

# Appendix B

## Hydraulic Computations

B-1 – UDFCD Worksheets for the Rational Method

B-2 – UDFCD Worksheets for Inlets and Pipes

B-3 – UDFCD Worksheets for BMPs

B-4 – StormCAD System Analysis 5- and 100-year Event

**Calculation of Peak Runoff using Rational Method**

Designer: Alex Popp  
 Company: SEH Inc  
 Date: 8/26/2020  
 Project: New Horizon Academy  
 Location: Parker, CO

Version 2.00 released May 2017

Cells of this color are for required user-input  
 Cells of this color are for optional override values  
 Cells of this color are for calculated results based on overrides

$$t_t = \frac{0.395(1.1 - C_s)\sqrt{L_i}}{S^{0.33}}$$

$$t_t = \frac{L_i}{60K\sqrt{S_i}} = \frac{L_i}{60V_i}$$

Computed  $t_c = t_t + t_r$

Regional  $t_c = (26 - 17i) + \frac{L_i}{60(14i + 9)\sqrt{S_i}}$

$t_{\text{minimum}} = 5$  (urban)  
 $t_{\text{minimum}} = 10$  (non-urban)

Selected  $t_c = \max\{t_{\text{minimum}}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$

Select UDFCD location for NOAA Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained from the NOAA website (click this link)

|                                  |      |      |       |       |       |        |        |
|----------------------------------|------|------|-------|-------|-------|--------|--------|
| 1-hour rainfall depth, P1 (in) = | 2-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr | 500-yr |
|                                  | 0.99 | 1.39 |       |       |       | 2.60   |        |

Rainfall Intensity Equation Coefficients =  $I(\text{in/hr}) = \frac{a \cdot P_1}{(b + t_c)^c}$

$Q(\text{cfs}) = CIA$

| Subcatchment Name | Area (ac) | NRCS Hydrologic Soil Group | Percent Imperviousness | Runoff Coefficient, C |      |       |       |       |        |        | Overland (Initial) Flow Time             |                               |                               |  |   |   | Channelized (Travel) Flow Time |                               |   |                          |   |  | Time of Concentration         |                               |                               | Rainfall Intensity, I (in/hr) |      |       |       |       |        | Peak Flow, Q (cfs) |      |      |       |       |       |        |        |
|-------------------|-----------|----------------------------|------------------------|-----------------------|------|-------|-------|-------|--------|--------|--|-------------------------------|-------------------------------|--|---|---|--------------------------------|-------------------------------|---|--------------------------|---|--|-------------------------------|-------------------------------|-------------------------------|-------------------------------|------|-------|-------|-------|--------|--------------------|------|------|-------|-------|-------|--------|--------|
|                   |           |                            |                        | 2-yr                  | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr | 500-yr | Overland Flow Length L <sub>i</sub> (ft) | U/S Elevation (ft) (Optional) | D/S Elevation (ft) (Optional) | Overland Flow Slope S <sub>i</sub> (ft/ft) | Overland Flow Time t <sub>i</sub> (min) | Channelized Flow Length L <sub>i</sub> (ft) | U/S Elevation (ft) (Optional)  | D/S Elevation (ft) (Optional) | Channelized Flow Slope S <sub>i</sub> (ft/ft) | NRCS Conveyance Factor K | Channelized Flow Velocity V <sub>i</sub> (ft/sec) | Channelized Flow Time t <sub>i</sub> (min) | Computed t <sub>c</sub> (min) | Regional t <sub>c</sub> (min) | Selected t <sub>c</sub> (min) | 2-yr                          | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr | 500-yr             | 2-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr | 500-yr |
| ST-1              | 0.40      | B                          | 90.0                   | 0.74                  | 0.76 | 0.78  | 0.81  | 0.83  | 0.84   | 0.87   | 115.00                                   |                               |                               | 0.030                                      | 4.52                                    | 0.00  |                                |                               | 0.100   | 20                       | 6.32  | 0.00                                       | 4.52                          | 10.70                         | 5.00                          | 3.36                          | 4.71 |       |       |       |        | 8.82               | 0.99 | 1.44 |       |       |       |        | 2.98   |
| ST-2              | 0.15      | B                          | 90.0                   | 0.74                  | 0.76 | 0.78  | 0.81  | 0.83  | 0.84   | 0.87   | 75.00                                    |                               |                               | 0.100                                      | 2.46                                    | 0.00  |                                |                               | 0.100   | 20                       | 6.32  | 0.00                                       | 2.46                          | 10.70                         | 5.00                          | 3.36                          | 4.71 |       |       |       |        | 8.82               | 0.37 | 0.54 |       |       |       |        | 1.12   |
| ST-3              | 0.37      | D                          | 90.0                   | 0.74                  | 0.77 | 0.79  | 0.82  | 0.84  | 0.85   | 0.87   | 150.00                                   |                               |                               | 0.030                                      | 5.10                                    | 0.00  |                                |                               | 0.100   | 20                       | 6.32  | 0.00                                       | 5.10                          | 10.70                         | 5.10                          | 3.34                          | 4.69 |       |       |       |        | 8.77               | 0.92 | 1.33 |       |       |       |        | 2.77   |
| ST-3 Roof         | 0.15      | D                          | 90.0                   | 0.74                  | 0.77 | 0.79  | 0.82  | 0.84  | 0.85   | 0.87   | 75.00                                    |                               |                               | 0.100                                      | 2.42                                    | 0.00  |                                |                               | 0.100   | 20                       | 6.32  | 0.00                                       | 2.42                          | 10.70                         | 5.00                          | 3.36                          | 4.71 |       |       |       |        | 8.82               | 0.37 | 0.54 |       |       |       |        | 1.13   |
| EX-1              | 0.28      | B                          | 25.0                   | 0.17                  | 0.19 | 0.26  | 0.41  | 0.47  | 0.54   | 0.63   | 200.00                                   |                               |                               | 0.020                                      | 18.49                                   | 0.00  |                                |                               | 0.100   | 20                       | 6.32  | 0.00                                       | 18.49                         | 21.75                         | 15.00                         | 2.03                          | 2.85 |       |       |       |        | 5.33               | 0.09 | 0.15 |       |       |       |        | 0.81   |

