

-2010-001-



SHAFFER, KLINE & WARREN, INC.

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JAN 19 2010

Planning & Development



December 18, 2009

Mr. Kent Monter  
Development Review Manager  
City of Lee's Summit  
220 SE Green St  
Lee's Summit, Missouri 64083

Re: Stormwater Calculations—Building F (Saint Luke's East Hospital)

Dear Mr. Monter:

We have performed the stormwater runoff calculations for the new Building "F" on the Saint Luke's hospital site on the southwest corner of Interstate 470 and Douglas Road.

Existing runoff patterns in the Building "F" area drained westerly into storm sewers and bypassed the detention basin. Proposed runoff patterns show approximately two-thirds (0.42 acres) of the runoff from the Building "F" area draining westerly into the previously mentioned storm sewers, eventually going off-site without passing through the existing detention basin. The remaining one-third (0.21 acres) of the runoff from the Building "F" area drains northerly via new storm sewer and ties in to the existing detention basin. The detention basin was initially designed so that the post-development flow was equal to or below the pre-development flow for the 25-year storm (per City of Lee's Summit design criteria at the time). The maximum release rate based on previous analysis was 142cfs, but the detention basin was designed with a peak outflow of 93.28cfs for the 25-year storm.

The attached Pondpack and CulvertMaster calculations are provided to show the effects of the increased impervious area on the site and the subsequent flows going toward the detention basin and the culvert immediately downstream on the northwest corner of the site (an 8' x 5' RCB heading north under Interstate-470).

The following table summarizes the flows before and after Building "F" is placed. These flows take an area larger than the footprint affected by Building "F", but they do show the changes in runoff as a result of the Building "F" construction.

| Flow Location-----Pondpack Node Name (Hydrology)                  | Flow Case | Flows (cfs) |          |
|-------------------------------------------------------------------|-----------|-------------|----------|
|                                                                   |           | 25-year     | 100-year |
| Undetained-----"EX-DEV-UNDET2" (DA=12.70ac, CN=83, $t_c$ =10min)  | Existing  | 72.30       | 96.25    |
| Undetained-----"PRO-DEV-UNDET2" (DA=12.49ac, CN=84, $t_c$ =10min) | Proposed  | 72.52       | 96.06    |
| Detained-----"EX-DEV-DET" (DA=26.11ac, CN=87, $t_c$ =15min)       | Existing  | 142.97      | 186.89   |
| Detained-----"PRO-DEV-DET" (DA=26.32ac, CN=87, $t_c$ =15min)      | Proposed  | 144.12      | 188.39   |
| RCB Under Interstate 470                                          | Existing  |             | 502.97   |
| RCB Under Interstate 470                                          | Proposed  |             | 502.87   |



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If runoff from both detained and undetained areas were added together, the 25-year storm flows change from 215.27cfs to 216.64cfs (higher by 0.6%) and the 100-year storm flows change from 283.14cfs to 284.45cfs (higher by 0.4%).

All of the flow from the building addition will be captured via roof drains and storm sewers. None of the existing on-site storm sewer pipes will be effected as a result of the increased impervious area. The 25-year flow leaving the detention basin is 96.21cfs, which is 3.1% higher than the outflow from the initial analysis of 93.28cfs.

Based on the timing of all of the flows going toward the downstream culvert, the 100-year flow increases from 502.97cfs to 502.87cfs (lower by 0.02%). As the effects on amount of flow toward the culvert are essentially unchanged, previous capacity analysis is included. The attached CulvertMaster output shows the 503cfs that would be heading to the 8' x 5' RCB to be well within the capacity of the culvert before it overtops (overtopping flow is 720cfs).

Please contact me if you should have questions about this letter.

SHAFER, KLINE & WARREN, INC.

By: Matt Eblen, P.E.  
Director, Stormwater Management

Enclosure(s)



