

Referenced Material

# Memorandum

City of Las Vegas  
Department of Public Works  
Engineering Planning

**To:** Richard Danielson, A.I.A.  
Architectural Services

**From:** John Bettencourt, P.E.  
Flood Control

**Date:** January 19, 2005

**Re:** Deer Springs Park and Deer Springs Way

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We reviewed the improvement plans and drainage study for Deer Springs Park, by Stantec received on May 29, 2002, and found the study acceptable.

**Cc:**  
Guy Ruddy – Stantec Fax: 258-4956  
Wayne Dowdey – CLV Land Development  
Greg McDermott – CLV Flood Control

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Other elements of the HEC-1s have also been changed. The original submission included a 96-inch rcp, which drained Pond 1. That pipe has been removed and replaced with an open channel. The one advantage of the 96-inch pipe in the original HEC-1 was the headwater required to generate the model flow. An open channel simply draining the Pond, requires no headwater. Hence, the Pond drained so fast that no storage was achieved. This submission, and the enclosed plans include a culvert of 3, 48-inch HDPE pipes draining the Pond into the open channel.

The revised HEC-1s, Enclosure 7B, and form 6 are included.

## **Comment 2.**

***In previous meetings with the consultant it was agreed that all future 10-year flows at "Pond 1" would be routed south to "Pond 2." Neither the HEC-1 nor exhibit 7B reflects this routing. The HEC-1 model should be revised at "Pond 1" and "FS Pond" to reflect the 10-year flow in the basin. By doing so the entire future 10-year flow will be routed south along Deer Springs Way as agreed. The engineer should also revise all the down stream concentration points that were affected by this change.***

## **Response 2.**

All HEC-1s have been revised to rout all future 10-year flows south to Pond 2. The revised HEC-1s and Enclosure 7B are included.

## **Comment 3.**

***(PP-1 & PP-2) No hydraulic calculations were included for the 96-inch RCP that drains the detention basin. The next submittal must include hydraulic calculations for this pipe if this system is to be constructed with Phase I of the park. The 100-year flow, 10-year flow, and hydraulic grade lines must be identified on the plan and profile sheets. A headwall and trash-rack must be provided at the outlet of the basin into the 96-inch pipe. The discharge of the pipe should also occur further west of Buffalo Drive to allow the storm flows to surface drain prior to reaching Buffalo Drive. Proper erosion protection should be provided at the outlet of the pipe.***

## **Response 3.**

As noted above in response 1, the 96-inch RCP has been replaced with an open channel. The channel is designated as the North Channel and is to be constructed in two phases. The first phase is to be constructed with the current phase of the park, the north 20 plus acres. The second phase is to be constructed along with the construction of Deer Springs Way. In the first phase the proposed channel extends from the eastern terminus at Buffalo at Wittig, westerly to the southeast corner of the Clark County Middle School site. This channel is designed to convey 550 cfs. A smaller open channel to be constructed on the park site, along the southern boundary of the Middle School, drains into the main North Channel. The smaller channel is to convey storm flow from the cul-de-sac in Conough Lane to the main North Channel.

**Stantec**

As a part of the Middle School project, a drop inlet to capture nuisance flow is to be constructed at the low point of the Conough cul-de-sac. As a part of the park project, an 18-inch HDPE will drain the Conough cul-de-sac drop inlet. The plans and calculations supporting the design various design elements are included.

#### **Comment 4.**

***(C-2) The drop inlets at STA 1+05 and STA 1+11 on Deer Springs Way should be modified to 6-foot Neenah drop inlets. Contact the Flood Control Section to obtain a digital copy of the Neenah drop inlet detail. Calculations for the proposed 24-inch pipe must be included with the next submittal to ensure that this pipe can adequately convey stormwater from the existing pipe in Deer Springs Way. Also Detail A on this sheet must be revised to show a 1/2 inch curb face rather than a zero curb face. The channel construction and proposed culverts along the north side of Deer Springs must be included as part of these roadway improvements.***

#### **Response 4.**

The following revisions appear on sheet C-2 and others as noted below. Neenah, CM2 Drop Inlets, are now shown on the plans. The construction details provided by the City of Las Vegas has been modified and are included in the plans.

Given an existing Q100 flow in Deer Spring at the west side of the site, the drop inlets would accept approximately 17 cfs each. The existing 24 inch RCP in Deer Springs Rd. is dry; there are no inlets to the pipe and each end is capped. The approved constructions drawing, CLV dwg No. 107-V3108 by VTN, delineates an HGL at the top of the pipe. This response assumes, based on the approved HGL, that the existing 24 inch pipe flows full at 35 cfs. The Q calculations and the VTN drawing are included. Based on the inlet capacities and the capacity of the 24 inch pipe, the drain pipes have been calculated to be 42 inches. The storm drain hydraulic calculation is included.

Detail A has been modified to indicate a 1/2 inch curb face.

Deer Springs Way drainage channel with associated culverts and nuisance pipes are shown in plan and profile on sheets C8 and C9. All appropriate calculations are included.

#### **Comment 5.**

***(C-3) Detail A must be revised for all of Deer Springs Way to show regular "L" Type curb and gutter along the south side of the roadway to collect nuisance water.***

#### **Response 5.**

The plans have been revised. An offset crown and an "L-curb" are called for along the entire length of the south side of Deer Spring Way. The revised plans are included.

**Stantec**

In the future condition, none of these culvert flows will occur. In the future the runoff generated in the historical tributary basins located west of Hwy 95 will not impact the site.

The tributary basins located east of Hwy 95 are rapidly developing. While some parcels are undeveloped, this study considers entire area developed.

As mentioned above off-site flows impact the site at 3 locations. First are the flows reaching the site in Elkhorn Road. Second are the flows reaching the site in Deer Springs Way. Third are flows reaching the site in Buffalo Road, at the south end of the site. These basins, their sub-basin, the collection points etc. are shown Drainage Basin Maps, Enclosure 7A and 7B.

Runoff in the existing condition, which includes the culvert flows at Hwy 95, arriving at the site in Elkhorn, splits at the intersection with Buffalo. One third of the existing 100 and 10 year flows in Elkhorn turns south in Buffalo. In the future condition, the 100 year flow will split, one third south in Buffalo, as in the existing condition. But in the future 10 year storm, no split occurs.

Runoff in the existing condition, which includes the culvert flows at Hwy 95, arriving at the site in Deer Springs joins with minor runoff from adjacent subdivisions. The undeveloped site conveys these flows directly east across the property into residential areas along Deer Springs east of Buffalo. The developed site will divert ← the runoff arriving in Deer Springs into a pond with two outlets. One outlet conveys the main 100 and 10 year existing flow northeasterly to Buffalo at Wittig. The second outlet conveys the rest of the flow southeasterly to Buffalo at John Herbert. Some of the southeasterly flow will split east, drain through the proposed parking areas, and drain into Deer Springs. In the future condition, the 100 year flow will fill the pond and drain from the two outlets as in the existing condition. But in the future 10 year condition, the entire runoff will flow southeast, none will flow to the northeast.

Runoff in the existing condition, which includes the culvert flows at Hwy 95, arriving at the site in Buffalo joins with runoff from adjacent subdivisions. In all conditions, existing and future, 100 and 10 year storms, these flows drain east in Buffalo to John Herbert, the south away from the site.

Overflow into  
Pond-1

**DEERSPRINGS WAY TOP**  
**Worksheet for Irregular Channel**

10yr Interim  
236 cfs

- Just before Proposed St.

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | DEER SPRINGS W    |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Input Data    |                |
|---------------|----------------|
| Channel Slope | 0.027000 ft/ft |
| Discharge     | 236.00 cfs     |

| Options                         |                          |
|---------------------------------|--------------------------|
| Current Roughness Method        | Improved Lotter's Method |
| Open Channel Weighting Method   | Improved Lotter's Method |
| Closed Channel Weighting Method | Horton's Method          |

| Results                 |                      |
|-------------------------|----------------------|
| Mannings Coefficient    | 0.016                |
| Water Surface Elevation | 0.88 ft              |
| Elevation Range         | 0.00 to 0.83         |
| Flow Area               | 30.6 ft <sup>2</sup> |
| Wetted Perimeter        | 85.47 ft             |
| Top Width               | 84.00 ft             |
| Actual Depth            | 0.88 ft              |
| Critical Elevation      | 1.14 ft              |
| Critical Slope          | 0.004466 ft/ft       |
| Velocity                | 7.72 ft/s            |
| Velocity Head           | 0.93 ft              |
| Specific Energy         | 1.80 ft              |
| Froude Number           | 2.26                 |
| Flow Type               | Supercritical        |

\* Assumed all flows below the South side Crown remain, while all other flow above the sidewalk on the north side weir/flow over.

Calculation Messages:  
Water elevation exceeds lowest end station by 0.27698231 ft.

| Roughness Segments |             |                      |
|--------------------|-------------|----------------------|
| Start Station      | End Station | Mannings Coefficient |
| 0+00               | 7+00        | 0.013                |
| 7+00               | 72+00       | 0.017                |
| 72+00              | 84+00       | 0.013                |

| Natural Channel Points |                |
|------------------------|----------------|
| Station (ft)           | Elevation (ft) |
| 0+00                   | 0.60           |
| 5+00                   | 0.50           |
| 5+50                   | 0.50           |
| 5+50                   | 0.00           |
| 7+00                   | 0.17           |
| 40+00                  | 0.83           |
| 72+00                  | 0.19           |
| 73+50                  | 0.02           |