**INLET MANAGEMENT**

Worksheet Protected

| INLET NAME                         | ST-1                     | ST-3                     | EX-1        |
|------------------------------------|--------------------------|--------------------------|-------------|
| Site Type (Urban or Rural)         | URBAN                    | URBAN                    | URBAN       |
| Inlet Application (Street or Area) | STREET                   | STREET                   | AREA        |
| Hydraulic Condition                | In Sump                  | In Sump                  | Swale       |
| Inlet Type                         | CDOT Type R Curb Opening | CDOT Type R Curb Opening | CDOT Type C |

**USER-DEFINED INPUT**

| <b>User-Defined Design Flows</b>              |                         |                         |                         |
|---|-------------------------|-------------------------|-------------------------|
| Minor $Q_{kdown}$ (cfs)                       | 1.4                     | 1.3                     | 0.2                     |
| Major $Q_{kdown}$ (cfs)                       | 3.0                     | 2.8                     | 0.9                     |
| <b>Bypass (Carry-Over) Flow from Upstream</b> |                         |                         |                         |
| Receive Bypass Flow from:                     | No Bypass Flow Received | No Bypass Flow Received | No Bypass Flow Received |
| Minor Bypass Flow Received, $Q_b$ (cfs)       | 0.0                     | 0.0                     | 0.0                     |
| Major Bypass Flow Received, $Q_b$ (cfs)       | 0.0                     | 0.0                     | 0.0                     |
| <b>Watershed Characteristics</b>              |                         |                         |                         |
| Subcatchment Area (acres)                     |                         |                         |                         |
| Percent Impervious                            |                         |                         |                         |
| NRCS Soil Type                                |                         |                         |                         |
| <b>Watershed Profile</b>                      |                         |                         |                         |
| Overland Slope (ft/ft)                        |                         |                         |                         |
| Overland Length (ft)                          |                         |                         |                         |
| Channel Slope (ft/ft)                         |                         |                         |                         |
| Channel Length (ft)                           |                         |                         |                         |
| <b>Minor Storm Rainfall Input</b>             |                         |                         |                         |
| Design Storm Return Period, $T_r$ (years)     |                         |                         |                         |
| One-Hour Precipitation, $P_1$ (inches)        |                         |                         |                         |
| <b>Major Storm Rainfall Input</b>             |                         |                         |                         |
| Design Storm Return Period, $T_r$ (years)     |                         |                         |                         |
| One-Hour Precipitation, $P_1$ (inches)        |                         |                         |                         |

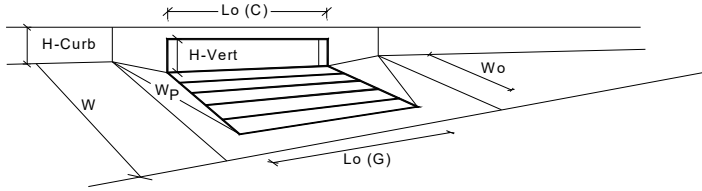
**CALCULATED OUTPUT**

| <b>Minor Total Design Peak Flow, Q (cfs)</b>          | <b>1.4</b> | <b>1.3</b> | <b>0.2</b> |
|---|------------|------------|------------|
| <b>Major Total Design Peak Flow, Q (cfs)</b>          | <b>3.0</b> | <b>2.8</b> | <b>0.9</b> |
| Minor Flow Bypassed Downstream, $Q_b$ (cfs)           | N/A        | N/A        | 0.0        |
| Major Flow Bypassed Downstream, $Q_b$ (cfs)           | N/A        | N/A        | 0.0        |
| <b>Minor Storm (Calculated) Analysis of Flow Time</b> |            |            |            |
| C   | N/A        | N/A        | N/A        |
| $C_s$   | N/A        | N/A        | N/A        |
| Overland Flow Velocity, $V_i$                         | N/A        | N/A        | N/A        |
| Channel Flow Velocity, $V_t$                          | N/A        | N/A        | N/A        |
| Overland Flow Time, $T_i$                             | N/A        | N/A        | N/A        |
| Channel Travel Time, $T_t$                            | N/A        | N/A        | N/A        |
| Calculated Time of Concentration, $T_c$               | N/A        | N/A        | N/A        |
| Regional $T_c$  | N/A        | N/A        | N/A        |
| Recommended $T_c$                                     | N/A        | N/A        | N/A        |
| $T_c$ selected by User                                | N/A        | N/A        | N/A        |
| Design Rainfall Intensity, $I$                        | N/A        | N/A        | N/A        |
| Calculated Local Peak Flow, $Q_p$                     | N/A        | N/A        | N/A        |
| <b>Major Storm (Calculated) Analysis of Flow Time</b> |            |            |            |
| C   | N/A        | N/A        | N/A        |
| $C_s$   | N/A        | N/A        | N/A        |
| Overland Flow Velocity, $V_i$                         | N/A        | N/A        | N/A        |
| Channel Flow Velocity, $V_t$                          | N/A        | N/A        | N/A        |
| Overland Flow Time, $T_i$                             | N/A        | N/A        | N/A        |
| Channel Travel Time, $T_t$                            | N/A        | N/A        | N/A        |
| Calculated Time of Concentration, $T_c$               | N/A        | N/A        | N/A        |
| Regional $T_c$  | N/A        | N/A        | N/A        |
| Recommended $T_c$                                     | N/A        | N/A        | N/A        |
| $T_c$ selected by User                                | N/A        | N/A        | N/A        |
| Design Rainfall Intensity, $I$                        | N/A        | N/A        | N/A        |
| Calculated Local Peak Flow, $Q_p$                     | N/A        | N/A        | N/A        |