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PONDPACK

OUT PUT

1971-1972

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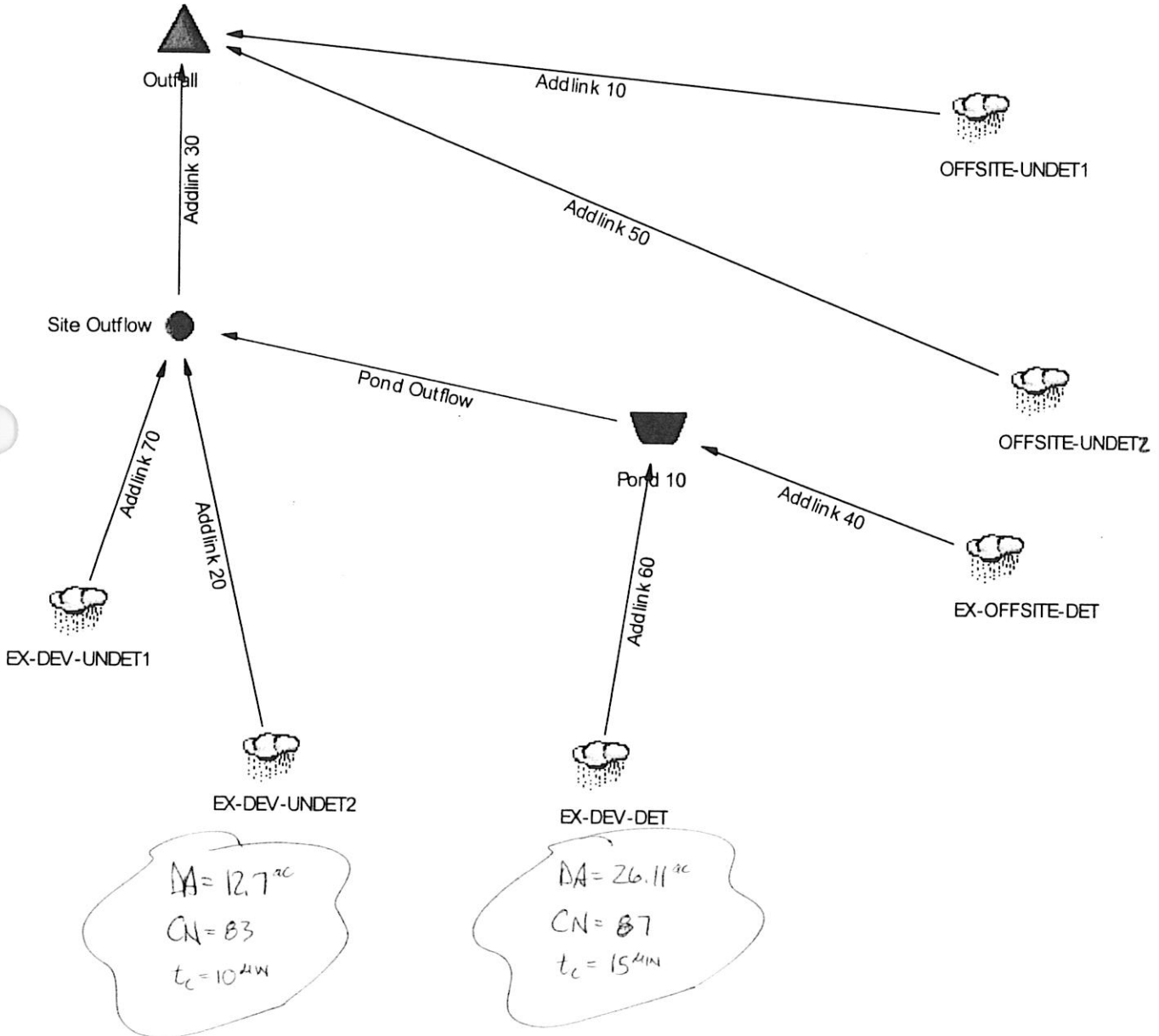
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## MASTER DESIGN STORM SUMMARY

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Network Storm Collection: KC-ALL

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| Return Event | Total<br>Depth<br>in | Rainfall<br>Type | RNF ID |      |
|--------------|----------------------|------------------|--------|------|
| 2 YR         | 3.6000               | Synthetic Curve  | TypeII | 24hr |
| 5 YR         | 4.6000               | Synthetic Curve  | TypeII | 24hr |
| 10 YR        | 5.4000               | Synthetic Curve  | TypeII | 24hr |
| 25 YR        | 6.2000               | Synthetic Curve  | TypeII | 24hr |
| 50 YR        | 6.9000               | Synthetic Curve  | TypeII | 24hr |
| 100 YR       | 7.8000               | Synthetic Curve  | TypeII | 24hr |

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MASTER NETWORK SUMMARY  
SCS Unit Hydrograph Method

(\*Node=Outfall; +Node=Diversion;)  
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

| Node ID       | Type | Return<br>Event | HYG Vol<br>ac-ft | Trun | Qpeak<br>hrs | Qpeak<br>cfs | Max WSEL<br>ft | Max<br>Pond Storage<br>ac-ft |
|---------------|------|-----------------|------------------|------|--------------|--------------|----------------|------------------------------|
| EX-DEV-DET    | AREA | 2               | 4.945            |      | 12.0500      | 71.21        |                |                              |
| EX-DEV-DET    | AREA | 5               | 6.946            |      | 12.0500      | 98.79        |                |                              |
| EX-DEV-DET    | AREA | 10              | 8.585            |      | 12.0500      | 120.90       |                |                              |
| EX-DEV-DET    | AREA | 25              | 10.246           |      | 12.0500      | 142.97       |                |                              |
| EX-DEV-DET    | AREA | 50              | 11.712           |      | 12.0500      | 162.22       |                |                              |
| EX-DEV-DET    | AREA | 100             | 13.610           |      | 12.0500      | 186.89       |                |                              |
| EX-DEV-UNDET1 | AREA | 2               | .492             |      | 11.9500      | 8.36         |                |                              |
| EX-DEV-UNDET1 | AREA | 5               | .686             |      | 11.9500      | 11.52        |                |                              |
| EX-DEV-UNDET1 | AREA | 10              | .844             |      | 11.9500      | 14.05        |                |                              |
| EX-DEV-UNDET1 | AREA | 25              | 1.004            |      | 11.9500      | 16.57        |                |                              |
| EX-DEV-UNDET1 | AREA | 50              | 1.145            |      | 11.9500      | 18.76        |                |                              |
| EX-DEV-UNDET1 | AREA | 100             | 1.328            |      | 11.9500      | 21.58        |                |                              |

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Type.... Master Network Summary