**DEERSPRINGS WAY TOP**  
**Worksheet for Irregular Channel**

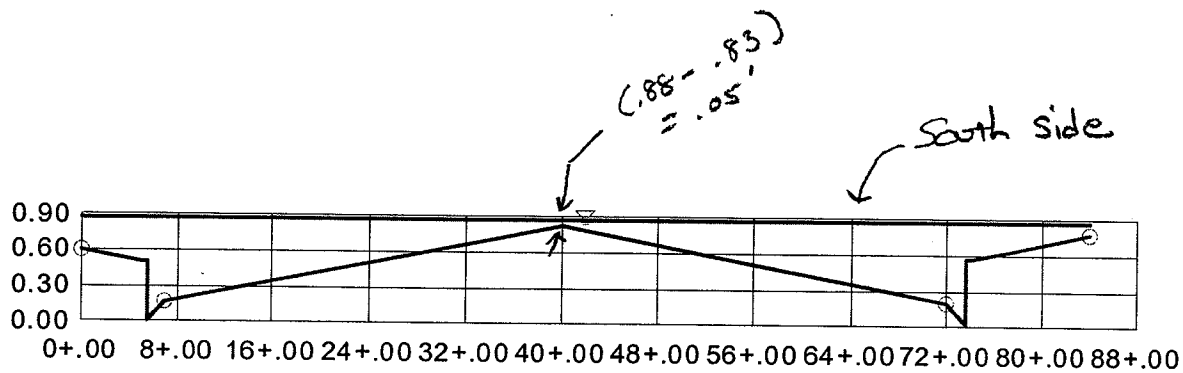
| Natural Channel Points |                   |
|------------------------|-------------------|
| Station<br>(ft)        | Elevation<br>(ft) |
| 73+.50                 | 0.57              |
| 74+.00                 | 0.57              |
| 78+.00                 | 0.65              |
| 84+.00                 | 0.77              |

# DEERSPRINGS WAY TOP

## Cross Section for Irregular Channel

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | DEER SPRINGS W    |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Section Data            |                |
|-------------------------|----------------|
| Mannings Coefficient    | 0.016          |
| Channel Slope           | 0.027000 ft/ft |
| Water Surface Elevation | 0.88 ft        |
| Elevation Range         | 0.00 to 0.83   |
| Discharge               | 236.00 cfs     |



V:10.0  
H:1  
NTS

South side only

$$\text{Area} = (44 \times .05)$$

$$V = 2.72$$

$$\begin{aligned} Q_{\text{above crown}} &= AV \\ &= (44 \times .05) 2.72 \\ &= 17 \text{ cfs} \end{aligned}$$

$$\begin{aligned} Q_{\text{remain}} &= Q_{\text{total south side}} - 17 \text{ cfs} \\ &= 118 - 17 \\ &= 101 \text{ cfs} + Q_{\text{north}} = 13 \text{ cfs} \end{aligned}$$

$$= 114 \text{ cfs}$$

Check 10 yr

Weir check for South Side

$$L = 300' \text{ (STA 200} \rightarrow \text{500)}$$

$$C = 2.6$$

$$H = 0.05' \text{ elevation above the crown.}$$

$$Q = CLH^{1.5}$$

$$= 2.6(300)(.05)^{1.5}$$

$$= 9 \text{ cfs} \quad \text{we slowed 17 cfs but this doesn't} \leftarrow \\ \text{account for momentum.}$$

Weir check for North Side

$$L = 300'$$

$$C = 2.6$$

$$H = (0.88' - 0.6) = 0.28' \text{ over the back of walk.} \\ \text{on the north side}$$

$$Q = 2.6(300)(.28)^{1.5}$$

$$= 116 \text{ cfs overtopping}$$

$$Q_{\text{remain}} = 236 - 116 = 120 \text{ cfs}$$

$\therefore$  close to the 114 cfs calculated

$\rightarrow$  thus 114 cfs in street

122 into the Pond

# DEERSPRINGS WAY TOP Worksheet for Irregular Channel

100 ft  
694 cfs

- Just before proposed ST.

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | DEER SPRINGS W    |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Input Data    |                |
|---------------|----------------|
| Channel Slope | 0.027000 ft/ft |
| Discharge     | 694.00 cfs     |

| Options                         |                          |
|---------------------------------|--------------------------|
| Current Roughness Method        | Improved Lotter's Method |
| Open Channel Weighting Method   | Improved Lotter's Method |
| Closed Channel Weighting Method | Horton's Method          |

| Results                 |                |
|-------------------------|----------------|
| Mannings Coefficient    | 0.016          |
| Water Surface Elevation | 1.21 ft        |
| Elevation Range         | 0.00 to 0.83   |
| Flow Area               | 58.6 ft²       |
| Wetted Perimeter        | 86.14 ft       |
| Top Width               | 84.00 ft       |
| Actual Depth            | 1.21 ft        |
| Critical Elevation      | 1.80 ft        |
| Critical Slope          | 0.003597 ft/ft |
| Velocity                | 11.83 ft/s     |
| Velocity Head           | 2.18 ft        |
| Specific Energy         | 3.39 ft        |
| Froude Number           | 2.50           |
| Flow Type               | Supercritical  |

\* Assumed all flows below the South side Crown remain. Meanwhile, all other flows overtop the sidewalk on the north side.

Calculation Messages:  
Water elevation exceeds lowest end station by 0.61106999 ft.

| Roughness Segments |             |                      |
|--------------------|-------------|----------------------|
| Start Station      | End Station | Mannings Coefficient |
| 0+.00              | 7+.00       | 0.013                |
| 7+.00              | 72+.00      | 0.017                |
| 72+.00             | 84+.00      | 0.013                |

| Natural Channel Points |                |
|------------------------|----------------|
| Station (ft)           | Elevation (ft) |
| 0+.00                  | 0.60           |
| 5+.00                  | 0.50           |
| 5+.50                  | 0.50           |
| 5+.50                  | 0.00           |
| 7+.00                  | 0.17           |
| 40+.00                 | 0.83           |
| 72+.00                 | 0.19           |
| 73+.50                 | 0.02           |

- 2% cross slope both sides

**DEERSPRINGS WAY TOP**  
**Worksheet for Irregular Channel**

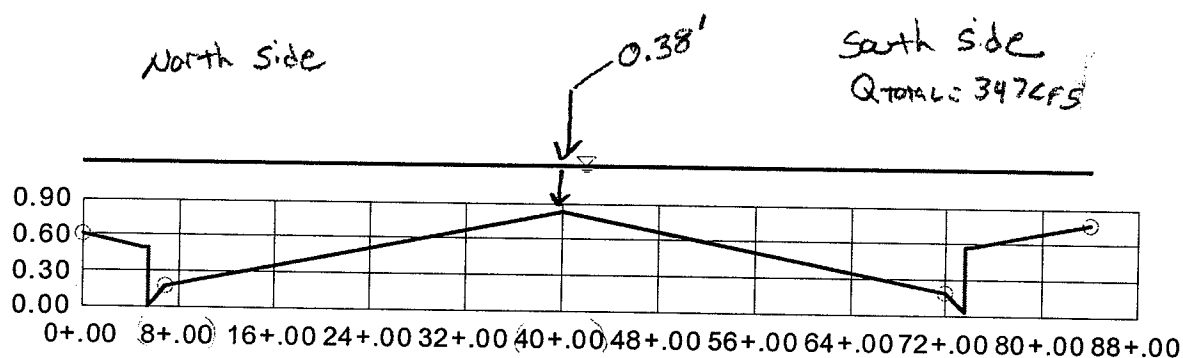
| Natural Channel Points |                   |
|------------------------|-------------------|
| Station<br>(ft)        | Elevation<br>(ft) |
| 73+.50                 | 0.57              |
| 74+.00                 | 0.57              |
| 78+.00                 | 0.65              |
| 84+.00                 | 0.77              |

# DEERSPRINGS WAY TOP

## Cross Section for Irregular Channel

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | DEER SPRINGS W    |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Section Data            |                |
|-------------------------|----------------|
| Mannings Coefficient    | 0.016          |
| Channel Slope           | 0.027000 ft/ft |
| Water Surface Elevation | 1.21 ft        |
| Elevation Range         | 0.00 to 0.83   |
| Discharge               | 694.00 cfs     |



South side only

V: 10.0  
H: 1  
NTS

$$Q_{total} = 347 \text{ cfs}$$

$$Area = (0.38 \times 44)$$

$$V = 11.8$$

$$\begin{aligned} Q_{above crown} &= A \times V \\ &= (.38 \times 44) 11.8 \\ &= 197 \text{ cfs} \end{aligned}$$

$$\begin{aligned} Q_{remain} &= Q_{total} - Q_{above} \\ &= 347 - 197 \\ &= 150 \text{ cfs} \end{aligned}$$

## Check assumptions 1004r

Weir check for South side

$$L = 300' \text{ (Sta 200} \rightarrow \text{500)}$$

$$C = 2.6$$

$$H = 0.38' \text{ elevation above crown.}$$

$$\begin{aligned} Q &= CLH^{1.5} \\ &= 2.6(300)(0.38)^{1.5} \\ &= 183 \text{ cfs approximately / 197 calculated.} \end{aligned}$$

Weir check for North side

$$\begin{aligned} Q_{\text{total overflow}} &= 694 - 163 \\ &= 531 \text{ cfs} \end{aligned}$$

$$Q = CLH^{1.5}$$

$$Q = 531 \text{ needed}$$

$$C = 2.6$$

$$L = 300$$

$$\therefore H = 0.77'$$

$$\text{back of walk} = 0.6'$$

$$\begin{aligned} \text{total depth needed} &= 0.77 + 0.6 \\ &= 1.37' \end{aligned}$$

At first we only have 1.21' depth but then it rises as the slope goes down. (at 1.8% slope  $d = 1.30'$ , when  $Q = 694$ ) thus, this is close. Also, we are ignoring Momentum, which will have some effect, especially around the bend.

# NORTH SIDE, 100-YR Worksheet for Irregular Channel

100yr, Interim

- Flow on the North  
Side below sidewalk  
after the weir.

| Project Description |                           |
|---------------------|---------------------------|
| Worksheet           | DEER SPRINGS WAY OUT, NOR |
| Flow Element        | Irregular Channel         |
| Method              | Manning's Formula         |
| Solve For           | Discharge                 |

| Input Data              |                |
|-------------------------|----------------|
| Channel Slope           | 0.008300 ft/ft |
| Water Surface Elevation | 0.60 ft        |

| Options                         |                          |
|---------------------------------|--------------------------|
| Current Roughness Method        | Improved Lotter's Method |
| Open Channel Weighting Method   | Improved Lotter's Method |
| Closed Channel Weighting Method | Horton's Method          |

| Results              |                     |
|----------------------|---------------------|
| Mannings Coefficient | 0.016               |
| Elevation Range      | 0.00 to 0.87        |
| Discharge            | 13.35 cfs           |
| Flow Area            | 4.9 ft <sup>2</sup> |
| Wetted Perimeter     | 27.09 ft            |
| Top Width            | 26.50 ft            |
| Actual Depth         | 0.60 ft             |
| Critical Elevation   | 0.62 ft             |
| Critical Slope       | 0.006572 ft/ft      |
| Velocity             | 2.72 ft/s           |
| Velocity Head        | 0.12 ft             |
| Specific Energy      | 0.72 ft             |
| Froude Number        | 1.12                |
| Flow Type            | Supercritical       |

← 13 cfs remains in the street on the  
North side of the road, after all  
other flows weir over.