## INLET IN A SUMP OR SAG LOCATION

Version 4.06 Released August 2018



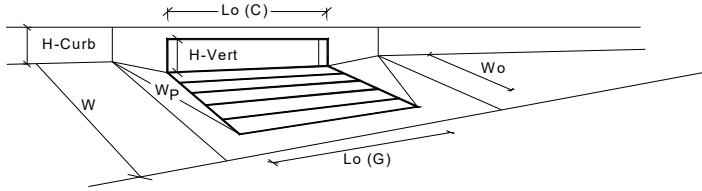
| Design Information (Input)   | MINOR                    | MAJOR |  |
|--|--------------------------|-------|--|
| Type of Inlet  | CDOT Type R Curb Opening |       |  |
| Local Depression (additional to continuous gutter depression 'a' from above) | 3.00                     | 3.00  | inches                                   |
| Number of Unit Inlets (Grate or Curb Opening)                                | 1                        | 1     |  |
| Water Depth at Flowline (outside of local depression)                        | 6.0                      | 6.0   | inches                                   |
| <b>Grate Information</b>   | MINOR                    | MAJOR | <input type="checkbox"/> Override Depths |
| Length of a Unit Grate   | N/A                      | N/A   | feet                                     |
| Width of a Unit Grate  | N/A                      | N/A   | feet                                     |
| Area Opening Ratio for a Grate (typical values 0.15-0.90)                    | N/A                      | N/A   |  |
| Clogging Factor for a Single Grate (typical value 0.50 - 0.70)               | N/A                      | N/A   |  |
| Grate Weir Coefficient (typical value 2.15 - 3.60)                           | N/A                      | N/A   |  |
| Grate Orifice Coefficient (typical value 0.60 - 0.80)                        | N/A                      | N/A   |  |
| <b>Curb Opening Information</b>  | MINOR                    | MAJOR |  |
| Length of a Unit Curb Opening  | 5.00                     | 5.00  | feet                                     |
| Height of Vertical Curb Opening in Inches                                    | 6.00                     | 6.00  | inches                                   |
| Height of Curb Orifice Throat in Inches                                      | 6.00                     | 6.00  | inches                                   |
| Angle of Throat (see USDCM Figure ST-5)                                      | 63.40                    | 63.40 | degrees                                  |
| Side Width for Depression Pan (typically the gutter width of 2 feet)         | 2.00                     | 2.00  | feet                                     |
| Clogging Factor for a Single Curb Opening (typical value 0.10)               | 0.10                     | 0.10  |  |
| Curb Opening Weir Coefficient (typical value 2.3-3.7)                        | 3.60                     | 3.60  |  |
| Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)                 | 0.67                     | 0.67  |  |
| <b>Low Head Performance Reduction (Calculated)</b>                           | MINOR                    | MAJOR |  |
| Depth for Grate Midwidth   | N/A                      | N/A   | ft                                       |
| Depth for Curb Opening Weir Equation   | 0.33                     | 0.33  | ft                                       |
| Combination Inlet Performance Reduction Factor for Long Inlets               | 0.77                     | 0.77  |  |
| Curb Opening Performance Reduction Factor for Long Inlets                    | 1.00                     | 1.00  |  |
| Grated Inlet Performance Reduction Factor for Long Inlets                    | N/A                      | N/A   |  |
| <b>Total Inlet Interception Capacity (assumes clogged condition)</b>         | MINOR                    | MAJOR |  |
| <b>Q<sub>a</sub></b>   | 5.4                      | 5.4   | cfs                                      |
| <b>Q<sub>PEAK REQUIRED</sub></b>   | 1.4                      | 3.0   | cfs                                      |

**Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)**



## INLET IN A SUMP OR SAG LOCATION

Version 4.06 Released August 2018

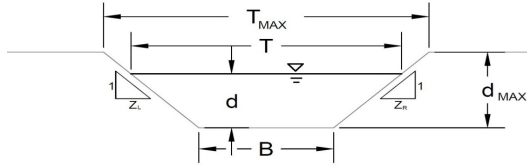


| Design Information (Input)   | CDOT Type R Curb Opening               |  |
|--|--|--|
| Type of Inlet  | Type = <b>CDOT Type R Curb Opening</b> |  |
| Local Depression (additional to continuous gutter depression 'a' from above) | $a_{local} = 3.00$                     | 3.00 inches                                    |
| Number of Unit Inlets (Grate or Curb Opening)                                | No = 1                                 | 1  |
| Water Depth at Flowline (outside of local depression)                        | Ponding Depth = 6.0                    | 6.0 inches                                     |
| <b>Grate Information</b>   | MINOR                                  | MAJOR <input type="checkbox"/> Override Depths |
| Length of a Unit Grate   | $L_o (G) = N/A$                        | N/A feet                                       |
| Width of a Unit Grate  | $W_o = N/A$                            | N/A feet                                       |
| Area Opening Ratio for a Grate (typical values 0.15-0.90)                    | $A_{ratio} = N/A$                      | N/A  |
| Clogging Factor for a Single Grate (typical value 0.50 - 0.70)               | $C_r (G) = N/A$                        | N/A  |
| Grate Weir Coefficient (typical value 2.15 - 3.60)                           | $C_w (G) = N/A$                        | N/A  |
| Grate Orifice Coefficient (typical value 0.60 - 0.80)                        | $C_o (G) = N/A$                        | N/A  |
| <b>Curb Opening Information</b>  | MINOR                                  | MAJOR  |
| Length of a Unit Curb Opening  | $L_o (C) = 5.00$                       | 5.00 feet                                      |
| Height of Vertical Curb Opening in Inches                                    | $H_{vert} = 6.00$                      | 6.00 inches                                    |
| Height of Curb Orifice Throat in Inches                                      | $H_{throat} = 6.00$                    | 6.00 inches                                    |
| Angle of Throat (see USDCM Figure ST-5)                                      | Theta = 63.40                          | 63.40 degrees                                  |
| Side Width for Depression Pan (typically the gutter width of 2 feet)         | $W_p = 2.00$                           | 2.00 feet                                      |
| Clogging Factor for a Single Curb Opening (typical value 0.10)               | $C_r (C) = 0.10$                       | 0.10   |
| Curb Opening Weir Coefficient (typical value 2.3-3.7)                        | $C_w (C) = 3.60$                       | 3.60   |
| Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)                 | $C_o (C) = 0.67$                       | 0.67   |
| <b>Low Head Performance Reduction (Calculated)</b>                           | MINOR                                  | MAJOR  |
| Depth for Grate Midwidth   | $d_{grate} = N/A$                      | N/A ft   |
| Depth for Curb Opening Weir Equation   | $d_{curb} = 0.33$                      | 0.33 ft  |
| Combination Inlet Performance Reduction Factor for Long Inlets               | $RF_{Combination} = 0.77$              | 0.77   |
| Curb Opening Performance Reduction Factor for Long Inlets                    | $RF_{Curb} = 1.00$                     | 1.00   |
| Grated Inlet Performance Reduction Factor for Long Inlets                    | $RF_{Grate} = N/A$                     | N/A  |
| <b>Total Inlet Interception Capacity (assumes clogged condition)</b>         | MINOR                                  | MAJOR  |
|  | $Q_a = 5.4$                            | 5.4 cfs  |
| Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)                   | $Q_{PEAK REQUIRED} = 1.3$              | 2.8 cfs  |

