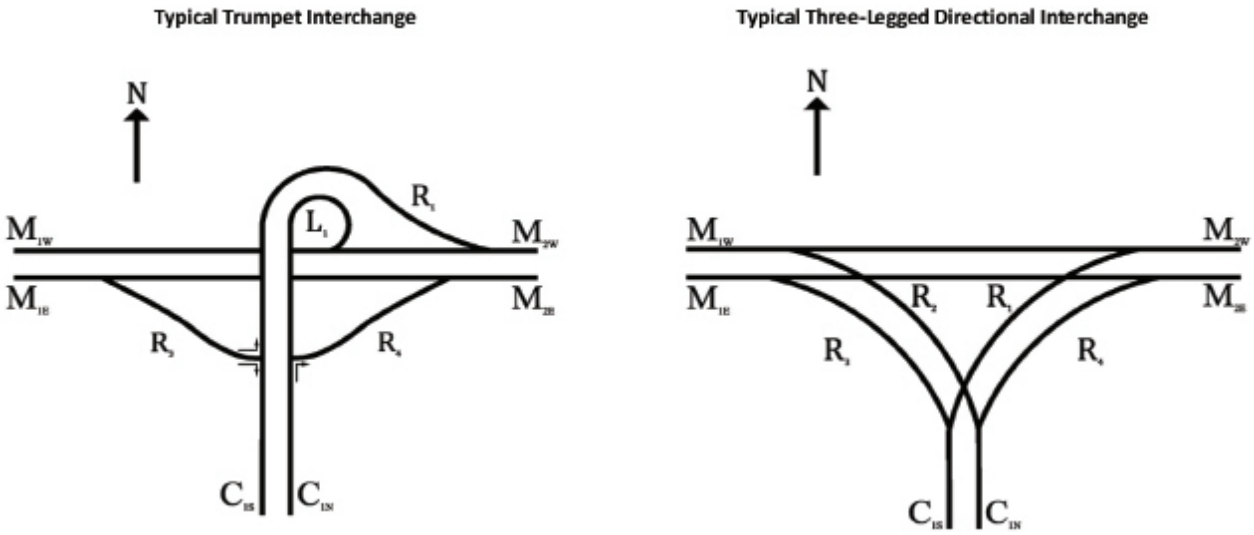
R_2 = 2,200

R_4 = $(M_{2E} - M_{1E}) + R_3$

2,350 = (23,200 - 25,000) + R_3

2,350 = -1,800 + R_3

R_3 = 4,150



Source: Federal Highway Administration.

FIGURE K-3. TYPICAL TRUMPET AND THREE-LEGGED DIRECTIONAL INTERCHANGES

Mathematical Formulas

$C_{1S} = R_1 + R_3$ (5)

$R_1 = (M_{2W} - M_{1W}) + L_1$ *or* $R_1 = (M_{2W} - M_{1W}) + R_2$ (6)

$R_3 = (M_{1E} - M_{2E}) + R_4$ (7)

$L_1 = C_{1N} - R_4$ *or* $R_2 = C_{1N} - R_4$ (8)

While formulas 5 and 8 require cross street data, ramps 2 (or loop 1) and 4 can be counted and formulas 6 and 7 can be used to estimate ramps 1 and 3.

Example

A trumpet interchange located on an E/W freeway has directional mainline data both upstream and downstream of the interchange. Two ramps need to be counted in order to use formulas (9) and (10). Ramps R_1 and R_4 were counted and the following data are now known:

M_{1E} = 21,000

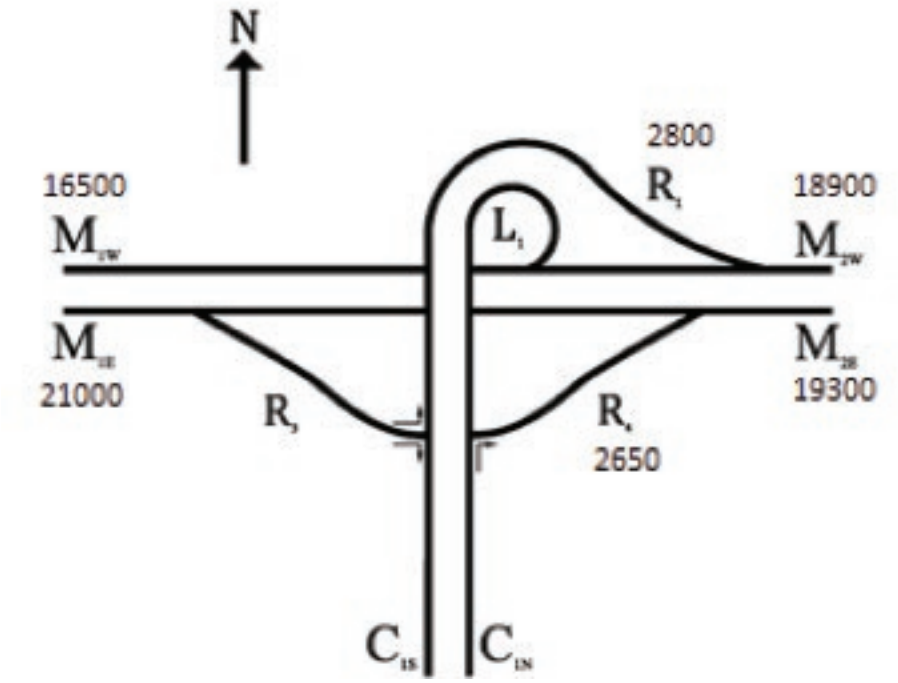
M_{2E} = 19,300

M_{1W} = 16,500

M_{2W} = 18,900

R_1 = 2,800

R_4 = 2,650



Source: Federal Highway Administration.

FIGURE K-4. TRUMPET INTERCHANGE RAMP ESTIMATION PROBLEM

R_1 = $(M_{2W} - M_{1W}) + L_1$

2,800 = (18,900 - 16,500)+ L_1

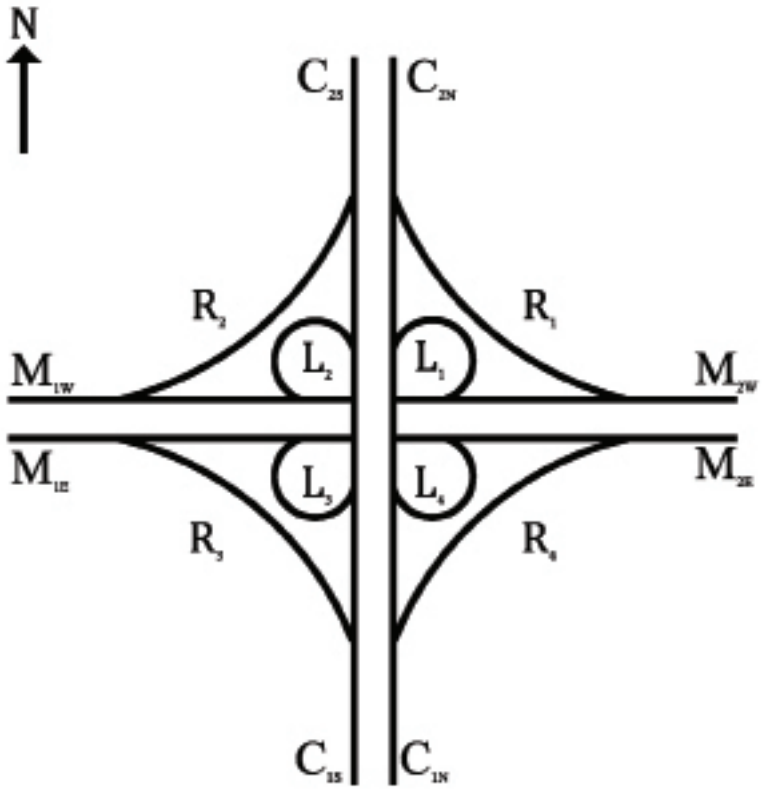
2,800 = 2,400 + L_1

L_1 = 400

R_3 = $(M_{1E} - M_{2E}) + R_4$

R_3 = (21,000 - 19,300) + 2,650

R_3 = 4,350



Source: Federal Highway Administration.

FIGURE K-5. TYPICAL CLOVERLEAF INTERCHANGE

Cloverleaf interchanges are the most complex and data intensive scenario for volume to ramp count relationships.

Formulas (9) through (12) can be used directly assuming some combination of mainline, cross street, and ramp volumes are known for a given year.

A weight factor does not need to be used for exit ramps when approaching the cross street because vehicles do not have an option of which direction to take once on a ramp.