\* assumes all flow above the sidewalk  
on the North side overtops, along  
with flows above the crown  
on the South side.

| Roughness Segments |                |                         |
|--------------------|----------------|-------------------------|
| Start<br>Station   | End<br>Station | Mannings<br>Coefficient |
| 0+.00              | 7+.00          | 0.013                   |
| 7+.00              | 40+.00         | 0.017                   |

| Natural Channel Points |                   |
|------------------------|-------------------|
| Station<br>(ft)        | Elevation<br>(ft) |
| 0+.00                  | 0.60              |
| 5+.00                  | 0.50              |
| 5+.50                  | 0.50              |
| 5+.50                  | 0.00              |
| 7+.00                  | 0.13              |
| 7+.00                  | 0.21              |
| 40+.00                 | 0.87              |

- 2% cross slope after weir

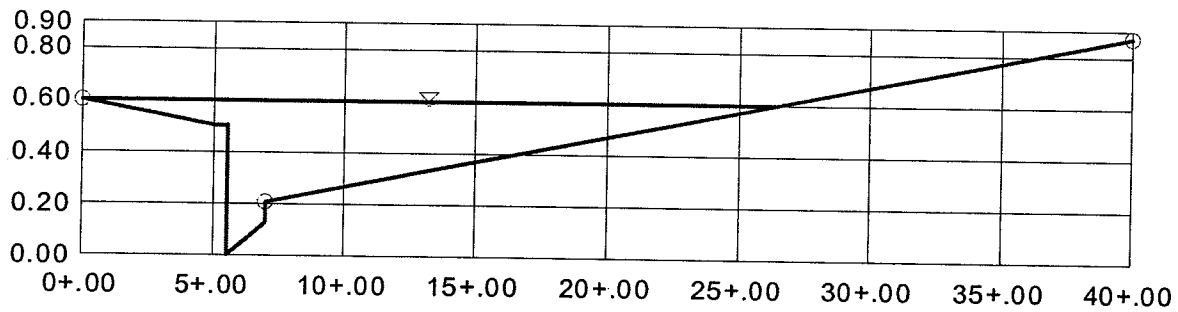
**NORTH SIDE, 100-YR  
Cross Section for Irregular Channel**

**Project Description**

|              |                           |
|--------------|---------------------------|
| Worksheet    | DEER SPRINGS WAY OUT, NOR |
| Flow Element | Irregular Channel         |
| Method       | Manning's Formula         |
| Solve For    | Discharge                 |

**Section Data**

|                         |                |
|-------------------------|----------------|
| Mannings Coefficient    | 0.016          |
| Channel Slope           | 0.008300 ft/ft |
| Water Surface Elevation | 0.60 ft        |
| Elevation Range         | 0.00 to 0.87   |
| Discharge               | 13.35 cfs      |



V:10.0  
H:1  
NTS

Street X sections

# X-SECTION A

## Worksheet for Irregular Channel

Future 10yr

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | X-SECTION A       |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Input Data    |                |
|---------------|----------------|
| Channel Slope | 0.029600 ft/ft |
| Discharge     | 33.00 cfs      |

$$= (47 - 14)$$

| Options                         |                          |
|---------------------------------|--------------------------|
| Current Roughness Method        | Improved Lotter's Method |
| Open Channel Weighting Method   | Improved Lotter's Method |
| Closed Channel Weighting Method | Horton's Method          |

| Results                 |                     |
|-------------------------|---------------------|
| Mannings Coefficient    | 0.015               |
| Water Surface Elevation | 0.50 ft             |
| Elevation Range         | 0.00 to 0.83        |
| Flow Area               | 6.3 ft <sup>2</sup> |
| Wetted Perimeter        | 35.77 ft            |
| Top Width               | 34.77 ft            |
| Actual Depth            | 0.50 ft             |
| Critical Elevation      | 0.63 ft             |
| Critical Slope          | 0.005722 ft/ft      |
| Velocity                | 5.27 ft/s           |
| Velocity Head           | 0.43 ft             |
| Specific Energy         | 0.93 ft             |
| Froude Number           | 2.19                |
| Flow Type               | Supercritical       |

$$D \times V$$

$$0.5 \times 5.27 = 2.6 < 6 \quad \checkmark$$

Calculation Messages:  
Flow is divided.

| Roughness Segments |             |                      |
|--------------------|-------------|----------------------|
| Start Station      | End Station | Mannings Coefficient |
| 0+00               | 7+00        | 0.013                |
| 7+00               | 72+00       | 0.017                |
| 72+00              | 84+00       | 0.013                |

| Natural Channel Points |                |
|------------------------|----------------|
| Station (ft)           | Elevation (ft) |
| 0+00                   | 0.60           |
| 5+00                   | 0.50           |
| 5+50                   | 0.50           |
| 5+50                   | 0.00           |
| 7+00                   | 0.17           |
| 40+00                  | 0.83           |
| 72+00                  | 0.19           |
| 73+50                  | 0.02           |

# X-SECTION A

## Worksheet for Irregular Channel

Future 100 yr

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | X-SECTION A       |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Input Data    |                |
|---------------|----------------|
| Channel Slope | 0.029600 ft/ft |
| Discharge     | 81.00 cfs      |

$\approx (103 - 22)$

| Options                         |                          |
|---------------------------------|--------------------------|
| Current Roughness Method        | Improved Lotter's Method |
| Open Channel Weighting Method   | Improved Lotter's Method |
| Closed Channel Weighting Method | Horton's Method          |

| Results                 |                      |
|-------------------------|----------------------|
| Mannings Coefficient    | 0.016                |
| Water Surface Elevation | 0.66 ft              |
| Elevation Range         | 0.00 to 0.83         |
| Flow Area               | 13.8 ft <sup>2</sup> |
| Wetted Perimeter        | 62.02 ft             |
| Top Width               | 60.88 ft             |
| Actual Depth            | 0.66 ft              |
| Critical Elevation      | 0.82 ft              |
| Critical Slope          | 0.005693 ft/ft       |
| Velocity                | 5.85 ft/s            |
| Velocity Head           | 0.53 ft              |
| Specific Energy         | 1.19 ft              |
| Froude Number           | 2.16                 |
| Flow Type               | Supercritical        |

Dxv

$$0.66 \times 5.85 = 3.9 < 8 \checkmark$$

### Calculation Messages:

Water elevation exceeds lowest end station by 0.55888576e-1 ft.  
Flow is divided.

| Roughness Segments |             |                      |
|--------------------|-------------|----------------------|
| Start Station      | End Station | Mannings Coefficient |
| 0+.00              | 7+.00       | 0.013                |
| 7+.00              | 72+.00      | 0.017                |
| 72+.00             | 84+.00      | 0.013                |

| Natural Channel Points |                |
|------------------------|----------------|
| Station (ft)           | Elevation (ft) |
| 0+.00                  | 0.60           |
| 5+.00                  | 0.50           |
| 5+.50                  | 0.50           |
| 5+.50                  | 0.00           |
| 7+.00                  | 0.17           |
| 40+.00                 | 0.83           |
| 72+.00                 | 0.19           |

**X-SECTION A**  
**Worksheet for Irregular Channel**

| Natural Channel Points |                   |
|------------------------|-------------------|
| Station<br>(ft)        | Elevation<br>(ft) |
| 73+.50                 | 0.02              |
| 73+.50                 | 0.57              |
| 74+.00                 | 0.57              |
| 78+.00                 | 0.65              |
| 84+.00                 | 0.77              |

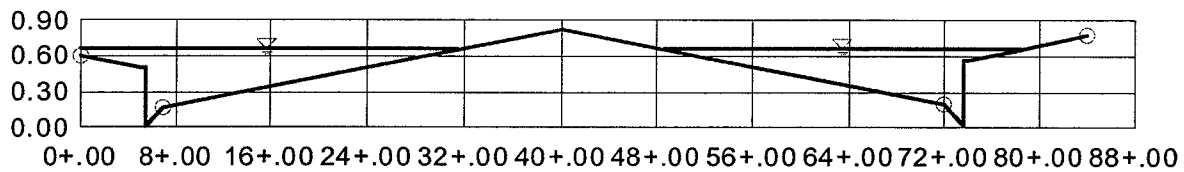
# X-SECTION A

## Cross Section for Irregular Channel

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | X-SECTION A       |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

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| Section Data            |                |
|-------------------------|----------------|
| Mannings Coefficient    | 0.016          |
| Channel Slope           | 0.029600 ft/ft |
| Water Surface Elevation | 0.66 ft        |
| Elevation Range         | 0.00 to 0.83   |
| Discharge               | 81.00 cfs      |



V:10.0  
H:1  
NTS

# X-SECTION A

## Worksheet for Irregular Channel

Existing 10 yr  
(proposed flows in street)

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | X-SECTION A       |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Input Data    |                |
|---------------|----------------|
| Channel Slope | 0.029600 ft/ft |
| Discharge     | 114.00 cfs     |

Storm drain Capacities were NOT used for Existing flows.

| Options                         |                          |
|---------------------------------|--------------------------|
| Current Roughness Method        | Improved Lotter's Method |
| Open Channel Weighting Method   | Improved Lotter's Method |
| Closed Channel Weighting Method | Horton's Method          |

| Results                 |                      |
|-------------------------|----------------------|
| Mannings Coefficient    | 0.016                |
| Water Surface Elevation | 0.72 ft              |
| Elevation Range         | 0.00 to 0.83         |
| Flow Area               | 17.9 ft <sup>2</sup> |
| Wetted Perimeter        | 71.34 ft             |
| Top Width               | 70.14 ft             |
| Actual Depth            | 0.72 ft              |
| Critical Elevation      | 0.90 ft              |
| Critical Slope          | 0.005219 ft/ft       |
| Velocity                | 6.37 ft/s            |
| Velocity Head           | 0.63 ft              |
| Specific Energy         | 1.35 ft              |
| Froude Number           | 2.22                 |
| Flow Type               | Supercritical        |

$$\frac{D \times V}{0.72 \times 6.37} = 4.6 < 6 \checkmark$$

Calculation Messages:  
Water elevation exceeds lowest end station by 0.11760574 ft.  
Flow is divided.