## AREA INLET IN A SWALE

New Horizon Academy, Parker, CO

EX-1



This worksheet uses the NRCS vegetative retardance method to determine Manning's n.  
For more information see Section 7.2.3 of the USDCM.

| <b>Analysis of Trapezoidal Grass-Lined Channel Using SCS Method</b>   |  |                                    |                                    |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
|---|--|------------------------------------|------------------------------------|-------------------------------|-------------|-----------------|----------------------|---------|------|-------|----------------------|------|--|----|-------------|-------------|--|---|-------|-------|------|---|------|------|------|
| NRCS Vegetal Retardance (A, B, C, D, or E)<br>Manning's n (Leave cell D16 blank to manually enter an n value)<br>Channel Invert Slope<br>Bottom Width<br>Left Side Slope<br>Right Side Slope<br>Check one of the following soil types:  | A, B, C, D or E<br><table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td style="text-align: center;">D</td></tr> <tr><td style="text-align: center;">see details below</td></tr> <tr><td style="text-align: center;">S<sub>0</sub> = 0.0600 ft/ft</td></tr> <tr><td style="text-align: center;">B = 0.00 ft</td></tr> <tr><td style="text-align: center;">Z1 = 0.29 ft/ft</td></tr> <tr><td style="text-align: center;">Z2 = 0.28 ft/ft</td></tr> </table> Choose One:<br><input checked="" type="checkbox"/> Non-Cohesive<br><input type="checkbox"/> Cohesive<br><input type="checkbox"/> Paved | D                                  | see details below                  | S <sub>0</sub> = 0.0600 ft/ft | B = 0.00 ft | Z1 = 0.29 ft/ft | Z2 = 0.28 ft/ft      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
| D   |  |                                    |                                    |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
| see details below   |  |                                    |                                    |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
| S <sub>0</sub> = 0.0600 ft/ft   |  |                                    |                                    |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
| B = 0.00 ft   |  |                                    |                                    |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
| Z1 = 0.29 ft/ft   |  |                                    |                                    |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
| Z2 = 0.28 ft/ft   |  |                                    |                                    |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
| <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Soil Type:</th> <th style="text-align: left;">Max. Velocity (V<sub>MAX</sub>)</th> <th style="text-align: left;">Max Froude No. (F<sub>MAX</sub>)</th> </tr> </thead> <tbody> <tr> <td>Non-Cohesive</td> <td>5.0 fps</td> <td>0.60</td> </tr> <tr> <td>Cohesive</td> <td>7.0 fps</td> <td>0.80</td> </tr> <tr> <td>Paved</td> <td>N/A</td> <td>N/A</td> </tr> </tbody> </table> | Soil Type:   | Max. Velocity (V <sub>MAX</sub> )  | Max Froude No. (F <sub>MAX</sub> ) | Non-Cohesive                  | 5.0 fps     | 0.60            | Cohesive             | 7.0 fps | 0.80 | Paved | N/A                  | N/A  | <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th style="text-align: center;">Minor Storm</th> <th style="text-align: center;">Major Storm</th> <th></th> </tr> </thead> <tbody> <tr> <td>Max. Allowable Top Width of Channel for Minor &amp; Major Storm</td> <td style="text-align: center;">10.00</td> <td style="text-align: center;">10.00</td> <td style="text-align: right;">feet</td> </tr> <tr> <td>Max. Allowable Water Depth in Channel for Minor &amp; Major Storm</td> <td style="text-align: center;">1.40</td> <td style="text-align: center;">1.40</td> <td style="text-align: right;">feet</td> </tr> </tbody> </table> |    | Minor Storm | Major Storm |  | Max. Allowable Top Width of Channel for Minor & Major Storm | 10.00 | 10.00 | feet | Max. Allowable Water Depth in Channel for Minor & Major Storm | 1.40 | 1.40 | feet |
| Soil Type:  | Max. Velocity (V <sub>MAX</sub> )  | Max Froude No. (F <sub>MAX</sub> ) |                                    |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
| Non-Cohesive  | 5.0 fps  | 0.60                               |                                    |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
| Cohesive  | 7.0 fps  | 0.80                               |                                    |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
| Paved   | N/A  | N/A                                |                                    |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
|   | Minor Storm  | Major Storm                        |                                    |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
| Max. Allowable Top Width of Channel for Minor & Major Storm   | 10.00  | 10.00                              | feet                               |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
| Max. Allowable Water Depth in Channel for Minor & Major Storm   | 1.40   | 1.40                               | feet                               |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
| <b>Allowable Channel Capacity Based On Channel Geometry</b>   |  |                                    |                                    |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
| MINOR STORM Allowable Capacity is based on Depth Criterion<br>MAJOR STORM Allowable Capacity is based on Depth Criterion  | <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th style="text-align: center;">Minor Storm</th> <th style="text-align: center;">Major Storm</th> <th></th> </tr> </thead> <tbody> <tr> <td>Q<sub>allow</sub> =</td> <td style="text-align: center;">0.4</td> <td style="text-align: center;">0.4</td> <td style="text-align: right;">cfs</td> </tr> <tr> <td>d<sub>allow</sub> =</td> <td style="text-align: center;">1.40</td> <td style="text-align: center;">1.40</td> <td style="text-align: right;">ft</td> </tr> </tbody> </table>                                    |                                    |                                    | Minor Storm                   | Major Storm |                 | Q <sub>allow</sub> = | 0.4     | 0.4  | cfs   | d <sub>allow</sub> = | 1.40 | 1.40   | ft |             |             |  |   |       |       |      |   |      |      |      |
|   | Minor Storm  | Major Storm                        |                                    |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
| Q <sub>allow</sub> =  | 0.4  | 0.4                                | cfs                                |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
| d <sub>allow</sub> =  | 1.40   | 1.40                               | ft                                 |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
| <b>Water Depth in Channel Based On Design Peak Flow</b>   |  |                                    |                                    |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
| Design Peak Flow<br>Water Depth   | <table border="1" style="width: 100%; border-collapse: collapse;"> <tbody> <tr> <td>Q<sub>c</sub> =</td> <td style="text-align: center;">0.2</td> <td style="text-align: center;">0.9</td> <td style="text-align: right;">cfs</td> </tr> <tr> <td>d =</td> <td style="text-align: center;">1.08</td> <td style="text-align: center;">1.63</td> <td style="text-align: right;">feet</td> </tr> </tbody> </table>  |                                    | Q <sub>c</sub> =                   | 0.2                           | 0.9         | cfs             | d =                  | 1.08    | 1.63 | feet  |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
| Q <sub>c</sub> =  | 0.2  | 0.9                                | cfs                                |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
| d =   | 1.08   | 1.63                               | feet                               |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |
| Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'<br>WARNING: MAJOR STORM max. allowable capacity is less than the design flow given on sheet 'Inlet Management'  |  |                                    |                                    |                               |             |                 |                      |         |      |       |                      |      |  |    |             |             |  |   |       |       |      |   |      |      |      |