Mathematical Formulas

$R_1 = (M_{2W} - M_{1W}) + (L_1 - L_2) + R_2$ (9)

$R_2 = (C_{2S} - C_{1S}) + (L_2 - L_3) + R_3$ (10)

$R_3 = (M_{1E} - M_{2E}) + (L_3 - L_4) + R_4$ (11)

$R_4 = (C_{1N} - C_{2N}) + (L_4 - L_1) + R_1$ (12)

Mainline and cross-street AADTs available with one ramp known.

- In order to calculate all ramps, two ramps from each of the following groupings need to be counted in total:

  $\{R_1, L_1, R_2, L_2\}$

  $\{R_3, L_3, R_4, L_4\}$

  For example, if R_1 is already known, then count L_1, R_2, or L_2 plus two ramps from the second group.

- Once volumes are known for four ramps, use formulas (9) through (12) to determine the remaining volumes.

If only mainline AADT data are available, count three ramps from each of the following lists:

$\{R_1, L_1, R_2, L_2\}$

$\{R_3, L_3, R_4, L_4\}$

With six ramps counted, use formulas (9) and (11) to determine the volumes for the remaining ramps.

Example

A cloverleaf interchange located at an intersection of two freeways has directional mainline (E/W) data both upstream and downstream of the interchange. Two ramps need to be counted in order to use formulas (9) and (11). Ramps R_1 and R_4 were counted and the following data are now known:

M_{1E} = 54,000

M_{2E} = 51,500

M_{1W} = 58,500

M_{2W} = 59,000

R_1 = 2,500

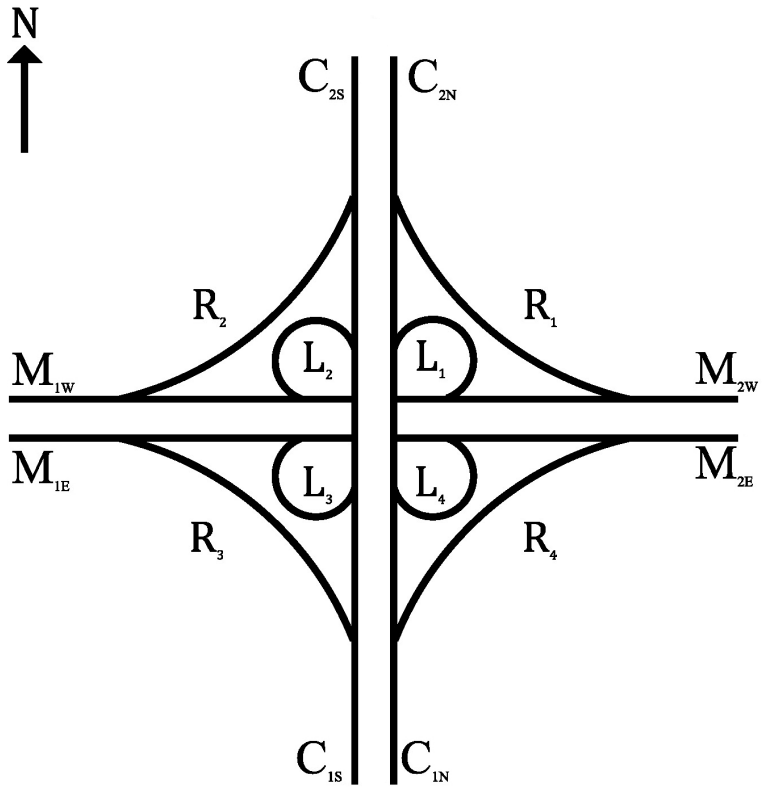
L_1 = 2,100

R_2 = 2,800

R_3 = 2,200

L_3 = 2,450

R_4 = 2,500



Source: Federal Highway Administration.

FIGURE K-6. CLOVERLEAF INTERCHANGE RAMP ESTIMATION PROBLEM

$R_1 = (M_{2W} - M_{1W}) + (L_1 - L_2) + R_2$

$2{,}500 = (59{,}000 – 58{,}500) + (2{,}100 - L_2) + 2{,}800$

$2{,}500 = 5{,}400 - L_2$

$L_2 = 2{,}900$

$R_3 = (M_{1E} – M_{2E}) + (L_3 - L_4) + R_4$

$2{,}200 = (54{,}000 – 51{,}500) + (2{,}450 - L_4) + 2{,}500$

$2{,}200 = 7{,}400 - L_4$

$L_4 = 5{,}250$