| Roughness Segments |             |                      |
|--------------------|-------------|----------------------|
| Start Station      | End Station | Mannings Coefficient |
| 0+.00              | 7+.00       | 0.013                |
| 7+.00              | 72+.00      | 0.017                |
| 72+.00             | 84+.00      | 0.013                |

| Natural Channel Points |                |
|------------------------|----------------|
| Station (ft)           | Elevation (ft) |
| 0+.00                  | 0.60           |
| 5+.00                  | 0.50           |
| 5+.50                  | 0.50           |
| 5+.50                  | 0.00           |
| 7+.00                  | 0.17           |
| 40+.00                 | 0.83           |
| 72+.00                 | 0.19           |

# X-SECTION A

## Worksheet for Irregular Channel

EXISTING (PR) 100 ft

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | X-SECTION A       |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Input Data    |                |
|---------------|----------------|
| Channel Slope | 0.029600 ft/ft |
| Discharge     | 163.00 cfs     |

| Options                         |                          |
|---------------------------------|--------------------------|
| Current Roughness Method        | Improved Lotter's Method |
| Open Channel Weighting Method   | Improved Lotter's Method |
| Closed Channel Weighting Method | Horton's Method          |

| Results                 |                      |
|-------------------------|----------------------|
| Mannings Coefficient    | 0.016                |
| Water Surface Elevation | 0.79 ft              |
| Elevation Range         | 0.00 to 0.83         |
| Flow Area               | 23.3 ft <sup>2</sup> |
| Wetted Perimeter        | 81.23 ft             |
| Top Width               | 79.93 ft             |
| Actual Depth            | 0.79 ft              |
| Critical Elevation      | 1.00 ft              |
| Critical Slope          | 0.004798 ft/ft       |
| Velocity                | 7.00 ft/s            |
| Velocity Head           | 0.76 ft              |
| Specific Energy         | 1.55 ft              |
| Froude Number           | 2.28                 |
| Flow Type               | Supercritical        |

Dxv  
 $0.79 \times 7.00 = 5.5 < 8 \checkmark$

Calculation Messages:  
 Water elevation exceeds lowest end station by 0.18934842 ft.  
 Flow is divided.

| Roughness Segments |             |                      |
|--------------------|-------------|----------------------|
| Start Station      | End Station | Mannings Coefficient |
| 0+.00              | 7+.00       | 0.013                |
| 7+.00              | 72+.00      | 0.017                |
| 72+.00             | 84+.00      | 0.013                |

| Natural Channel Points |                |
|------------------------|----------------|
| Station (ft)           | Elevation (ft) |
| 0+.00                  | 0.60           |
| 5+.00                  | 0.50           |
| 5+.50                  | 0.50           |
| 5+.50                  | 0.00           |
| 7+.00                  | 0.17           |
| 40+.00                 | 0.83           |
| 72+.00                 | 0.19           |

**X-SECTION A**  
**Worksheet for Irregular Channel**

| Natural Channel Points |                   |
|------------------------|-------------------|
| Station<br>(ft)        | Elevation<br>(ft) |
| 73+.50                 | 0.02              |
| 73+.50                 | 0.57              |
| 74+.00                 | 0.57              |
| 78+.00                 | 0.65              |
| 84+.00                 | 0.77              |

# X-SECTION A

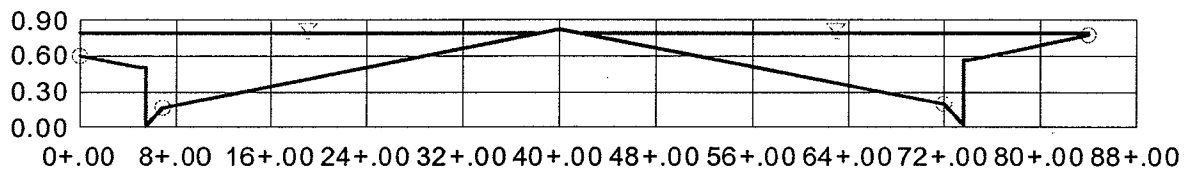
## Cross Section for Irregular Channel

### Project Description

|              |                   |
|--------------|-------------------|
| Worksheet    | X-SECTION A       |
| Flow Element | Irregular Channel |
| Method       | Manning's Formula |
| Solve For    | Channel Depth     |

### Section Data

|                         |                |
|-------------------------|----------------|
| Mannings Coefficient    | 0.016          |
| Channel Slope           | 0.029600 ft/ft |
| Water Surface Elevation | 0.79 ft        |
| Elevation Range         | 0.00 to 0.83   |
| Discharge               | 163.00 cfs     |



V:10.0  
H:1  
NTS

# DEER SPRINGS, 100-YR AFTER OVERFLOW

## Worksheet for Irregular Channel

100 yr

Interim/Proposed

X Section B

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | DEER SPRINGS WAY  |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Input Data    |                |
|---------------|----------------|
| Channel Slope | 0.008300 ft/ft |
| Discharge     | 163.00 cfs     |

← TOTAL flow from both N. + S. sides  
after the over flow.

Approximate station is 5+00.

| Options                         |                          |
|---------------------------------|--------------------------|
| Current Roughness Method        | Improved Lotter's Method |
| Open Channel Weighting Method   | Improved Lotter's Method |
| Closed Channel Weighting Method | Horton's Method          |

| Results                 |                      |
|-------------------------|----------------------|
| Mannings Coefficient    | 0.016                |
| Water Surface Elevation | 0.95 ft              |
| Elevation Range         | 0.00 to 0.87         |
| Flow Area               | 34.8 ft <sup>2</sup> |
| Wetted Perimeter        | 85.78 ft             |
| Top Width               | 84.00 ft             |
| Actual Depth            | 0.95 ft              |
| Critical Elevation      | 1.03 ft              |
| Critical Slope          | 0.004763 ft/ft       |
| Velocity                | 4.69 ft/s            |
| Velocity Head           | 0.34 ft              |
| Specific Energy         | 1.29 ft              |
| Froude Number           | 1.29                 |
| Flow Type               | Supercritical        |

$$D \times V = 0.95 \times 4.69$$

$$= 4.4 < 6 \text{ o.k.}$$

### Calculation Messages:

Water elevation exceeds lowest end station by 0.35065747 ft.

Note: no dry lane exists during  
the interim condition.

| Roughness Segments |             |                      |
|--------------------|-------------|----------------------|
| Start Station      | End Station | Mannings Coefficient |
| 0+00               | 7+00        | 0.013                |
| 7+00               | 72+00       | 0.017                |
| 72+00              | 84+00       | 0.013                |

| Natural Channel Points |                |
|------------------------|----------------|
| Station (ft)           | Elevation (ft) |
| 0+00                   | 0.60           |
| 5+00                   | 0.50           |
| 5+50                   | 0.50           |
| 5+50                   | 0.00           |
| 7+00                   | 0.13           |
| 7+00                   | 0.21           |
| 40+00                  | 0.87           |
| 72+00                  | 0.23           |

**DEER SPRINGS, 100-YR AFTER OVERFLOW**  
**Worksheet for Irregular Channel**

| Natural Channel Points |                   |
|------------------------|-------------------|
| Station<br>(ft)        | Elevation<br>(ft) |
| 72+.00                 | 0.14              |
| 73+.50                 | 0.02              |
| 73+.50                 | 0.52              |
| 74+.00                 | 0.52              |
| 78+.00                 | 0.60              |
| 84+.00                 | 0.72              |

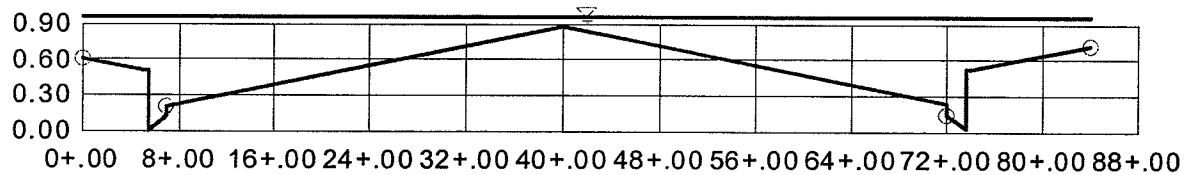
## Cross Section for Irregular Channel

## Project Description

|              |                   |
|--------------|-------------------|
| Worksheet    | DEER SPRINGS WAY  |
| Flow Element | Irregular Channel |
| Method       | Manning's Formula |
| Solve For    | Channel Depth     |

## Section Data

|                         |                |
|-------------------------|----------------|
| Mannings Coefficient    | 0.016          |
| Channel Slope           | 0.008300 ft/ft |
| Water Surface Elevation | 0.95 ft        |
| Elevation Range         | 0.00 to 0.87   |
| Discharge               | 163.00 cfs     |



V:10.0  
H:1  
NTS

# X-SECTION B

## Worksheet for Irregular Channel

Future 10 yr

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | X-SECTION B       |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Input Data    |                |
|---------------|----------------|
| Channel Slope | 0.008300 ft/ft |
| Discharge     | 33.00 cfs      |

= (47 - 14)

| Options                         |                          |
|---------------------------------|--------------------------|
| Current Roughness Method        | Improved Lotter's Method |
| Open Channel Weighting Method   | Improved Lotter's Method |
| Closed Channel Weighting Method | Horton's Method          |

| Results                 |                      |
|-------------------------|----------------------|
| Mannings Coefficient    | 0.016                |
| Water Surface Elevation | 0.61 ft              |
| Elevation Range         | 0.00 to 0.83         |
| Flow Area               | 11.3 ft <sup>2</sup> |
| Wetted Perimeter        | 55.44 ft             |
| Top Width               | 54.35 ft             |
| Actual Depth            | 0.61 ft              |
| Critical Elevation      | 0.63 ft              |
| Critical Slope          | 0.006481 ft/ft       |
| Velocity                | 2.91 ft/s            |
| Velocity Head           | 0.13 ft              |
| Specific Energy         | 0.74 ft              |
| Froude Number           | 1.12                 |
| Flow Type               | Supercritical        |

$$\frac{D_{xv}}{0.61} \times 2.91 = 1.8 < 6$$

Calculation Messages:  
Water elevation exceeds lowest end station by 0.12303191e-1 ft.  
Flow is divided.