Warning 01  
Warning 01

Warning 05

## AREA INLET IN A SWALE

New Horizon Academy, Parker, CO

EX-1

**Inlet Design Information (Input)**

Type of Inlet: CDOT Type C      Inlet Type = CDOT Type C

Angle of Inclined Grate (must be <= 30 degrees)       $\theta = 0.00$  degrees

Width of Grate       $W = 3.00$  feet

Length of Grate       $L = 3.00$  feet

Open Area Ratio       $A_{RATIO} = 0.70$

Height of Inclined Grate       $H_B = 0.00$  feet

Clogging Factor       $C_f = 0.50$

Grate Discharge Coefficient       $C_d = 0.96$

Orifice Coefficient       $C_o = 0.64$

Weir Coefficient       $C_w = 2.05$

|  | MINOR       | MAJOR       |            |
|--|-------------|-------------|------------|
| $d =$  | 1.08        | 1.63        |            |
| <b><math>Q_a =</math></b>                              | <b>16.8</b> | <b>20.7</b> | <b>cfs</b> |
| <b>Bypassed Flow, <math>Q_b =</math></b>               | <b>0.0</b>  | <b>0.0</b>  | <b>cfs</b> |
| <b>Capture Percentage = <math>Q_a/Q_o = C\%</math></b> | <b>100</b>  | <b>100</b>  | <b>%</b>   |

**Total Inlet Interception Capacity (assumes clogged condition)**

Warning 01: Sideslope steepness exceeds USDCM Volume I recommendation.

Warning 02: Depth (d) exceeds USDCM Volume I recommendation.

Warning 05: Depth (d) exceeds max allowable depth (dmax).

## Design Procedure Form: Grass Swale (GS)

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 1

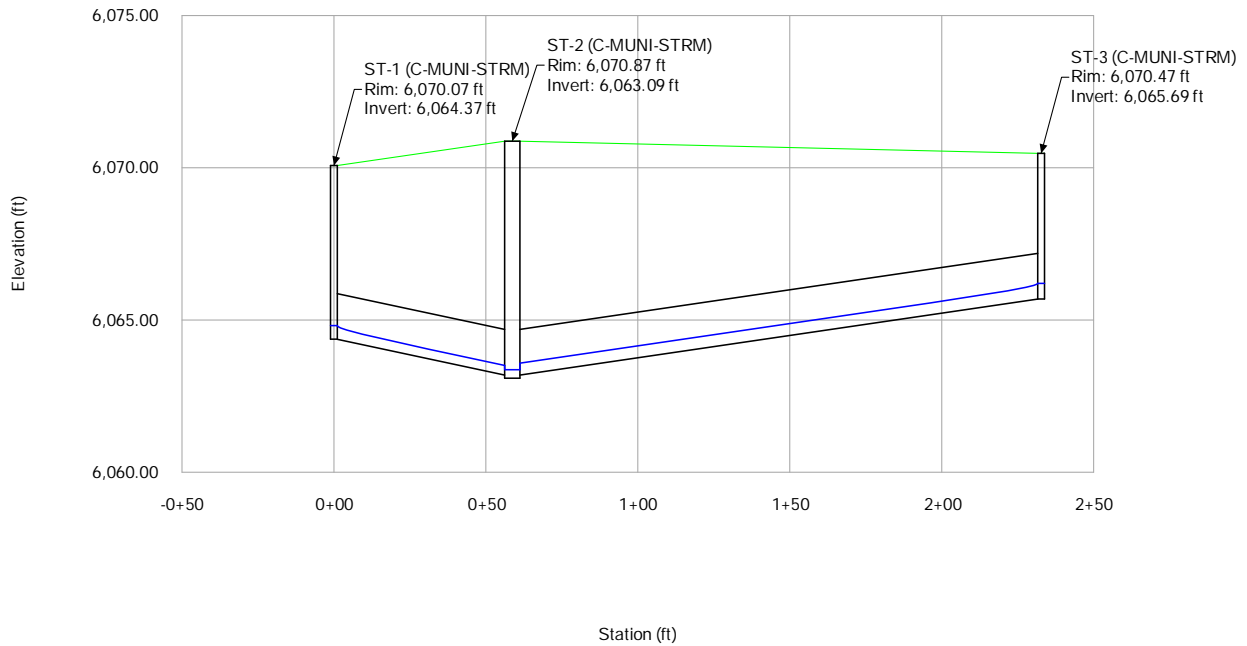
**Designer:** Alex Popp  
**Company:** SEH Inc.  
**Date:** August 26, 2020  
**Project:** New Horizon Academy  
**Location:** Parker, CO

