

# LEFT TURN LANE CALCULATIONS

| LT section #1 2 yr    |                 | LT section #1 10 yr   |                 | LT section #2 2 yr    |                 | LT section #2 10 yr   |                 | LT section #3 2 yr    |                 | LT section #3 10 yr   |                 |
|-----------------------|-----------------|-----------------------|-----------------|-----------------------|-----------------|-----------------------|-----------------|-----------------------|-----------------|-----------------------|-----------------|
| Project Description   |                 | Project Description   |                 | Project Description   |                 | Project Description   |                 | Project Description   |                 | Project Description   |                 |
| Friction Method       | Manning Formula | Friction Method       | Manning Formula | Friction Method       | Manning Formula | Friction Method       | Manning Formula | Friction Method       | Manning Formula | Friction Method       | Manning Formula |
| Solve For             | Normal Depth    | Solve For             | Normal Depth    | Solve For             | Normal Depth    | Solve For             | Normal Depth    | Solve For             | Normal Depth    | Solve For             | Normal Depth    |
| Input Data            |                 | Input Data            |                 | Input Data            |                 | Input Data            |                 | Input Data            |                 | Input Data            |                 |
| Roughness Coefficient | 0.033           | Roughness Coefficient | 0.05            | Roughness Coefficient | 0.033           | Roughness Coefficient | 0.05            | Roughness Coefficient | 0.033           | Roughness Coefficient | 0.05            |
| Channel Slope         | 0.0086 ft/ft    | Channel Slope         | 0.006 ft/ft     | Channel Slope         | 0.0086 ft/ft    | Channel Slope         | 0.0086 ft/ft    | Channel Slope         | 0.0086 ft/ft    | Channel Slope         | 0.0086 ft/ft    |
| Left Side Slope       | 12.5 HV         | Left Side Slope       | 12.5 HV         | Left Side Slope       | 7.5 HV          | Left Side Slope       | 7.5 HV          | Left Side Slope       | 9.4 HV          | Left Side Slope       | 9.4 HV          |
| Right Side Slope      | 17.24 HV        | Right Side Slope      | 17.24 HV        | Right Side Slope      | 9.3 HV          | Right Side Slope      | 9.3 HV          | Right Side Slope      | 10.6 HV         | Right Side Slope      | 10.6 HV         |
| Discharge             | 0.55 ft/s       | Discharge             | 0.75 ft/s       | Discharge             | 1.03 ft/s       | Discharge             | 1.42 ft/s       | Discharge             | 1.22 ft/s       | Discharge             | 1.68 ft/s       |
| Results               |                 | Results               |                 | Results               |                 | Results               |                 | Results               |                 | Results               |                 |
| Normal Depth          | 0.21 ft         | Normal Depth          | 0.28 ft         | Normal Depth          | 0.31 ft         | Normal Depth          | 0.41 ft         | Normal Depth          | 0.31 ft         | Normal Depth          | 0.41 ft         |
| Flow Area             | 0.67 ft²        | Flow Area             | 1.2 ft²         | Flow Area             | 0.81 ft²        | Flow Area             | 1.4 ft²         | Flow Area             | 0.95 ft²        | Flow Area             | 1.66 ft²        |
| Wetted Perimeter      | 6.33 ft         | Wetted Perimeter      | 8.46 ft         | Wetted Perimeter      | 5.24 ft         | Wetted Perimeter      | 6.91 ft         | Wetted Perimeter      | 6.21 ft         | Wetted Perimeter      | 8.18 ft         |
| Top Width             | 6.32 ft         | Top Width             | 8.44 ft         | Top Width             | 5.2 ft          | Top Width             | 6.86 ft         | Top Width             | 6.18 ft         | Top Width             | 8.14 ft         |
| Critical Depth        | 0.15 ft         | Critical Depth        | 0.17 ft         | Critical Depth        | 0.25 ft         | Critical Depth        | 0.28 ft         | Critical Depth        | 0.25 ft         | Critical Depth        | 0.28 ft         |
| Critical Slope        | 0.03748 ft/ft   | Critical Slope        | 0.08255 ft/ft   | Critical Slope        | 0.03214 ft/ft   | Critical Slope        | 0.07068 ft/ft   | Critical Slope        | 0.03207 ft/ft   | Critical Slope        | 0.07054 ft/ft   |
| Velocity              | 0.82 ft/s       | Velocity              | 0.63 ft/s       | Velocity              | 1.28 ft/s       | Velocity              | 1.01 ft/s       | Velocity              | 1.28 ft/s       | Velocity              | 1.01 ft/s       |
| Velocity Head         | 0.01 ft         | Velocity Head         | 0.01 ft         | Velocity Head         | 0.03 ft         | Velocity Head         | 0.02 ft         | Velocity Head         | 0.03 ft         | Velocity Head         | 0.02 ft         |
| Specific Energy       | 0.22 ft         | Specific Energy       | 0.29 ft         | Specific Energy       | 0.34 ft         | Specific Energy       | 0.42 ft         | Specific Energy       | 0.33 ft         | Specific Energy       | 0.42 ft         |
| Froude Number         | 0.44            | Froude Number         | 0.29            | Froude Number         | 0.57            | Froude Number         | 0.4             | Froude Number         | 0.57            | Froude Number         | 0.4             |