Page 2.02

Name.... Watershed

File.... P:\700303-130\\_Project Management\Reports\Pondpack\EX-DET-12-15-2009.ppw

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MASTER NETWORK SUMMARY  
SCS Unit Hydrograph Method(\*Node=Outfall; +Node=Diversion;)  
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

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| Node ID        | Type | Return<br>Event | HYG Vol<br>ac-ft | Trun | Qpeak<br>hrs | Qpeak<br>cfs | Max WSEL<br>ft | Max<br>Pond Storage<br>ac-ft |
|----------------|------|-----------------|------------------|------|--------------|--------------|----------------|------------------------------|
| EX-DEV-UNDET2  | AREA | 2               | 2.056            |      | 12.0000      | 33.71        |                |                              |
| EX-DEV-UNDET2  | AREA | 5               | 2.979            |      | 12.0000      | 48.40        |                |                              |
| EX-DEV-UNDET2  | AREA | 10              | 3.745            |      | 12.0000      | 60.32        |                |                              |
| EX-DEV-UNDET2  | AREA | 25              | 4.527            |      | 12.0000      | 72.30        |                |                              |
| EX-DEV-UNDET2  | AREA | 50              | 5.221            |      | 12.0000      | 82.78        |                |                              |
| EX-DEV-UNDET2  | AREA | 100             | 6.124            |      | 12.0000      | 96.25        |                |                              |
| EX-OFFSITE-DET | AREA | 2               | .880             |      | 12.0500      | 12.75        |                |                              |
| EX-OFFSITE-DET | AREA | 5               | 1.255            |      | 12.0500      | 18.01        |                |                              |
| EX-OFFSITE-DET | AREA | 10              | 1.564            |      | 12.0500      | 22.26        |                |                              |
| EX-OFFSITE-DET | AREA | 25              | 1.879            |      | 12.0500      | 26.51        |                |                              |
| EX-OFFSITE-DET | AREA | 50              | 2.157            |      | 12.0500      | 30.23        |                |                              |
| EX-OFFSITE-DET | AREA | 100             | 2.519            |      | 12.0500      | 34.99        |                |                              |
| OFFSITE-UNDET1 | AREA | 2               | 2.002            |      | 12.0500      | 29.08        |                |                              |
| OFFSITE-UNDET1 | AREA | 5               | 2.972            |      | 12.0500      | 43.16        |                |                              |
| OFFSITE-UNDET1 | AREA | 10              | 3.785            |      | 12.0500      | 54.75        |                |                              |
| OFFSITE-UNDET1 | AREA | 25              | 4.623            |      | 12.0500      | 66.49        |                |                              |
| OFFSITE-UNDET1 | AREA | 50              | 5.369            |      | 12.0500      | 76.83        |                |                              |
| OFFSITE-UNDET1 | AREA | 100             | 6.344            |      | 12.0500      | 90.16        |                |                              |
| OFFSITE-UNDET2 | AREA | 2               | 5.789            |      | 12.1000      | 73.82        |                |                              |
| OFFSITE-UNDET2 | AREA | 5               | 8.386            |      | 12.1000      | 106.51       |                |                              |
| OFFSITE-UNDET2 | AREA | 10              | 10.542           |      | 12.1000      | 133.12       |                |                              |
| OFFSITE-UNDET2 | AREA | 25              | 12.745           |      | 12.1000      | 159.91       |                |                              |
| OFFSITE-UNDET2 | AREA | 50              | 14.700           |      | 12.1000      | 183.38       |                |                              |
| OFFSITE-UNDET2 | AREA | 100             | 17.242           |      | 12.1000      | 213.56       |                |                              |
| *OUTFALL       | JCT  | 2               | 16.164           |      | 12.0500      | 206.42       |                |                              |
| *OUTFALL       | JCT  | 5               | 23.223           |      | 12.0500      | 278.99       |                |                              |
| *OUTFALL       | JCT  | 10              | 29.065           |      | 12.0500      | 335.65       |                |                              |
| *OUTFALL       | JCT  | 25              | 35.023           |      | 12.0500      | 391.82       |                |                              |
| *OUTFALL       | JCT  | 50              | 40.305           |      | 12.0500      | 440.63       |                |                              |
| *OUTFALL       | JCT  | 100             | 47.167           |      | 12.0500      | 502.97       |                |                              |

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Type.... Master Network Summary

Page 2.03

Name.... Watershed

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MASTER NETWORK SUMMARY  
SCS Unit Hydrograph Method

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(\*Node=Outfall; +Node=Diversion;)  
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

