# GEOPAK Drainage V8*i* Course Manual



Tennessee Department of Transportation Roadway Design Division

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The information in this manual is based on the following software versions: MicroStation V8i - SELECT Series 2 Edition (08.11.07.443) GEOPAK V8i – SELECT Series 2 Edition (08.11.07.615).

## Resources

Tennessee Department of Transportation Drainage Manual:

http://www.tdot.state.tn.us/Chief\_Engineer/assistant\_engineer\_design/design/DrainManChap%201-11.htm

Tennessee Department of Transportation Design Guidelines and Instructional Bulletins: <a href="http://www.tdot.state.tn.us/Chief\_Engineer/assistant\_engineer\_design/design/DesGuide.htm">http://www.tdot.state.tn.us/Chief\_Engineer/assistant\_engineer\_design/design/DesGuide.htm</a>

Tennessee Department of Transportation Design V8 CADD Standards and Downloads: <a href="http://www.tdot.state.tn.us/Chief\_Engineer/assistant\_engineer\_design/design/v8/V8design.htm">http://www.tdot.state.tn.us/Chief\_Engineer/assistant\_engineer\_design/design/v8/V8design.htm</a>

Tennessee Department of Transportation Standard Drawings Library:

http://www.tdot.state.tn.us/Chief\_Engineer/engr\_library/stddrlib.htm

Federal Highway Administration Hydraulic Engineering Circular NO. 22, Second Edition Urban Drainage Design Manual:

http://isddc.dot.gov/OLPFiles/FHWA/010593.pdf

# GEOPAK Drainage V8*i* Course Manual

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## 1. Getting Started

This exercise introduces the GEOPAK Drainage workflow to complete the setup required for a new project. The user will review the project information and set the preferences.

GEOPAK Drainage gives you the best design and analysis based on the input that you enter. Engineering judgment must be used to evaluate the output that the program produces. Refer to the TDOT Roadway Design Division Drainage Manual for additional guidance.

## **1.1 Project Workflow**

The GEOPAK Drainage workflow mirrors a conventional design process beginning with the design of the surface collection system (inlets, drainage areas) followed by the design of the conveyance system (subsurface pipes, channels).

Roadway alignments, vertical profiles, and digital terrain models (DTM) may be used throughout GEOPAK Drainage to provide pertinent information to the drainage design. All drainage components feature interactive *graphical placement tools* for easy definition of the drainage system.

Each of these components (inlets, areas, and pipes) is composed of two basic types of information:

- Spatial information describing its location, shape and connectivity.
- Hydraulic and Hydrologic information describing its properties, conventions and other associated attributes.

## **1.2 Drainage Components**

GEOPAK Drainage organizes the components of a drainage system according to their spatial characteristics. Spatial information is stored as **Nodes**, **Links** and **Networks**. This information is stored in a \*.gdf file – GEOPAK Drainage File.

**Nodes**: A node (inlets, manholes, etc.) is a point with a user-defined location. The location may be in Cartesian coordinates (x,y) or in curvilinear coordinates (station, offset).

**Links**: A Link represents a linear feature depicting a path connecting two nodes, traversing upstream to downstream. The path may be straight line or curvilinear (along a graphic element).

**Networks**: A network is a system of interconnected nodes and links that form a system through which water can flow to a single outlet node. A drainage project accommodates any number of Networks.

Other associated components in GEOPAK Drainage include:

**Areas**: A drainage area can be represented by a closed boundary or simply keyedin (acres or hectares). All flows from a single drainage area are tributary to a single Node. There is a <u>one to one</u> correspondence between a node and an area. Therefore areas and nodes share the same name (ID). A drainage area may contain multiple subareas representing homogeneous features such as soil types and land uses ("C" values), thereby allowing composite "C" value calculations.

**Profiles**: A profile represents a linear feature depicting a path connecting two nodes, it is different than a link in that a path may span multiple links and traverse upstream, downstream, or any combinations. The primary purpose of a profile is to allow visualization of a profile view between any two nodes in a drainage network.

## **1.3 Directory Information**

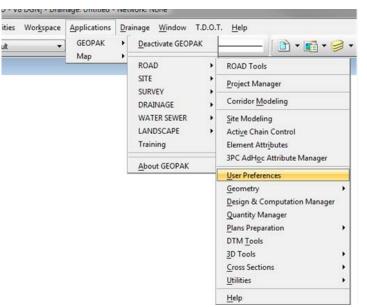
Class files are located in the directory c:\Projects\Drainage\\*.\*

## **1.4 GEOPAK User Preferences**

a) Copy the Geopak Drainage project template file, <u>DrainageProject.gdf</u> from standard directory: <u>C:\Users\Public\Geopak Standards</u> to class project directory: C:\Projects\Drainage\

**NOTE:** For your project, the 'copy to' location would be your project folder.

- b) Utilizing MicroStation, open DVSR1proposed.dgn using the tdot interface.
- c) Activate GEOPAK by going to Applications > GEOPAK > Activate GEOPAK. The GEOPAK User Preferences control the output format of data produced using GEOPAK. Access the User Preferences by selecting Applications > GEOPAK> Road > User Preferences.



d) Set the Units to English, Stationing to 12+34, and Working Directory to C:\Projects\Drainage\ and click OK.