| Roughness Segments |             |                      |
|--------------------|-------------|----------------------|
| Start Station      | End Station | Mannings Coefficient |
| 0+00               | 7+00        | 0.013                |
| 7+00               | 72+00       | 0.017                |
| 72+00              | 84+00       | 0.013                |

| Natural Channel Points |                |
|------------------------|----------------|
| Station (ft)           | Elevation (ft) |
| 0+00                   | 0.60           |
| 5+00                   | 0.50           |
| 5+50                   | 0.50           |
| 5+50                   | 0.00           |
| 7+00                   | 0.17           |
| 40+00                  | 0.83           |
| 72+00                  | 0.19           |

# X-SECTION B

## Cross Section for Irregular Channel

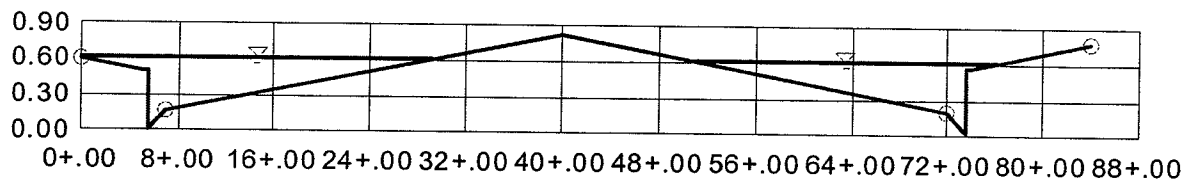
### Project Description

|              |                   |
|--------------|-------------------|
| Worksheet    | X-SECTION B       |
| Flow Element | Irregular Channel |
| Method       | Manning's Formula |
| Solve For    | Channel Depth     |

### Section Data

|                         |                |
|-------------------------|----------------|
| Mannings Coefficient    | 0.016          |
| Channel Slope           | 0.008300 ft/ft |
| Water Surface Elevation | 0.61 ft        |
| Elevation Range         | 0.00 to 0.83   |
| Discharge               | 33.00 cfs      |

10' dry lane does NOT exist.  
However, the Storm drain is Maxed.



V:10.0  
H:1  
NTS

# X-SECTION B

## Worksheet for Irregular Channel

Future 100 yr

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | X-SECTION B       |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Input Data    |                |
|---------------|----------------|
| Channel Slope | 0.008300 ft/ft |
| Discharge     | 81.00 cfs      |

= (103 - 22)

| Options                         |                          |
|---------------------------------|--------------------------|
| Current Roughness Method        | Improved Lotter's Method |
| Open Channel Weighting Method   | Improved Lotter's Method |
| Closed Channel Weighting Method | Horton's Method          |

| Results                 |                      |
|-------------------------|----------------------|
| Mannings Coefficient    | 0.016                |
| Water Surface Elevation | 0.78 ft              |
| Elevation Range         | 0.00 to 0.83         |
| Flow Area               | 22.3 ft <sup>2</sup> |
| Wetted Perimeter        | 79.90 ft             |
| Top Width               | 78.63 ft             |
| Actual Depth            | 0.78 ft              |
| Critical Elevation      | 0.82 ft              |
| Critical Slope          | 0.005544 ft/ft       |
| Velocity                | 3.64 ft/s            |
| Velocity Head           | 0.21 ft              |
| Specific Energy         | 0.98 ft              |
| Froude Number           | 1.21                 |
| Flow Type               | Supercritical        |

$D \times V$

$$0.78 \times 3.64 = 2.8 < 8 \checkmark$$

Calculation Messages:  
Water elevation exceeds lowest end station by 0.17631261 ft.  
Flow is divided.

| Roughness Segments |             |                      |
|--------------------|-------------|----------------------|
| Start Station      | End Station | Mannings Coefficient |
| 0+.00              | 7+.00       | 0.013                |
| 7+.00              | 72+.00      | 0.017                |
| 72+.00             | 84+.00      | 0.013                |

| Natural Channel Points |                |
|------------------------|----------------|
| Station (ft)           | Elevation (ft) |
| 0+.00                  | 0.60           |
| 5+.00                  | 0.50           |
| 5+.50                  | 0.50           |
| 5+.50                  | 0.00           |
| 7+.00                  | 0.17           |
| 40+.00                 | 0.83           |
| 72+.00                 | 0.19           |

**X-SECTION B**  
**Worksheet for Irregular Channel**

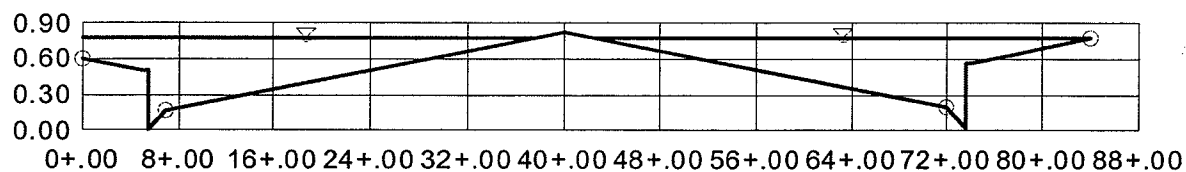
| Natural Channel Points |                   |
|------------------------|-------------------|
| Station<br>(ft)        | Elevation<br>(ft) |
| 73+.50                 | 0.02              |
| 73+.50                 | 0.57              |
| 74+.00                 | 0.57              |
| 78+.00                 | 0.65              |
| 84+.00                 | 0.77              |

# X-SECTION B

## Cross Section for Irregular Channel

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | X-SECTION B       |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Section Data            |                |
|-------------------------|----------------|
| Mannings Coefficient    | 0.016          |
| Channel Slope           | 0.008300 ft/ft |
| Water Surface Elevation | 0.78 ft        |
| Elevation Range         | 0.00 to 0.83   |
| Discharge               | 81.00 cfs      |



V:10.0  
H:1  
NTS

# X-SECTION C

## Worksheet for Irregular Channel

Existing 100 yr  
(or proposed existing flow in the street)

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | X-SECTION C       |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Input Data    |                |
|---------------|----------------|
| Channel Slope | 0.029600 ft/ft |
| Discharge     | 163.00 cfs     |

| Options                         |                          |
|---------------------------------|--------------------------|
| Current Roughness Method        | Improved Lotter's Method |
| Open Channel Weighting Method   | Improved Lotter's Method |
| Closed Channel Weighting Method | Horton's Method          |

| Results                 |                      |
|-------------------------|----------------------|
| Mannings Coefficient    | 0.016                |
| Water Surface Elevation | 0.79 ft              |
| Elevation Range         | 0.00 to 0.83         |
| Flow Area               | 23.3 ft <sup>2</sup> |
| Wetted Perimeter        | 81.23 ft             |
| Top Width               | 79.93 ft             |
| Actual Depth            | 0.79 ft              |
| Critical Elevation      | 1.00 ft              |
| Critical Slope          | 0.004798 ft/ft       |
| Velocity                | 7.00 ft/s            |
| Velocity Head           | 0.76 ft              |
| Specific Energy         | 1.55 ft              |
| Froude Number           | 2.28                 |
| Flow Type               | Supercritical        |

$$D \times V$$

$$(0.79)(7.00) = 5.5 < 8 \text{ ok.}$$

Calculation Messages:  
Water elevation exceeds lowest end station by 0.18934842 ft.  
Flow is divided.

Note: less than 6 thus, 10 yr O.K.

| Roughness Segments |             |                      |
|--------------------|-------------|----------------------|
| Start Station      | End Station | Mannings Coefficient |
| 0+.00              | 7+.00       | 0.013                |
| 7+.00              | 72+.00      | 0.017                |
| 72+.00             | 84+.00      | 0.013                |

| Natural Channel Points |                |
|------------------------|----------------|
| Station (ft)           | Elevation (ft) |
| 0+.00                  | 0.60           |
| 5+.00                  | 0.50           |
| 5+.50                  | 0.50           |
| 5+.50                  | 0.00           |
| 7+.00                  | 0.17           |
| 40+.00                 | 0.83           |
| 72+.00                 | 0.19           |

# X-SECTION C

## Worksheet for Irregular Channel

Future 10yr

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | X-SECTION C       |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Input Data    |                |
|---------------|----------------|
| Channel Slope | 0.029600 ft/ft |
| Discharge     | 22.00 cfs      |

| Options                         |                          |
|---------------------------------|--------------------------|
| Current Roughness Method        | Improved Lotter's Method |
| Open Channel Weighting Method   | Improved Lotter's Method |
| Closed Channel Weighting Method | Horton's Method          |

| Results                 |                     |
|-------------------------|---------------------|
| Mannings Coefficient    | 0.015               |
| Water Surface Elevation | 0.44 ft             |
| Elevation Range         | 0.00 to 0.83        |
| Flow Area               | 4.5 ft <sup>2</sup> |
| Wetted Perimeter        | 30.17 ft            |
| Top Width               | 29.28 ft            |
| Actual Depth            | 0.44 ft             |
| Critical Elevation      | 0.56 ft             |
| Critical Slope          | 0.005603 ft/ft      |
| Velocity                | 4.89 ft/s           |
| Velocity Head           | 0.37 ft             |
| Specific Energy         | 0.81 ft             |
| Froude Number           | 2.20                |
| Flow Type               | Supercritical       |

Dxv  
 $(0.44)(4.89) = 2.2 < 6 \checkmark$

Calculation Messages:  
 Flow is divided.

| Roughness Segments |             |                      |
|--------------------|-------------|----------------------|
| Start Station      | End Station | Mannings Coefficient |
| 0+.00              | 7+.00       | 0.013                |
| 7+.00              | 72+.00      | 0.017                |
| 72+.00             | 84+.00      | 0.013                |

| Natural Channel Points |                |
|------------------------|----------------|
| Station (ft)           | Elevation (ft) |
| 0+.00                  | 0.60           |
| 5+.00                  | 0.50           |
| 5+.50                  | 0.50           |
| 5+.50                  | 0.00           |
| 7+.00                  | 0.17           |
| 40+.00                 | 0.83           |
| 72+.00                 | 0.19           |
| 73+.50                 | 0.02           |