| C <sub>impervious</sub> = | 0.90                    |                                    |                    |                       |                |                 |
|---------------------------|-------------------------|------------------------------------|--------------------|-----------------------|----------------|-----------------|
| C <sub>pervious</sub> =   | 0.35                    |                                    |                    |                       |                |                 |
| Q =                       | 4.39                    |                                    |                    |                       |                |                 |
| I <sub>to</sub> =         | 6.04                    | [Based on T <sub>c</sub> = 5 min.] |                    |                       |                |                 |
| Structure                 | A <sub>impervious</sub> | A <sub>pervious</sub>              | A <sub>total</sub> | C <sub>weighted</sub> | Q <sub>2</sub> | Q <sub>10</sub> |
| Left Turn Lane Sections   |                         |                                    |                    |                       |                |                 |
| LT section 1              | 0.11                    | 0.07                               | 0.18               | 0.69                  | 0.55           | 0.75            |
| LT section 2              | 0.10                    | 0.06                               | 0.16               | 0.69                  | 0.48           | 0.67            |
| LT section 3              | 0.02                    | 0.07                               | 0.09               | 0.47                  | 0.19           | 0.26            |

# RIGHT CURB FLARE CALCULATIONS

| curb flare right 2yr  |                 | curb flare right 10yr |                 |
|-----------------------|-----------------|-----------------------|-----------------|
| Project Description   | Sta 12+34.89    | Project Description   | Sta 12+34.89    |
| Friction Method       | Manning Formula | Friction Method       | Manning Formula |
| Solve For             | Normal Depth    | Solve For             | Normal Depth    |
| Input Data            |                 | Input Data            |                 |
| Roughness Coefficient | 0.013           | Roughness Coefficient | 0.013           |
| Channel Slope         | 0.0325 ft/ft    | Channel Slope         | 0.0325 ft/ft    |
| Left Side Slope       | 12 HV           | Left Side Slope       | 12 HV           |
| Right Side Slope      | 3 HV            | Right Side Slope      | 3 HV            |
| Discharge             | 0.19 ft/s       | Discharge             | 0.26 ft/s       |
| Results               |                 | Results               |                 |
| Normal Depth          | 0.1 ft          | Normal Depth          | 0.11 ft         |
| Flow Area             | 0.07 ft²        | Flow Area             | 0.09 ft²        |
| Wetted Perimeter      | 1.47 ft         | Wetted Perimeter      | 1.65 ft         |
| Top Width             | 1.45 ft         | Top Width             | 1.63 ft         |
| Critical Depth        | 0.13 ft         | Critical Depth        | 0.15 ft         |
| Critical Slope        | 0.00821 ft/ft   | Critical Slope        | 0.00696 ft/ft   |
| Velocity              | 2.71 ft/s       | Velocity              | 2.93 ft/s       |
| Velocity Head         | 0.11 ft         | Velocity Head         | 0.13 ft         |
| Specific Energy       | 0.21 ft         | Specific Energy       | 0.24 ft         |
| Froude Number         | 2.16            | Froude Number         | 2.21            |

| CURB SECTION 3        |                 | CURB SECTION 2        |                 |
|-----------------------|-----------------|-----------------------|-----------------|
| Project Description   |                 | Project Description   |                 |
| Friction Method       | Manning Formula | Friction Method       | Manning Formula |
| Solve For             | Normal Depth    | Solve For             | Normal Depth    |
| Input Data            |                 | Input Data            |                 |
| Roughness Coefficient | 0.013           | Roughness Coefficient | 0.013           |
| Channel Slope         | 0.0511 ft/ft    | Channel Slope         | 0.0511 ft/ft    |
| Left Side Slope       | 8.93 HV         | Left Side Slope       | 12.64 HV        |
| Right Side Slope      | 1.65 HV         | Right Side Slope      | 47.26 HV        |
| Discharge             | 0.31 ft/s       | Discharge             | 0.34 ft/s       |
| Results               |                 | Results               |                 |
| Normal Depth          | 0.12 ft         | Normal Depth          | 0.07 ft         |
| Flow Area             | 0.08 ft²        | Flow Area             | 0.13 ft²        |
| Wetted Perimeter      | 1.34 ft         | Wetted Perimeter      | 3.93 ft         |
| Top Width             | 1.3 ft          | Top Width             | 3.93 ft         |
| Critical Depth        | 0.18 ft         | Critical Depth        | 0.1 ft          |
| Critical Slope        | 0.00588 ft/ft   | Critical Slope        | 0.00679 ft/ft   |
| Velocity              | 3.92 ft/s       | Velocity              | 2.65 ft/s       |
| Velocity Head         | 0.24 ft         | Velocity Head         | 0.11 ft         |
| Specific Energy       | 0.36 ft         | Specific Energy       | 0.17 ft         |
| Froude Number         | 2.79            | Froude Number         | 2.58            |