|   |   |
|---|---|
| 1. Design Discharge for 2-Year Return Period  | $Q_2 = $ <input style="width: 50px;" type="text" value="0.16"/> cfs   |
| 2. Hydraulic Residence Time<br>A) : Length of Grass Swale<br>B) Calculated Residence Time (based on design velocity below)  | $L_S = $ <input style="width: 50px;" type="text" value="254.0"/> ft<br>$T_{HR} = $ <input style="width: 50px;" type="text" value="6.7"/> minutes  |
| 3. Longitudinal Slope (vertical distance per unit horizontal)<br>A) Available Slope (based on site constraints)<br>B) Design Slope  | $S_{avail} = $ <input style="width: 50px;" type="text" value="0.015"/> ft / ft<br>$S_D = $ <input style="width: 50px;" type="text" value="0.015"/> ft / ft  |
| 4. Swale Geometry<br>A) Channel Side Slopes (Z = 4 min., horiz. distance per unit vertical)<br>B) Bottom Width of Swale (enter 0 for triangular section)  | $Z = $ <input style="width: 50px;" type="text" value="3.00"/> ft / ft <span style="color: red; font-weight: bold;">TOO STEEP (&lt; 4)</span><br>$W_B = $ <input style="width: 50px;" type="text" value="0.00"/> ft  |
| 5. Vegetation<br>A) Type of Planting (seed vs. sod, affects vegetal retardance factor)  | Choose One <input type="checkbox"/> <input checked="" type="radio"/> Grass From Seed <input type="checkbox"/> Grass From Sod  |
| 6. Design Velocity (0.847 ft / s maximum for desirable 5-minute residence time)   | $V_2 = $ <input style="width: 50px;" type="text" value="0.63"/> ft / s  |
| 7. Design Flow Depth (1 foot maximum)<br>A) Flow Area<br>B) Top Width of Swale<br>C) Froude Number (0.50 maximum)<br>D) Hydraulic Radius<br>E) Velocity-Hydraulic Radius Product for Vegetal Retardance<br>F) Manning's n (based on SCS vegetal retardance curve E for seeded grass)<br>G) Cumulative Height of Grade Control Structures Required | $D_2 = $ <input style="width: 50px;" type="text" value="0.29"/> ft<br>$A_2 = $ <input style="width: 50px;" type="text" value="0.3"/> sq ft<br>$W_T = $ <input style="width: 50px;" type="text" value="1.7"/> ft<br>$F = $ <input style="width: 50px;" type="text" value="0.29"/><br>$R_H = $ <input style="width: 50px;" type="text" value="0.14"/><br>$VR = $ <input style="width: 50px;" type="text" value="0.09"/><br>$n = $ <input style="width: 50px;" type="text" value="0.080"/><br>$H_D = $ <input style="width: 50px;" type="text" value="0.00"/> ft |
| 8. Underdrain<br>(Is an underdrain necessary?)  | Choose One <input checked="" type="radio"/> YES <input type="radio"/> NO <span style="color: blue; font-weight: bold; font-size: small;">AN UNDERDRAIN IS REQUIRED IF THE DESIGN SLOPE &lt; 2.0%</span>   |
| 9. Soil Preparation<br>(Describe soil amendment)  | _____<br>_____<br>_____   |
| 10. Irrigation  | Choose One <input type="radio"/> Temporary <input checked="" type="radio"/> Permanent   |