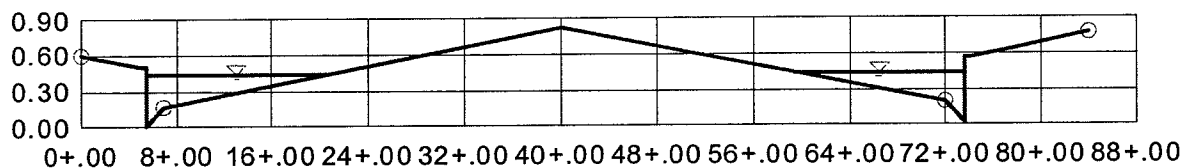
# X-SECTION C

## Cross Section for Irregular Channel

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | X-SECTION C       |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Section Data            |                |
|-------------------------|----------------|
| Mannings Coefficient    | 0.015          |
| Channel Slope           | 0.029600 ft/ft |
| Water Surface Elevation | 0.44 ft        |
| Elevation Range         | 0.00 to 0.83   |
| Discharge               | 22.00 cfs      |

\* 12' dry lane in each direction



V:10.0  
H:1  
NTS

# X-SECTION C

## Worksheet for Irregular Channel

Future 100 yr

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | X-SECTION C       |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Input Data    |                |
|---------------|----------------|
| Channel Slope | 0.029600 ft/ft |
| Discharge     | 62.00 cfs      |

| Options                         |                          |
|---------------------------------|--------------------------|
| Current Roughness Method        | Improved Lotter's Method |
| Open Channel Weighting Method   | Improved Lotter's Method |
| Closed Channel Weighting Method | Horton's Method          |

| Results                 |                      |
|-------------------------|----------------------|
| Mannings Coefficient    | 0.016                |
| Water Surface Elevation | 0.61 ft              |
| Elevation Range         | 0.00 to 0.83         |
| Flow Area               | 11.3 ft <sup>2</sup> |
| Wetted Perimeter        | 55.31 ft             |
| Top Width               | 54.22 ft             |
| Actual Depth            | 0.61 ft              |
| Critical Elevation      | 0.76 ft              |
| Critical Slope          | 0.005958 ft/ft       |
| Velocity                | 5.49 ft/s            |
| Velocity Head           | 0.47 ft              |
| Specific Energy         | 1.08 ft              |
| Froude Number           | 2.12                 |
| Flow Type               | Supercritical        |

$$D \times V =$$

$$- (0.61)(5.49) = 3.3 < 8$$

$$- \text{depth is less than 1 ft}$$

### Calculation Messages:

Water elevation exceeds lowest end station by 0.11469366e-1 ft.  
Flow is divided.

| Roughness Segments |             |                      |
|--------------------|-------------|----------------------|
| Start Station      | End Station | Mannings Coefficient |
| 0+.00              | 7+.00       | 0.013                |
| 7+.00              | 72+.00      | 0.017                |
| 72+.00             | 84+.00      | 0.013                |

| Natural Channel Points |                |
|------------------------|----------------|
| Station (ft)           | Elevation (ft) |
| 0+.00                  | 0.60           |
| 5+.00                  | 0.50           |
| 5+.50                  | 0.50           |
| 5+.50                  | 0.00           |
| 7+.00                  | 0.17           |
| 40+.00                 | 0.83           |
| 72+.00                 | 0.19           |

# X-SECTION D

## Worksheet for Irregular Channel

Existing 100 yr

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | X-SECTION D       |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Input Data    |                |
|---------------|----------------|
| Channel Slope | 0.013800 ft/ft |
| Discharge     | 195.00 cfs     |

| Options                         |                          |
|---------------------------------|--------------------------|
| Current Roughness Method        | Improved Lotter's Method |
| Open Channel Weighting Method   | Improved Lotter's Method |
| Closed Channel Weighting Method | Horton's Method          |

| Results                 |                      |
|-------------------------|----------------------|
| Mannings Coefficient    | 0.016                |
| Water Surface Elevation | 0.91 ft              |
| Elevation Range         | 0.00 to 0.83         |
| Flow Area               | 33.4 ft <sup>2</sup> |
| Wetted Perimeter        | 85.54 ft             |
| Top Width               | 84.00 ft             |
| Actual Depth            | 0.91 ft              |
| Critical Elevation      | 1.06 ft              |
| Critical Slope          | 0.004653 ft/ft       |
| Velocity                | 5.84 ft/s            |
| Velocity Head           | 0.53 ft              |
| Specific Energy         | 1.44 ft              |
| Froude Number           | 1.63                 |
| Flow Type               | Supercritical        |

$D \times V$   
 $(0.91)(5.84) = 5.3 < 8 \checkmark$   
 Note: less than 6 thus 10 yr o.k.

Calculation Messages:  
 Water elevation exceeds lowest end station by 0.31024719 ft.

| Roughness Segments |             |                      |
|--------------------|-------------|----------------------|
| Start Station      | End Station | Mannings Coefficient |
| 0+00               | 7+00        | 0.013                |
| 7+00               | 72+00       | 0.017                |
| 72+00              | 84+00       | 0.013                |

| Natural Channel Points |                |
|------------------------|----------------|
| Station (ft)           | Elevation (ft) |
| 0+00                   | 0.60           |
| 5+00                   | 0.50           |
| 5+50                   | 0.50           |
| 5+50                   | 0.00           |
| 7+00                   | 0.17           |
| 40+00                  | 0.83           |
| 72+00                  | 0.19           |
| 73+50                  | 0.02           |

# X-SECTION D

## Worksheet for Irregular Channel

Future 10 yr

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | X-SECTION D       |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Input Data    |                |
|---------------|----------------|
| Channel Slope | 0.013800 ft/ft |
| Discharge     | 30.00 cfs      |

| Options                         |                          |
|---------------------------------|--------------------------|
| Current Roughness Method        | Improved Lotter's Method |
| Open Channel Weighting Method   | Improved Lotter's Method |
| Closed Channel Weighting Method | Horton's Method          |

| Results                 |                     |
|-------------------------|---------------------|
| Mannings Coefficient    | 0.016               |
| Water Surface Elevation | 0.55 ft             |
| Elevation Range         | 0.00 to 0.83        |
| Flow Area               | 8.3 ft <sup>2</sup> |
| Wetted Perimeter        | 43.92 ft            |
| Top Width               | 42.87 ft            |
| Actual Depth            | 0.55 ft             |
| Critical Elevation      | 0.62 ft             |
| Critical Slope          | 0.006271 ft/ft      |
| Velocity                | 3.63 ft/s           |
| Velocity Head           | 0.20 ft             |
| Specific Energy         | 0.75 ft             |
| Froude Number           | 1.46                |
| Flow Type               | Supercritical       |

Calculation Messages:  
Flow is divided.

DxV  
 $0.55 \times 3.63 = 2.0 < 6 \checkmark$

12' dry lane exists both ways

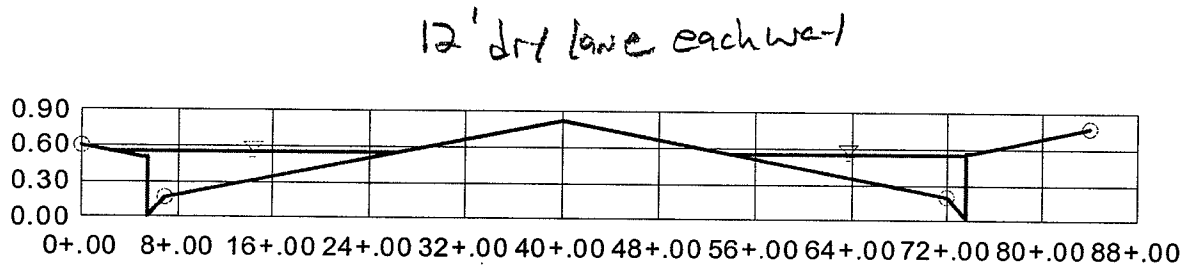
| Roughness Segments |             |                      |
|--------------------|-------------|----------------------|
| Start Station      | End Station | Mannings Coefficient |
| 0+.00              | 7+.00       | 0.013                |
| 7+.00              | 72+.00      | 0.017                |
| 72+.00             | 84+.00      | 0.013                |

| Natural Channel Points |                |
|------------------------|----------------|
| Station (ft)           | Elevation (ft) |
| 0+.00                  | 0.60           |
| 5+.00                  | 0.50           |
| 5+.50                  | 0.50           |
| 5+.50                  | 0.00           |
| 7+.00                  | 0.17           |
| 40+.00                 | 0.83           |
| 72+.00                 | 0.19           |
| 73+.50                 | 0.02           |

# X-SECTION D

## Cross Section for Irregular Channel

| Project Description     |                   |
|-------------------------|-------------------|
| Worksheet               | X-SECTION D       |
| Flow Element            | Irregular Channel |
| Method                  | Manning's Formula |
| Solve For               | Channel Depth     |
| Section Data            |                   |
| Mannings Coefficient    | 0.016             |
| Channel Slope           | 0.013800 ft/ft    |
| Water Surface Elevation | 0.55 ft           |
| Elevation Range         | 0.00 to 0.83      |
| Discharge               | 30.00 cfs         |



V:10.0  
H:1  
NTS

# X-SECTION D

## Worksheet for Irregular Channel

Future 100 yr

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | X-SECTION D       |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Input Data    |                |
|---------------|----------------|
| Channel Slope | 0.013800 ft/ft |
| Discharge     | 78.00 cfs      |

| Options                         |                          |
|---------------------------------|--------------------------|
| Current Roughness Method        | Improved Lotter's Method |
| Open Channel Weighting Method   | Improved Lotter's Method |
| Closed Channel Weighting Method | Horton's Method          |

| Results                 |                      |
|-------------------------|----------------------|
| Mannings Coefficient    | 0.016                |
| Water Surface Elevation | 0.72 ft              |
| Elevation Range         | 0.00 to 0.83         |
| Flow Area               | 17.9 ft <sup>2</sup> |
| Wetted Perimeter        | 71.40 ft             |
| Top Width               | 70.20 ft             |
| Actual Depth            | 0.72 ft              |
| Critical Elevation      | 0.81 ft              |
| Critical Slope          | 0.005632 ft/ft       |
| Velocity                | 4.35 ft/s            |
| Velocity Head           | 0.29 ft              |
| Specific Energy         | 1.01 ft              |
| Froude Number           | 1.52                 |
| Flow Type               | Supercritical        |