| Node ID      | Type | Return<br>Event | HYG Vol<br>ac-ft | Trun | Qpeak<br>hrs | Qpeak<br>cfs | Max WSEL<br>ft | Max<br>Pond Storage<br>ac-ft |
|--------------|------|-----------------|------------------|------|--------------|--------------|----------------|------------------------------|
| POND 10      | IN   | POND 2          | 5.825            |      | 12.0500      | 83.97        |                |                              |
| POND 10      | IN   | POND 5          | 8.201            |      | 12.0500      | 116.80       |                |                              |
| POND 10      | IN   | POND 10         | 10.149           |      | 12.0500      | 143.15       |                |                              |
| POND 10      | IN   | POND 25         | 12.125           |      | 12.0500      | 169.48       |                |                              |
| POND 10      | IN   | POND 50         | 13.869           |      | 12.0500      | 192.45       |                |                              |
| POND 10      | IN   | POND 100        | 16.129           |      | 12.0500      | 221.88       |                |                              |
| POND 10      | OUT  | POND 2          | 5.825            |      | 12.1000      | 70.26        | 965.86         | .297                         |
| POND 10      | OUT  | POND 5          | 8.201            |      | 12.1500      | 82.58        | 967.52         | .731                         |
| POND 10      | OUT  | POND 10         | 10.149           |      | 12.2000      | 89.53        | 968.57         | 1.159                        |
| POND 10      | OUT  | POND 25         | 12.125           |      | 12.2000      | 95.96        | 969.62         | 1.673                        |
| POND 10      | OUT  | POND 50         | 13.869           |      | 12.2000      | 100.79       | 970.45         | 2.149                        |
| POND 10      | OUT  | POND 100        | 16.129           |      | 12.2000      | 130.82       | 971.22         | 2.664                        |
| SITE OUTFLOW | JCT  | 2               | 8.373            |      | 12.0000      | 105.79       |                |                              |
| SITE OUTFLOW | JCT  | 5               | 11.865           |      | 12.0000      | 132.85       |                |                              |
| SITE OUTFLOW | JCT  | 10              | 14.738           |      | 12.0000      | 153.08       |                |                              |
| SITE OUTFLOW | JCT  | 25              | 17.656           |      | 12.0000      | 172.23       |                |                              |
| SITE OUTFLOW | JCT  | 50              | 20.236           |      | 12.0000      | 188.42       |                |                              |
| SITE OUTFLOW | JCT  | 100             | 23.581           |      | 12.0000      | 208.87       |                |                              |

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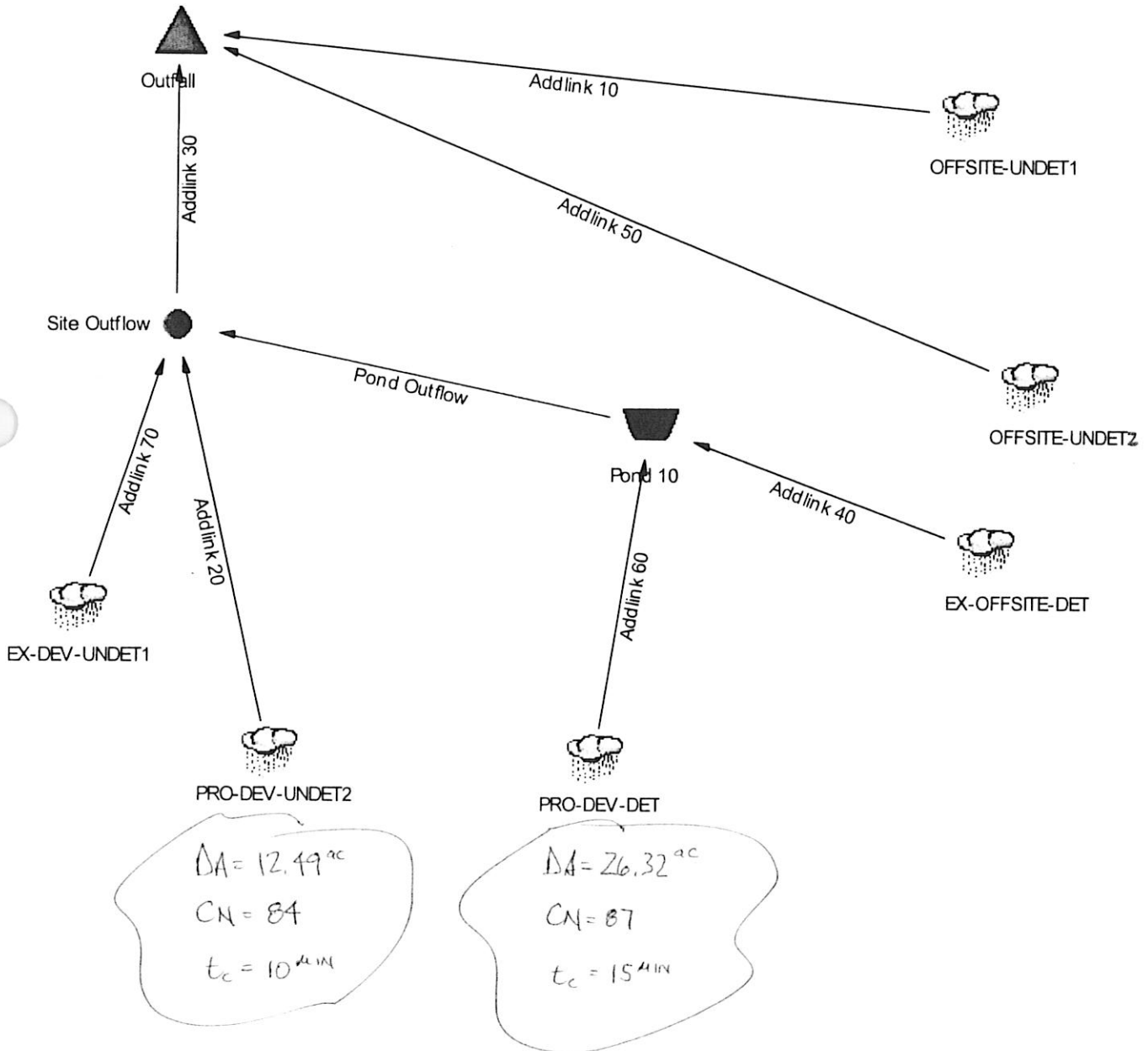
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## MASTER DESIGN STORM SUMMARY