| CURB SECTION 1        |                 |
|-----------------------|-----------------|
| Project Description   |                 |
| Friction Method       | Manning Formula |
| Solve For             | Normal Depth    |
| Input Data            |                 |
| Roughness Coefficient | 0.013           |
| Channel Slope         | 0.0511 ft/ft    |
| Left Side Slope       | 21.45 HV        |
| Right Side Slope      | 17.18 HV        |
| Discharge             | 0.36 ft/s       |
| Results               |                 |
| Normal Depth          | 0.08 ft         |
| Flow Area             | 0.12 ft²        |
| Wetted Perimeter      | 3.04 ft         |
| Top Width             | 3.04 ft         |
| Critical Depth        | 0.12 ft         |
| Critical Slope        | 0.00636 ft/ft   |
| Velocity              | 2.99 ft/s       |
| Velocity Head         | 0.14 ft         |
| Specific Energy       | 0.22 ft         |
| Froude Number         | 2.66            |

# LEFT CURB FLARE CALCULATIONS

| curb flare left 2yr   |                 | curb flare left 10yr  |                 | Sta 12+60. |
|-----------------------|-----------------|-----------------------|-----------------|------------|
| Project Description   | Sta 12+60.27    | Project Description   |                 |            |
| Friction Method       | Manning Formula | Friction Method       | Manning Formula |            |
| Solve For             | Normal Depth    | Solve For             | Normal Depth    |            |
| Input Data            |                 | Input Data            |                 |            |
| Roughness Coefficient | 0.013           | Roughness Coefficient | 0.013           |            |
| Channel Slope         | 0.0325 ft/ft    | Channel Slope         | 0.0325 ft/ft    |            |
| Left Side Slope       | 3 HV            | Left Side Slope       | 3 HV            |            |
| Right Side Slope      | 12 HV           | Right Side Slope      | 12 HV           |            |
| Discharge             | 0.49 ft/s       | Discharge             | 0.67 ft/s       |            |
| Results               |                 | Results               |                 |            |
| Normal Depth          | 0.14 ft         | Normal Depth          | 0.16 ft         |            |
| Flow Area             | 0.14 ft²        | Flow Area             | 0.18 ft²        |            |
| Wetted Perimeter      | 2.09 ft         | Wetted Perimeter      | 2.36 ft         |            |
| Top Width             | 2.07 ft         | Top Width             | 2.33 ft         |            |
| Critical Depth        | 0.19 ft         | Critical Depth        | 0.22 ft         |            |
| Critical Slope        | 0.00547 ft/ft   | Critical Slope        | 0.00525 ft/ft   |            |
| Velocity              | 3.45 ft/s       | Velocity              | 3.71 ft/s       |            |
| Velocity Head         | 0.18 ft         | Velocity Head         | 0.21 ft         |            |
| Specific Energy       | 0.32 ft         | Specific Energy       | 0.37 ft         |            |
| Froude Number         | 2.31            | Froude Number         | 2.35            |            |