Notes: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

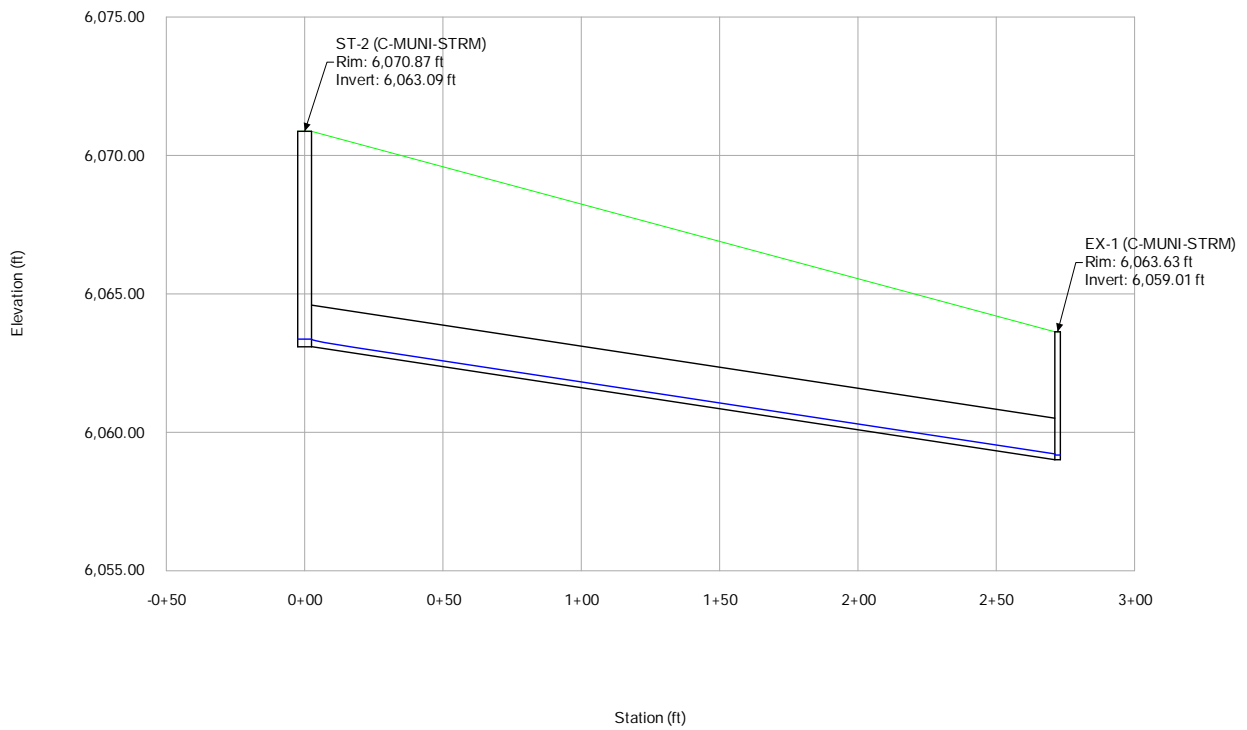
# 5-Year Storm Event Profile Report

## Engineering Profile - Profile - 1 (NHOAC156217 StormCAD.stsw)



# 5-Year Storm Event Profile Report

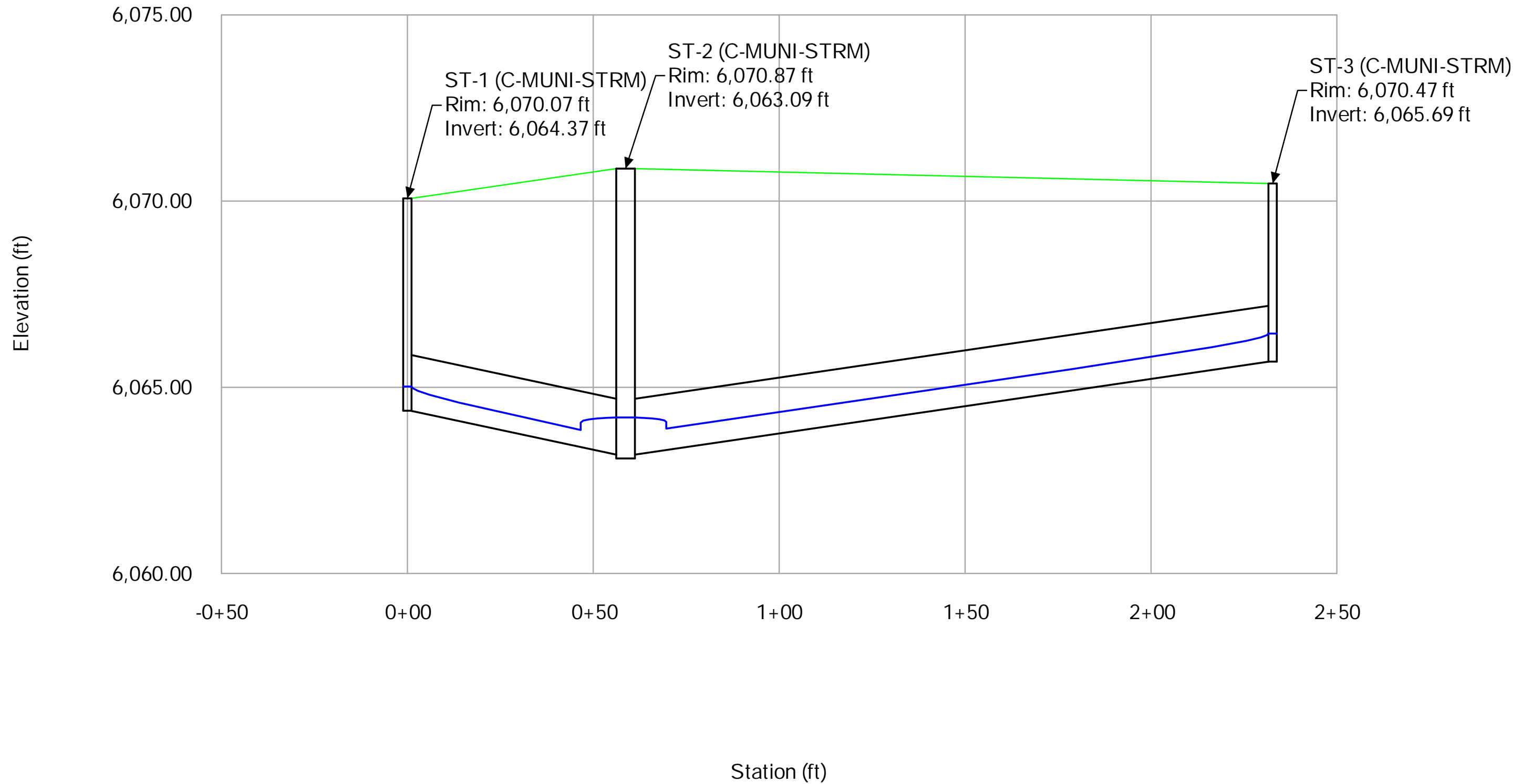
## Engineering Profile - Profile - 2 (NHOAC156217 StormCAD.stsw)



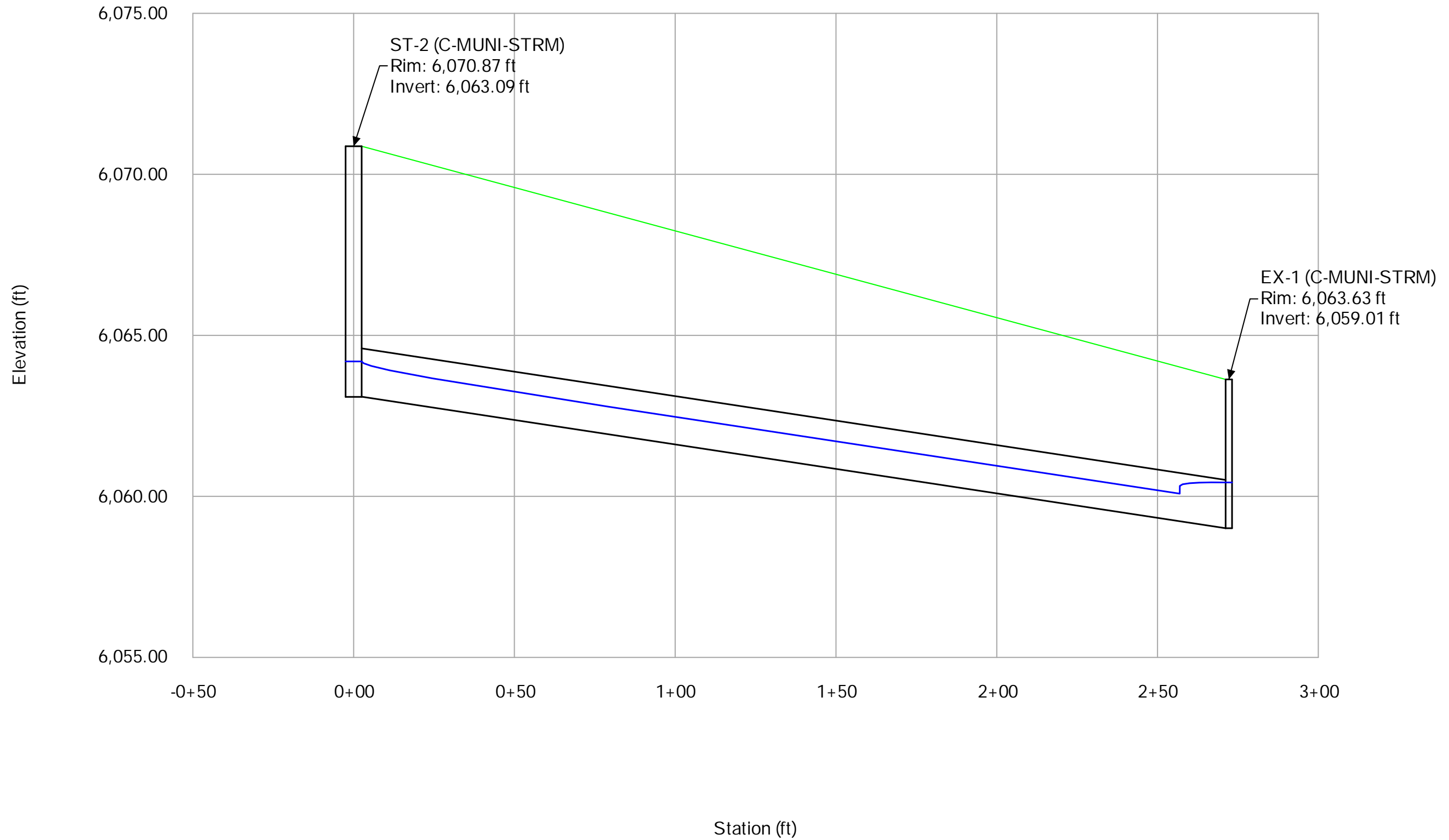
5-Year Storm Event  
Conduit FlexTable: Combined Pipe/Node Report