DxV  
 $(0.72)(4.35) = 3.1 < 6 \text{ O.K.}$

Calculation Messages:  
 Water elevation exceeds lowest end station by 0.11799938 ft.  
 Flow is divided.

| Roughness Segments |             |                      |
|--------------------|-------------|----------------------|
| Start Station      | End Station | Mannings Coefficient |
| 0+.00              | 7+.00       | 0.013                |
| 7+.00              | 72+.00      | 0.017                |
| 72+.00             | 84+.00      | 0.013                |

| Natural Channel Points |                |
|------------------------|----------------|
| Station (ft)           | Elevation (ft) |
| 0+.00                  | 0.60           |
| 5+.00                  | 0.50           |
| 5+.50                  | 0.50           |
| 5+.50                  | 0.00           |
| 7+.00                  | 0.17           |
| 40+.00                 | 0.83           |
| 72+.00                 | 0.19           |

# X-SECTION E

## Worksheet for Irregular Channel

Proposed  
existing flow 100-yr

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | X-SECTION E       |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Input Data    |                |
|---------------|----------------|
| Channel Slope | 0.004000 ft/ft |
| Discharge     | 180.00 cfs     |

| Options                         |                          |
|---------------------------------|--------------------------|
| Current Roughness Method        | Improved Lotter's Method |
| Open Channel Weighting Method   | Improved Lotter's Method |
| Closed Channel Weighting Method | Horton's Method          |

| Results                 |                      |
|-------------------------|----------------------|
| Mannings Coefficient    | 0.016                |
| Water Surface Elevation | 99.04 ft             |
| Elevation Range         | 97.97 to 99.36       |
| Flow Area               | 44.8 ft <sup>2</sup> |
| Wetted Perimeter        | 78.53 ft             |
| Top Width               | 76.00 ft             |
| Actual Depth            | 1.07 ft              |
| Critical Elevation      | 97.97 ft             |
| Critical Slope          | 0.000000 ft/ft       |
| Velocity                | 4.02 ft/s            |
| Velocity Head           | 0.25 ft              |
| Specific Energy         | 99.29 ft             |
| Froude Number           | 0.92                 |
| Flow Type               | Subcritical          |

Dxv

$$1.07(4.02) = 4.3 < 6$$

→ Will work for 10 yr also  
- less than 2-feet depth

Calculation Messages:  
Water elevation exceeds lowest end station by 0.46931551 ft.  
Flow is divided.

| Roughness Segments |             |                      |
|--------------------|-------------|----------------------|
| Start Station      | End Station | Mannings Coefficient |
| 0+00               | 7+00        | 0.013                |
| 7+00               | 73+00       | 0.017                |
| 73+00              | 80+00       | 0.013                |

| Natural Channel Points |                |
|------------------------|----------------|
| Station (ft)           | Elevation (ft) |
| 0+00                   | 98.57          |
| 5+00                   | 98.47          |
| 5+50                   | 98.47          |
| 5+50                   | 97.97          |
| 7+00                   | 98.14          |
| 43+00                  | 98.86          |
| 43+00                  | 99.36          |

# X-SECTION E

## Worksheet for Irregular Channel

Future 10yr

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | X-SECTION E       |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Input Data    |                |
|---------------|----------------|
| Channel Slope | 0.004000 ft/ft |
| Discharge     | 30.00 cfs      |

| Options                         |                          |
|---------------------------------|--------------------------|
| Current Roughness Method        | Improved Lotter's Method |
| Open Channel Weighting Method   | Improved Lotter's Method |
| Closed Channel Weighting Method | Horton's Method          |

| Results                 |                      |
|-------------------------|----------------------|
| Mannings Coefficient    | 0.016                |
| Water Surface Elevation | 98.61 ft             |
| Elevation Range         | 97.97 to 99.36       |
| Flow Area               | 13.9 ft <sup>2</sup> |
| Wetted Perimeter        | 62.41 ft             |
| Top Width               | 61.29 ft             |
| Actual Depth            | 0.64 ft              |
| Critical Elevation      | 98.58 ft             |
| Critical Slope          | 0.006541 ft/ft       |
| Velocity                | 2.15 ft/s            |
| Velocity Head           | 0.07 ft              |
| Specific Energy         | 98.69 ft             |
| Froude Number           | 0.80                 |
| Flow Type               | Subcritical          |

$$D \times V = (0.64)(2.15) = 1.4 < 6$$

Calculation Messages:  
 Water elevation exceeds lowest end station by 0.42892623e-1 ft.  
 Flow is divided.

Note: 12' dry lane does NOT happen. However, this is due to offsite flows. Our storm drain is maxed. Also, D = .64  
 $2 \times D = 1.3$ , FF should be 18" above highest tc or 2 feet, thus, FF are protected.

| Roughness Segments |             |                      |
|--------------------|-------------|----------------------|
| Start Station      | End Station | Mannings Coefficient |
| 0+00               | 7+00        | 0.013                |
| 7+00               | 73+00       | 0.017                |
| 73+00              | 80+00       | 0.013                |

| Natural Channel Points |                |
|------------------------|----------------|
| Station (ft)           | Elevation (ft) |
| 0+00                   | 98.57          |
| 5+00                   | 98.47          |
| 5+50                   | 98.47          |
| 5+50                   | 97.97          |
| 7+00                   | 98.14          |
| 43+00                  | 98.86          |
| 43+00                  | 99.36          |

**A-SECTION E**  
**Worksheet for Irregular Channel**

| Natural Channel Points |                   |
|------------------------|-------------------|
| Station<br>(ft)        | Elevation<br>(ft) |
| 47+.00                 | 99.16             |
| 47+.00                 | 98.66             |
| 73+.00                 | 98.14             |
| 74+.50                 | 97.97             |
| 74+.50                 | 98.47             |
| 75+.00                 | 98.47             |
| 80+.00                 | 98.57             |

# X-SECTION E

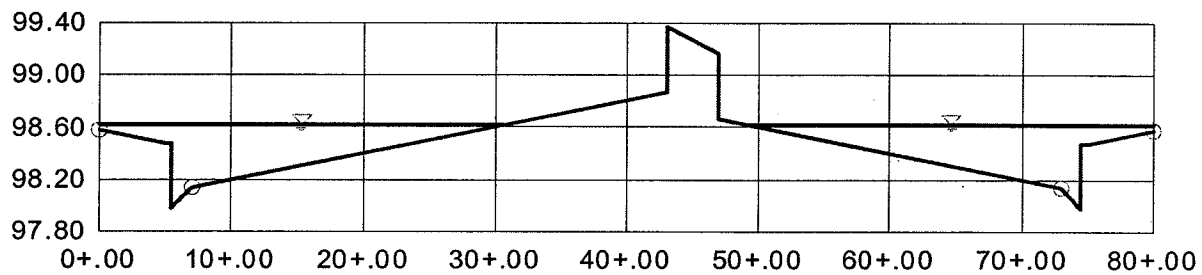
## Cross Section for Irregular Channel

### Project Description

|              |                   |
|--------------|-------------------|
| Worksheet    | X-SECTION E       |
| Flow Element | Irregular Channel |
| Method       | Manning's Formula |
| Solve For    | Channel Depth     |

### Section Data

|                         |                |
|-------------------------|----------------|
| Mannings Coefficient    | 0.016          |
| Channel Slope           | 0.004000 ft/ft |
| Water Surface Elevation | 98.61 ft       |
| Elevation Range         | 97.97 to 99.36 |
| Discharge               | 30.00 cfs      |



V:10.0  
H:1  
NTS

# X-SECTION E

## Worksheet for Irregular Channel

Future 100 yr

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | X-SECTION E       |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

| Input Data    |                |
|---------------|----------------|
| Channel Slope | 0.004000 ft/ft |
| Discharge     | 93.00 cfs      |

| Options                         |                          |
|---------------------------------|--------------------------|
| Current Roughness Method        | Improved Lotter's Method |
| Open Channel Weighting Method   | Improved Lotter's Method |
| Closed Channel Weighting Method | Horton's Method          |

| Results                 |                      |
|-------------------------|----------------------|
| Mannings Coefficient    | 0.016                |
| Water Surface Elevation | 98.84 ft             |
| Elevation Range         | 97.97 to 99.36       |
| Flow Area               | 29.8 ft <sup>2</sup> |
| Wetted Perimeter        | 76.90 ft             |
| Top Width               | 75.13 ft             |
| Actual Depth            | 0.87 ft              |
| Critical Elevation      | 97.97 ft             |
| Critical Slope          | 0.000000 ft/ft       |
| Velocity                | 3.12 ft/s            |
| Velocity Head           | 0.15 ft              |
| Specific Energy         | 98.99 ft             |
| Froude Number           | 0.87                 |
| Flow Type               | Subcritical          |

D<sub>xv</sub>  
 $(0.87)(3.12) = 2.7 < 6$  ✓  
 - less than 1' depth.

Calculation Messages:  
 Water elevation exceeds lowest end station by 0.2726904 ft.  
 Flow is divided.

| Roughness Segments |             |                      |
|--------------------|-------------|----------------------|
| Start Station      | End Station | Mannings Coefficient |
| 0+.00              | 7+.00       | 0.013                |
| 7+.00              | 73+.00      | 0.017                |
| 73+.00             | 80+.00      | 0.013                |

| Natural Channel Points |                |
|------------------------|----------------|
| Station (ft)           | Elevation (ft) |
| 0+.00                  | 98.57          |
| 5+.00                  | 98.47          |
| 5+.50                  | 98.47          |
| 5+.50                  | 97.97          |
| 7+.00                  | 98.14          |
| 43+.00                 | 98.86          |
| 43+.00                 | 99.36          |

Buffalo/95 - Resency

Cit of Las Vegas

Tetra tech, Inc. 3/27/01

Sheet PP9

ALV # 3277-4625

1" = 30'

ALV DRIVE  
P17 FOR CONTINUATION

STEM WALL / 3 COURSES  
ABOVE BACK OF SIDEWALK

STEM WALL / 3 COURSES  
ABOVE BACK OF SIDEWALK

CL STA=101+00.00 BUFFALO RD.  
CL STA=27+44.89 BUFFALO DR.