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Network Storm Collection: KC-ALL

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| Return Event | Total<br>Depth<br>in | Rainfall<br>Type | RNF ID |      |
|--------------|----------------------|------------------|--------|------|
| 2 YR         | 3.6000               | Synthetic Curve  | TypeII | 24hr |
| 5 YR         | 4.6000               | Synthetic Curve  | TypeII | 24hr |
| 10 YR        | 5.4000               | Synthetic Curve  | TypeII | 24hr |
| 25 YR        | 6.2000               | Synthetic Curve  | TypeII | 24hr |
| 50 YR        | 6.9000               | Synthetic Curve  | TypeII | 24hr |
| 100 YR       | 7.8000               | Synthetic Curve  | TypeII | 24hr |

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MASTER NETWORK SUMMARY  
SCS Unit Hydrograph Method

(\*Node=Outfall; +Node=Diversion;)  
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

| Node ID        | Type | Return<br>Event | HYG Vol<br>ac-ft | Trun | Qpeak<br>hrs | Qpeak<br>cfs | Max WSEL<br>ft | Max<br>Pond Storage<br>ac-ft |
|----------------|------|-----------------|------------------|------|--------------|--------------|----------------|------------------------------|
| EX-DEV-UNDET1  | AREA | 2               | .492             |      | 11.9500      | 8.36         |                |                              |
| EX-DEV-UNDET1  | AREA | 5               | .686             |      | 11.9500      | 11.52        |                |                              |
| EX-DEV-UNDET1  | AREA | 10              | .844             |      | 11.9500      | 14.05        |                |                              |
| EX-DEV-UNDET1  | AREA | 25              | 1.004            |      | 11.9500      | 16.57        |                |                              |
| EX-DEV-UNDET1  | AREA | 50              | 1.145            |      | 11.9500      | 18.76        |                |                              |
| EX-DEV-UNDET1  | AREA | 100             | 1.328            |      | 11.9500      | 21.58        |                |                              |
| EX-OFFSITE-DET | AREA | 2               | .880             |      | 12.0500      | 12.75        |                |                              |
| EX-OFFSITE-DET | AREA | 5               | 1.255            |      | 12.0500      | 18.01        |                |                              |
| EX-OFFSITE-DET | AREA | 10              | 1.564            |      | 12.0500      | 22.26        |                |                              |
| EX-OFFSITE-DET | AREA | 25              | 1.879            |      | 12.0500      | 26.51        |                |                              |
| EX-OFFSITE-DET | AREA | 50              | 2.157            |      | 12.0500      | 30.23        |                |                              |
| EX-OFFSITE-DET | AREA | 100             | 2.519            |      | 12.0500      | 34.99        |                |                              |

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SCS Unit Hydrograph Method

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(\*Node=Outfall; +Node=Diversion;)  
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