| Label                  | Start Node         | Stop Node          | Length (Unified)<br>(ft) | Flow<br>(cfs) | Rise (Unified)<br>(ft) | Capacity (Full<br>Flow)<br>(cfs) | Velocity<br>(ft/s) | Invert (Start)<br>(ft) | Invert (Stop)<br>(ft) | Slope<br>(Calculated)<br>(ft/ft) | Notes             | Hydraulic Grade<br>Line (In)<br>(ft) | Hydraulic Grade<br>Line (Out)<br>(ft) |
|------------------------|--------------------|--------------------|--------------------------|---------------|------------------------|----------------------------------|--------------------|------------------------|-----------------------|----------------------------------|-------------------|--------------------------------------|---------------------------------------|
| Pipe - 3 (C-MUNI-STRM) | ST-2 (C-MUNI-STRM) | EX-1 (C-MUNI-STRM) | 272.2                    | 0.54          | 1.50                   | 12.86                            | 3.60               | 6,063.09               | 6,059.01              | 0.015                            | 18" RCP Class III | 6,063.37                             | 6,059.22                              |
| Pipe - 2 (C-MUNI-STRM) | ST-3 (C-MUNI-STRM) | ST-2 (C-MUNI-STRM) | 174.0                    | 1.88          | 1.50                   | 12.58                            | 5.11               | 6,065.69               | 6,063.19              | 0.014                            | 18" RCP Class IV  | 6,066.20                             | 6,063.58                              |
| Pipe - 1 (C-MUNI-STRM) | ST-1 (C-MUNI-STRM) | ST-2 (C-MUNI-STRM) | 58.7                     | 1.44          | 1.50                   | 14.85                            | 5.33               | 6,064.37               | 6,063.19              | 0.020                            | 18" RCP Class IV  | 6,064.82                             | 6,063.51                              |
| CO-2                   | EX-1 (C-MUNI-STRM) | O-1                | 35.2                     | 0.17          | 1.50                   | 31.15                            | 4.70               | 6,059.01               | 6,055.92              | 0.088                            |                   | 6,059.16                             | 6,056.00                              |

100-Year Storm Event  
 Profile Report  
 Engineering Profile - Profile - 1 (NHOAC156217 StormCAD 100-Year.stsw)



100-Year Storm Event  
Profile Report  
Engineering Profile - Profile - 2 (NHOAC156217 StormCAD 100-Year.stsw)



100-Year Storm Event  
Conduit FlexTable: Combined Pipe/Node Report

| Label                  | Start Node         | Stop Node          | Length (Unified)<br>(ft) | Flow<br>(cfs) | Rise (Unified)<br>(ft) | Capacity (Full<br>Flow)<br>(cfs) | Velocity<br>(ft/s) | Invert (Start)<br>(ft) | Invert (Stop)<br>(ft) | Slope<br>(Calculated)<br>(ft/ft) | Notes             | Hydraulic Grade<br>Line (In)<br>(ft) | Hydraulic Grade<br>Line (Out)<br>(ft) |
|------------------------|--------------------|--------------------|--------------------------|---------------|------------------------|----------------------------------|--------------------|------------------------|-----------------------|----------------------------------|-------------------|--------------------------------------|---------------------------------------|
| Pipe - 3 (C-MUNI-STRM) | ST-2 (C-MUNI-STRM) | EX-1 (C-MUNI-STRM) | 272.2                    | 8.01          | 1.50                   | 12.86                            | 7.67               | 6,063.09               | 6,059.01              | 0.015                            | 18" RCP Class III | 6,064.19                             | 6,060.43                              |
| Pipe - 2 (C-MUNI-STRM) | ST-3 (C-MUNI-STRM) | ST-2 (C-MUNI-STRM) | 174.0                    | 3.91          | 1.50                   | 12.58                            | 6.28               | 6,065.69               | 6,063.19              | 0.014                            | 18" RCP Class IV  | 6,066.44                             | 6,064.19                              |
| Pipe - 1 (C-MUNI-STRM) | ST-1 (C-MUNI-STRM) | ST-2 (C-MUNI-STRM) | 58.7                     | 2.98          | 1.50                   | 14.85                            | 6.57               | 6,064.37               | 6,063.19              | 0.020                            | 18" RCP Class IV  | 6,065.02                             | 6,064.19                              |
| CO-2                   | EX-1 (C-MUNI-STRM) | O-1                | 35.2                     | 15.80         | 1.50                   | 31.15                            | 17.70              | 6,059.01               | 6,055.92              | 0.088                            |                   | 6,060.43                             | 6,056.78                              |