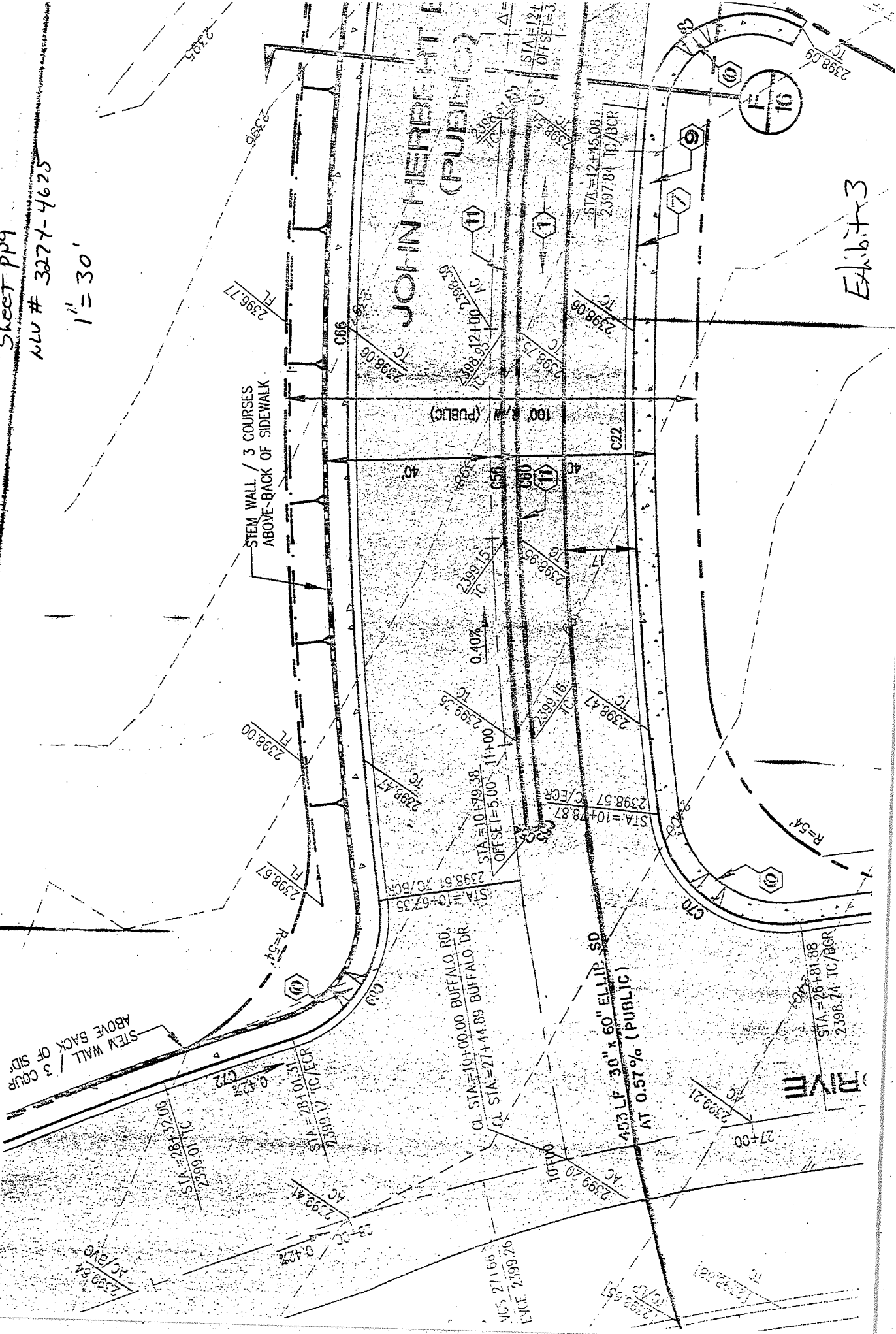
453 LF 30" x 60" ELLIP. SD  
AT 0.57% (PUBLIC)

RIVER

STA=26+81.88  
2398.74 TC/BGR

JOHN HERBERT (PUBLIC)

Exhibit 3



# X-SECTION F

## Worksheet for Irregular Channel

| Project Description |                   |
|---------------------|-------------------|
| Worksheet           | X-SECTION F       |
| Flow Element        | Irregular Channel |
| Method              | Manning's Formula |
| Solve For           | Channel Depth     |

Proposed existing 100-yr

| Input Data    |                |
|---------------|----------------|
| Channel Slope | 0.024000 ft/ft |
| Discharge     | 91.00 cfs      |

| Options                         |                          |
|---------------------------------|--------------------------|
| Current Roughness Method        | Improved Lotter's Method |
| Open Channel Weighting Method   | Improved Lotter's Method |
| Closed Channel Weighting Method | Horton's Method          |

| Results                 |                      |
|-------------------------|----------------------|
| Mannings Coefficient    | 0.017                |
| Water Surface Elevation | 98.96 ft             |
| Elevation Range         | 98.39 to 99.05       |
| Flow Area               | 20.2 ft <sup>2</sup> |
| Wetted Perimeter        | 109.05 ft            |
| Top Width               | 108.03 ft            |
| Actual Depth            | 0.57 ft              |
| Critical Elevation      | 99.05 ft             |
| Critical Slope          | 0.006254 ft/ft       |
| Velocity                | 4.51 ft/s            |
| Velocity Head           | 0.32 ft              |
| Specific Energy         | 99.27 ft             |
| Froude Number           | 1.84                 |
| Flow Type               | Supercritical        |

$$D \times V = (0.57)(4.51) = 2.6 < 6$$

Calculation Messages:  
Flow is divided.

Will work for 10-yr also

| Roughness Segments |             |                      |
|--------------------|-------------|----------------------|
| Start Station      | End Station | Mannings Coefficient |
| 0+00               | 7+00        | 0.013                |
| 7+00               | 108+00      | 0.017                |
| 108+00             | 115+00      | 0.013                |

| Natural Channel Points |                |
|------------------------|----------------|
| Station (ft)           | Elevation (ft) |
| 0+00                   | 98.99          |
| 5+00                   | 98.89          |
| 5+50                   | 98.89          |
| 5+50                   | 98.39          |
| 7+00                   | 98.56          |
| 65+00                  | 98.96          |
| 108+00                 | 98.62          |
| 109+50                 | 98.45          |

# Buffalo, 100-yr flow split to north Worksheet for Irregular Channel

Future 10yr

Note: Flows will be  
contained west side  
below crown.

| Project Description |                        |
|---------------------|------------------------|
| Worksheet           | Buffalo, flow to north |
| Flow Element        | Irregular Channel      |
| Method              | Manning's Formula      |
| Solve For           | Channel Depth          |

| Input Data    |                |
|---------------|----------------|
| Channel Slope | 0.024000 ft/ft |
| Discharge     | 38.00 cfs      |

| Options                         |                          |
|---------------------------------|--------------------------|
| Current Roughness Method        | Improved Lotter's Method |
| Open Channel Weighting Method   | Improved Lotter's Method |
| Closed Channel Weighting Method | Horton's Method          |

| Results                 |                     |
|-------------------------|---------------------|
| Mannings Coefficient    | 0.017               |
| Water Surface Elevation | 98.90 ft            |
| Elevation Range         | 98.39 to 98.99      |
| Flow Area               | 8.8 ft <sup>2</sup> |
| Wetted Perimeter        | 51.59 ft            |
| Top Width               | 51.08 ft            |
| Actual Depth            | 0.51 ft             |
| Critical Elevation      | 98.99 ft            |
| Critical Slope          | 0.006636 ft/ft      |
| Velocity                | 4.30 ft/s           |
| Velocity Head           | 0.29 ft             |
| Specific Energy         | 99.18 ft            |
| Froude Number           | 1.82                |
| Flow Type               | Supercritical       |

DxV

$$(0.51)(4.30) = 2.2 < 6$$

| Roughness Segments |             |                      |
|--------------------|-------------|----------------------|
| Start Station      | End Station | Mannings Coefficient |
| 0+00               | 7+00        | 0.013                |
| 7+00               | 65+00       | 0.017                |

Dry Lanes exist since the  
entire East side is open.

| Natural Channel Points |                |
|------------------------|----------------|
| Station (ft)           | Elevation (ft) |
| 0+00                   | 98.99          |
| 5+00                   | 98.89          |
| 5+50                   | 98.89          |
| 5+50                   | 98.39          |
| 7+00                   | 98.56          |
| 65+00                  | 98.96          |

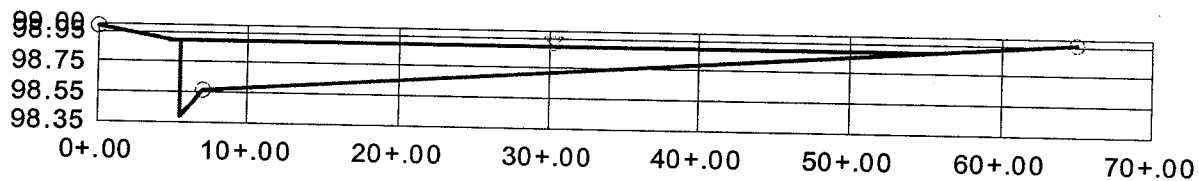
# A-SECTION F

## Cross Section for Irregular Channel

| Project Description |                        |
|---------------------|------------------------|
| Worksheet           | Buffalo, flow to north |
| Flow Element        | Irregular Channel      |
| Method              | Manning's Formula      |
| Solve For           | Channel Depth          |

| Section Data            |                |
|-------------------------|----------------|
| Mannings Coefficient    | 0.017          |
| Channel Slope           | 0.024000 ft/ft |
| Water Surface Elevation | 98.90 ft       |
| Elevation Range         | 98.39 to 98.99 |
| Discharge               | 38.00 cfs      |

Whole East side  
open 9150.



V:10.0  
H:1  
NTS