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| Node ID        | Type     | Return<br>Event | HYG Vol<br>ac-ft | Trun | Qpeak<br>hrs | Qpeak<br>cfs | Max WSEL<br>ft | Max<br>Pond Storage<br>ac-ft |
|----------------|----------|-----------------|------------------|------|--------------|--------------|----------------|------------------------------|
| OFFSITE-UNDET1 | AREA     | 2               | 2.002            |      | 12.0500      | 29.08        |                |                              |
| OFFSITE-UNDET1 | AREA     | 5               | 2.972            |      | 12.0500      | 43.16        |                |                              |
| OFFSITE-UNDET1 | AREA     | 10              | 3.785            |      | 12.0500      | 54.75        |                |                              |
| OFFSITE-UNDET1 | AREA     | 25              | 4.623            |      | 12.0500      | 66.49        |                |                              |
| OFFSITE-UNDET1 | AREA     | 50              | 5.369            |      | 12.0500      | 76.83        |                |                              |
| OFFSITE-UNDET1 | AREA     | 100             | 6.344            |      | 12.0500      | 90.16        |                |                              |
| OFFSITE-UNDET2 | AREA     | 2               | 5.789            |      | 12.1000      | 73.82        |                |                              |
| OFFSITE-UNDET2 | AREA     | 5               | 8.386            |      | 12.1000      | 106.51       |                |                              |
| OFFSITE-UNDET2 | AREA     | 10              | 10.542           |      | 12.1000      | 133.12       |                |                              |
| OFFSITE-UNDET2 | AREA     | 25              | 12.745           |      | 12.1000      | 159.91       |                |                              |
| OFFSITE-UNDET2 | AREA     | 50              | 14.700           |      | 12.1000      | 183.38       |                |                              |
| OFFSITE-UNDET2 | AREA     | 100             | 17.242           |      | 12.1000      | 213.56       |                |                              |
| *OUTFALL       | JCT      | 2               | 16.253           |      | 12.0500      | 207.20       |                |                              |
| *OUTFALL       | JCT      | 5               | 23.326           |      | 12.0500      | 279.63       |                |                              |
| *OUTFALL       | JCT      | 10              | 29.177           |      | 12.0500      | 336.11       |                |                              |
| *OUTFALL       | JCT      | 25              | 35.142           |      | 12.0500      | 392.10       |                |                              |
| *OUTFALL       | JCT      | 50              | 40.429           |      | 12.0500      | 440.76       |                |                              |
| *OUTFALL       | JCT      | 100             | 47.297           |      | 12.0500      | 502.87       |                |                              |
| POND 10        | IN POND  | 2               | 5.865            |      | 12.0500      | 84.54        |                |                              |
| POND 10        | IN POND  | 5               | 8.257            |      | 12.0500      | 117.59       |                |                              |
| POND 10        | IN POND  | 10              | 10.218           |      | 12.0500      | 144.13       |                |                              |
| POND 10        | IN POND  | 25              | 12.207           |      | 12.0500      | 170.63       |                |                              |
| POND 10        | IN POND  | 50              | 13.964           |      | 12.0500      | 193.75       |                |                              |
| POND 10        | IN POND  | 100             | 16.238           |      | 12.0500      | 223.38       |                |                              |
| POND 10        | OUT POND | 2               | 5.865            |      | 12.1000      | 70.53        | 965.89         | .303                         |
| POND 10        | OUT POND | 5               | 8.257            |      | 12.1500      | 82.80        | 967.55         | .742                         |
| POND 10        | OUT POND | 10              | 10.218           |      | 12.2000      | 89.78        | 968.61         | 1.177                        |
| POND 10        | OUT POND | 25              | 12.207           |      | 12.2000      | 96.21        | 969.66         | 1.695                        |
| POND 10        | OUT POND | 50              | 13.964           |      | 12.2000      | 101.05       | 970.50         | 2.178                        |
| POND 10        | OUT POND | 100             | 16.238           |      | 12.2000      | 133.16       | 971.23         | 2.678                        |

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MASTER NETWORK SUMMARY  
SCS Unit Hydrograph Method(\*Node=Outfall; +Node=Diversion;)  
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

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| Node ID        | Type | Return<br>Event | HYG Vol<br>ac-ft | Trun | Qpeak<br>hrs | Qpeak<br>cfs | Max WSEL<br>ft | Max<br>Pond Storage<br>ac-ft |
|----------------|------|-----------------|------------------|------|--------------|--------------|----------------|------------------------------|
| PRO-DEV-DET    | AREA | 2               | 4.984            |      | 12.0500      | 71.79        |                |                              |
| PRO-DEV-DET    | AREA | 5               | 7.002            |      | 12.0500      | 99.58        |                |                              |
| PRO-DEV-DET    | AREA | 10              | 8.654            |      | 12.0500      | 121.87       |                |                              |
| PRO-DEV-DET    | AREA | 25              | 10.328           |      | 12.0500      | 144.12       |                |                              |
| PRO-DEV-DET    | AREA | 50              | 11.806           |      | 12.0500      | 163.53       |                |                              |
| PRO-DEV-DET    | AREA | 100             | 13.720           |      | 12.0500      | 188.39       |                |                              |
| PRO-DEV-UNDET2 | AREA | 2               | 2.105            |      | 12.0000      | 34.44        |                |                              |
| PRO-DEV-UNDET2 | AREA | 5               | 3.025            |      | 12.0000      | 48.97        |                |                              |
| PRO-DEV-UNDET2 | AREA | 10              | 3.787            |      | 12.0000      | 60.73        |                |                              |
| PRO-DEV-UNDET2 | AREA | 25              | 4.563            |      | 12.0000      | 72.52        |                |                              |
| PRO-DEV-UNDET2 | AREA | 50              | 5.251            |      | 12.0000      | 82.83        |                |                              |
| PRO-DEV-UNDET2 | AREA | 100             | 6.144            |      | 12.0000      | 96.06        |                |                              |
| SITE OUTFLOW   | JCT  | 2               | 8.461            |      | 12.0000      | 106.69       |                |                              |
| SITE OUTFLOW   | JCT  | 5               | 11.968           |      | 12.0000      | 133.63       |                |                              |
| SITE OUTFLOW   | JCT  | 10              | 14.849           |      | 12.0000      | 153.67       |                |                              |
| SITE OUTFLOW   | JCT  | 25              | 17.774           |      | 12.0000      | 172.64       |                |                              |
| SITE OUTFLOW   | JCT  | 50              | 20.360           |      | 12.0000      | 188.66       |                |                              |
| SITE OUTFLOW   | JCT  | 100             | 23.710           |      | 12.0000      | 208.86       |                |                              |

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CULVERMASTER  
OUTPUT

10-10-1944  
10-10-1944  
10-10-1944

10-10-1944

10-10-1944

# Culvert Designer/Analyzer Report

## Culvert-1-8x5

### Analysis Component

Storm Event                      Design                      Discharge                      503.00 cfs →

100 YR PROPOSED  
SITE OUTFLOW

Peak Discharge Method: User-Specified

Design Discharge                      503.00 cfs                      Check Discharge                      720.00 cfs