| CURB SECTION 7        |                 | CURB SECTION 6        |                 |
|-----------------------|-----------------|-----------------------|-----------------|
| Project Description   |                 | Project Description   |                 |
| Friction Method       | Manning Formula | Friction Method       | Manning Formula |
| Solve For             | Normal Depth    | Solve For             | Normal Depth    |
| Input Data            |                 | Input Data            |                 |
| Roughness Coefficient | 0.013           | Roughness Coefficient | 0.013           |
| Channel Slope         | 0.039 ft/ft     | Channel Slope         | 0.038 ft/ft     |
| Left Side Slope       | 12.34 HV        | Left Side Slope       | 16.94 HV        |
| Right Side Slope      | 2.21 HV         | Right Side Slope      | 3.51 HV         |
| Discharge             | 0.68 ft/s       | Discharge             | 0.7 ft/s        |
| Results               |                 | Results               |                 |
| Normal Depth          | 0.15 ft         | Normal Depth          | 0.14 ft         |
| Flow Area             | 0.17 ft²        | Flow Area             | 0.19 ft²        |
| Wetted Perimeter      | 2.26 ft         | Wetted Perimeter      | 2.8 ft          |
| Top Width             | 2.22 ft         | Top Width             | 2.78 ft         |
| Critical Depth        | 0.22 ft         | Critical Depth        | 0.2 ft          |
| Critical Slope        | 0.00524 ft/ft   | Critical Slope        | 0.0054 ft/ft    |
| Velocity              | 4.01 ft/s       | Velocity              | 3.72 ft/s       |
| Velocity Head         | 0.25 ft         | Velocity Head         | 0.22 ft         |
| Specific Energy       | 0.4 ft          | Specific Energy       | 0.35 ft         |
| Froude Number         | 2.56            | Froude Number         | 2.52            |

| CURB SECTION 5        |                 | CURB SECTION 4        |                 |
|-----------------------|-----------------|-----------------------|-----------------|
| Project Description   |                 | Project Description   |                 |
| Friction Method       | Manning Formula | Friction Method       | Manning Formula |
| Solve For             | Normal Depth    | Solve For             | Normal Depth    |
| Input Data            |                 | Input Data            |                 |
| Roughness Coefficient | 0.013           | Roughness Coefficient | 0.013           |
| Channel Slope         | 0.039 ft/ft     | Channel Slope         | 0.039 ft/ft     |
| Left Side Slope       | 17.85 HV        | Left Side Slope       | 2 HV            |
| Right Side Slope      | 3.49 HV         | Right Side Slope      | 6.09 HV         |
| Discharge             | 0.78 ft/s       | Discharge             | 0.97 ft/s       |
| Results               |                 | Results               |                 |
| Normal Depth          | 0.14 ft         | Normal Depth          | 0.22 ft         |
| Flow Area             | 0.2 ft²         | Flow Area             | 0.19 ft²        |
| Wetted Perimeter      | 2.97 ft         | Wetted Perimeter      | 1.84 ft         |
| Top Width             | 2.95 ft         | Top Width             | 1.77 ft         |
| Critical Depth        | 0.2 ft          | Critical Depth        | 0.32 ft         |
| Critical Slope        | 0.00535 ft/ft   | Critical Slope        | 0.00475 ft/ft   |
| Velocity              | 3.8 ft/s        | Velocity              | 5.03 ft/s       |
| Velocity Head         | 0.22 ft         | Velocity Head         | 0.39 ft         |
| Specific Energy       | 0.36 ft         | Specific Energy       | 0.61 ft         |
| Froude Number         | 2.55            | Froude Number         | 2.88            |

| C <sub>impervious</sub> = | 0.90                    |                                    |                    |                       |                |                 |
|---------------------------|-------------------------|------------------------------------|--------------------|-----------------------|----------------|-----------------|
| C <sub>pervious</sub> =   | 0.35                    |                                    |                    |                       |                |                 |
| Q =                       | 4.39                    |                                    |                    |                       |                |                 |
| I <sub>to</sub> =         | 6.04                    | [Based on T <sub>c</sub> = 5 min.] |                    |                       |                |                 |
| Structure                 | A <sub>impervious</sub> | A <sub>pervious</sub>              | A <sub>total</sub> | C <sub>weighted</sub> | Q <sub>2</sub> | Q <sub>10</sub> |
| Curb Flare RT             | 0.02                    | 0.07                               | 0.09               | 0.47                  | 0.19           | 0.26            |
| Section 3                 | 0.005                   | 0.012                              | 0.017              | 0.51                  | 0.038          | 0.052           |
| Section 2                 | 0.001                   | 0.011                              | 0.012              | 0.40                  | 0.021          | 0.029           |
| Section 1                 | 0.000                   | 0.008                              | 0.008              | 0.35                  | 0.012          | 0.017           |
| Curb Flare LT             | 0.04                    | 0.22                               | 0.26               | 0.43                  | 0.49           | 0.67            |
| Section 7                 | 0.001                   | 0.001                              | 0.002              | 0.63                  | 0.006          | 0.008           |
| Section 6                 | 0.001                   | 0.009                              | 0.010              | 0.41                  | 0.018          | 0.024           |
| Section 5                 | 0.002                   | 0.030                              | 0.032              | 0.38                  | 0.053          | 0.073           |
| Section 4                 | 0.023                   | 0.035                              | 0.058              | 0.57                  | 0.145          | 0.199           |
|                           |                         |                                    |                    |                       | 0.775          | 0.974           |