Tailwater properties: Irregular Channel

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### Roughness Segments

| Start Station | End Station | Mannings Coefficient |
|---------------|-------------|----------------------|
| 0+00          | 1+01        | 0.080                |
| 1+01          | 1+32        | 0.040                |
| 1+32          | 2+03        | 0.080                |

### Natural Channel Points

| Station (ft) | Elevation (ft) |
|--------------|----------------|
| 0+00         | 908.58         |
| 0+50         | 905.48         |
| 0+61         | 905.18         |
| 0+77         | 904.43         |
| 0+88         | 903.01         |
| 1+01         | 901.95         |
| 1+05         | 898.29         |
| 1+09         | 898.36         |
| 1+17         | 898.00         |
| 1+32         | 902.00         |
| 1+50         | 903.38         |
| 2+00         | 907.18         |
| 2+03         | 907.58         |

### Tailwater conditions for Design Storm.

|           |            |              |         |
|-----------|------------|--------------|---------|
| Discharge | 503.00 cfs | Actual Depth | 5.03 ft |
| Velocity  | 3.96 ft/s  |              |         |

| Name      | Description    | Discharge  | HW Elev.  | Velocity   |
|-----------|----------------|------------|-----------|------------|
| Culvert-1 | 1-8 x 5 ft Box | 502.98 cfs | 909.35 ft | 16.13 ft/s |
| Weir      | Roadway        | 0.00 cfs   | 909.35 ft | N/A        |
| Total     | -----          | 502.98 cfs | 909.35 ft | N/A        |

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# Culvert Designer/Analyzer Report

## Culvert-1-8x5

-2010-001-

Component: Culvert-1

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### Culvert Summary

|                          |           |                     |               |
|--------------------------|-----------|---------------------|---------------|
| Computed Headwater Elev. | 909.35 ft | Discharge           | 502.98 cfs    |
| Inlet Control HW Elev.   | 909.35 ft | Tailwater Elevation | 903.03 ft     |
| Outlet Control HW Elev.  | 908.70 ft | Control Type        | Inlet Control |
| Headwater Depth/Height   | 1.87      |                     |               |

### Grades

|                 |           |                   |                |
|-----------------|-----------|-------------------|----------------|
| Upstream Invert | 900.00 ft | Downstream Invert | 898.50 ft      |
| Length          | 150.00 ft | Constructed Slope | 0.010000 ft/ft |

### Hydraulic Profile

|                     |               |                   |                |
|---------------------|---------------|-------------------|----------------|
| Profile             | S2            | Depth, Downstream | 3.90 ft        |
| Slope Type          | Steep         | Normal Depth      | 3.59 ft        |
| Flow Regime         | Supercritical | Critical Depth    | 4.97 ft        |
| Velocity Downstream | 16.13 ft/s    | Critical Slope    | 0.004236 ft/ft |

### Section

|                  |          |                      |         |
|------------------|----------|----------------------|---------|
| Section Shape    | Box      | Mannings Coefficient | 0.013   |
| Section Material | Concrete | Span                 | 8.00 ft |
| Section Size     | 8 x 5 ft | Rise                 | 5.00 ft |
| Number Sections  | 1        |                      |         |

### Outlet Control Properties

|                         |           |                        |         |
|-------------------------|-----------|------------------------|---------|
| Outlet Control HW Elev. | 908.70 ft | Upstream Velocity Head | 2.49 ft |
| Ke                      | 0.50      | Entrance Loss          | 1.24 ft |

### Inlet Control Properties

|                                           |           |               |           |
|-------------------------------------------|-----------|---------------|-----------|
| Inlet Control HW Elev.                    | 909.35 ft | Flow Control  | Submerged |
| Inlet Type 45° non-offset wingwall flares |           | Area Full     | 40.0 ft²  |
| K                                         | 0.49700   | HDS 5 Chart   | 12        |
| M                                         | 0.66700   | HDS 5 Scale   | 1         |
| C                                         | 0.03390   | Equation Form | 2         |
| Y                                         | 0.80300   |               |           |

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# Culvert Designer/Analyzer Report Culvert-1-8x5

Component Weir

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## Hydraulic Component(s): Roadway

|                            |           |                         |           |
|----------------------------|-----------|-------------------------|-----------|
| Discharge                  | 0.00 cfs  | Allowable HW Elevation  | 909.35 ft |
| Roadway Width              | 100.00 ft | Overtopping Coefficient | 2.90 US   |
| Low Point                  | 915.00 ft | Headwater Elevation     | N/A ft    |
| Discharge Coefficient (Cr) | 2.90      | Submergence Factor (Kt) | 1.00      |
| Tailwater Elevation        | 903.03 ft |                         |           |

| Sta. (ft) | Elev. (ft) |
|-----------|------------|
| 0.00      | 917.08     |
| 50.00     | 916.04     |
| 100.00    | 915.38     |
| 117.53    | 915.00     |
| 150.00    | 915.50     |
| 200.00    | 916.00     |
| 250.00    | 916.87     |



# Culvert Designer/Analyzer Report

## Culvert-1-8x5

### Analysis Component

|             |       |           |            |
|-------------|-------|-----------|------------|
| Storm Event | Check | Discharge | 720.00 cfs |
|-------------|-------|-----------|------------|

→ CAPACITY BEFORE  
OVERTOPPING

Peak Discharge Method: User-Specified

|                  |            |                 |            |
|------------------|------------|-----------------|------------|
| Design Discharge | 503.00 cfs | Check Discharge | 720.00 cfs |
|------------------|------------|-----------------|------------|

-2010-001-

Tailwater properties: Irregular Channel

### Roughness Segments

| Start Station | End Station | Mannings Coefficient |
|---------------|-------------|----------------------|
| 0+00          | 1+01        | 0.080                |
| 1+01          | 1+32        | 0.040                |
| 1+32          | 2+03        | 0.080                |

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### Natural Channel Points

| Station (ft) | Elevation (ft) |
|--------------|----------------|
| 0+00         | 908.58         |
| 0+50         | 905.48         |
| 0+61         | 905.18         |
| 0+77         | 904.43         |
| 0+88         | 903.01         |
| 1+01         | 901.95         |
| 1+05         | 898.29         |
| 1+09         | 898.36         |
| 1+17         | 898.00         |
| 1+32         | 902.00         |
| 1+50         | 903.38         |
| 2+00         | 907.18         |
| 2+03         | 907.58         |

### Tailwater conditions for Check Storm.

|           |            |              |         |
|-----------|------------|--------------|---------|
| Discharge | 720.00 cfs | Actual Depth | 5.64 ft |
| Velocity  | 4.33 ft/s  |              |         |

| Name      | Description    | Discharge  | HW Elev.  | Velocity   |
|-----------|----------------|------------|-----------|------------|
| Culvert-1 | 1-8 x 5 ft Box | 720.02 cfs | 914.97 ft | 18.00 ft/s |
| Weir      | Roadway        | 0.00 cfs   | 914.97 ft | N/A        |
| Total     | -----          | 720.02 cfs | 914.97 ft | N/A        |

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# Culvert Designer/Analyzer Report

## Culvert-1-8x5

Component: Culvert-1

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### Culvert Summary

|                          |           |                     |               |
|--------------------------|-----------|---------------------|---------------|
| Computed Headwater Elev. | 914.97 ft | Discharge           | 720.02 cfs    |
| Inlet Control HW Elev.   | 914.97 ft | Tailwater Elevation | 903.64 ft     |
| Outlet Control HW Elev.  | 913.29 ft | Control Type        | Inlet Control |
| Headwater Depth/Height   | 2.99      |                     |               |

### Grades

|                 |           |                   |                |
|-----------------|-----------|-------------------|----------------|
| Upstream Invert | 900.00 ft | Downstream Invert | 898.50 ft      |
| Length          | 150.00 ft | Constructed Slope | 0.010000 ft/ft |

### Hydraulic Profile

|                     |                  |                   |                |
|---------------------|------------------|-------------------|----------------|
| Profile             | Pressure Profile | Depth, Downstream | 5.14 ft        |
| Slope Type          | N/A              | Normal Depth      | N/A ft         |
| Flow Regime         | N/A              | Critical Depth    | 5.00 ft        |
| Velocity Downstream | 18.00 ft/s       | Critical Slope    | 0.013964 ft/ft |

### Section

|                  |          |                      |         |
|------------------|----------|----------------------|---------|
| Section Shape    | Box      | Mannings Coefficient | 0.013   |
| Section Material | Concrete | Span                 | 8.00 ft |
| Section Size     | 8 x 5 ft | Rise                 | 5.00 ft |
| Number Sections  | 1        |                      |         |

### Outlet Control Properties

|                         |           |                        |         |
|-------------------------|-----------|------------------------|---------|
| Outlet Control HW Elev. | 913.29 ft | Upstream Velocity Head | 5.04 ft |
| Ke                      | 0.50      | Entrance Loss          | 2.52 ft |

### Inlet Control Properties

|                                           |           |               |           |
|-------------------------------------------|-----------|---------------|-----------|
| Inlet Control HW Elev.                    | 914.97 ft | Flow Control  | Submerged |
| Inlet Type 45° non-offset wingwall flares |           | Area Full     | 40.0 ft²  |
| K                                         | 0.49700   | HDS 5 Chart   | 12        |
| M                                         | 0.66700   | HDS 5 Scale   | 1         |
| C                                         | 0.03390   | Equation Form | 2         |
| Y                                         | 0.80300   |               |           |

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**Culvert Designer/Analyzer Report**  
**Culvert-1-8x5**

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Component: Weir

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Hydraulic Component(s): Roadway

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|                            |           |                         |           |
|----------------------------|-----------|-------------------------|-----------|
| Discharge                  | 0.00 cfs  | Allowable HW Elevation  | 914.97 ft |
| Roadway Width              | 100.00 ft | Overtopping Coefficient | 2.90 US   |
| Low Point                  | 915.00 ft | Headwater Elevation     | N/A ft    |
| Discharge Coefficient (Cr) | 2.90      | Submergence Factor (Kt) | 1.00      |
| Tailwater Elevation        | 903.64 ft |                         |           |

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| Sta (ft) | Elev. (ft) |
|----------|------------|
| 0.00     | 917.08     |
| 50.00    | 916.04     |
| 100.00   | 915.38     |
| 117.53   | 915.00     |
| 150.00   | 915.50     |
| 200.00   | 916.00     |
| 250.00   | 916.87     |

1000

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