📕 User Preferences	- • -
Unit System: English  Coordinates: NE Direction: Bearing Station: 12+34	Output Accuracy Distance: 99.12 Station: 9+99(9).12 Angle Seconds: 9^9'9''
Working Directory: C:\Projects	Drainage Q
Eeature Preferences COGO Preferences	Show this dialog at startup
<u>о</u> к	Cancel

**NOTE:** For your project, this would be your working directory.

## 1.5 GEOPAK Drainage Menu

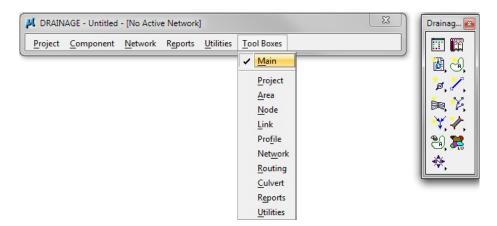
a) Access GEOPAK Drainage from MicroStation's Applications menu:

<u>T</u> ools <u>U</u> tilities Wor <u>k</u> space	Applications	Dra	iinage <u>W</u> indow T	.D.O.1	f. <u>H</u> elp
? Default -	GEOPAK Map	•	Deactivate GEOPA	ĸ	
			ROAD SITE SURVEY	+ +	
			DRAINAGE	•	Drainage
			WATER SEWER LANDSCAPE Training	•	<u>H</u> elp
			About GEOPAK	_	

All items in Drainage can be accessed through this main GEOPAK DRAINAGE Menu Bar:



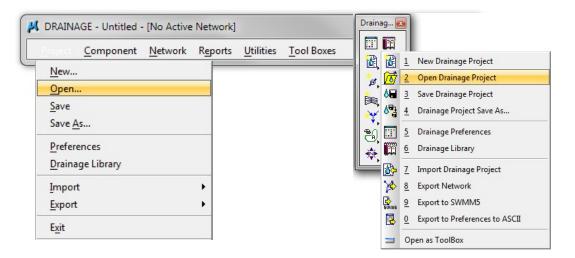
Or by invoking the GEOPAK Drainage Main Tool Box from Tool Boxes>Main:



Or they can be accessed through the Drainage Menu which has been added to the main menu bar once you load GEOPAK Drainage.

osed.dgn [2D - V8 DGN] - Drainage: Untitled -	Network: None
Tools Utilities Workspace Applications	Drainage Window T.D.O.T. Help
? Default - 0 -	Project
	Component
t	Network
	Reports +
	Utilities •
	Tool Boxes
	Exit

b) Open GEOPAK Drainage project file <u>DrainageProject.gdf</u> that was copied into the project directory: C:\Projects\Drainage\.

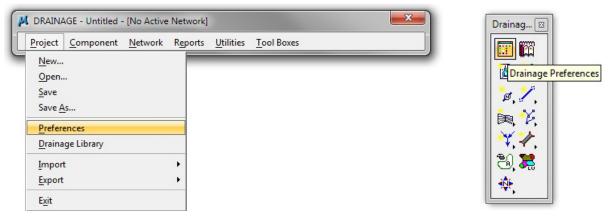


**NOTE:** Every time that you open GEOPAK Drainage, an untitled project will open. Therefore, you must go to **Project>Open** and select your project .gdf file every time you want to edit or continue working on a project.

## **1.6 Project Preferences**

The Project Preferences control the *graphic and computational* options of the drainage system. The Project Preferences may be changed at any time and the system can then be redesigned or analyzed utilizing the new preferences.

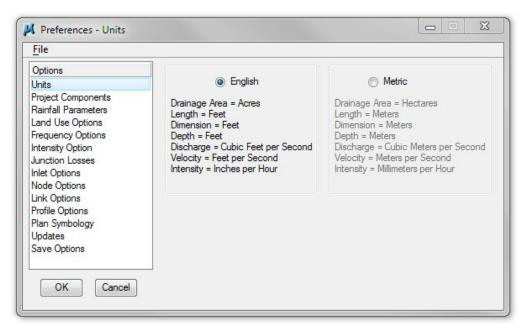
### a) Select Project > Preferences.



**NOTE:** Each Drainage Project should begin by copying the file in Step 1 of 1.4 into the project folder. This step automatically imports all needed preferences. If this step is missed, TDOT Standard Preferences may be loaded **after opening** the Preferences window and going to **File > Open** and navigating to the following file: **C:\Users\Public\Geopak Standards\TDOTdrainageprefs.dpf** 

Review the Preferences by selecting each option in the column and reviewing the various options.

### b) Units:



### c) Project Components:

<u>F</u> ile			
Options	Drainage Library File (DLB):	C:\Users\Public\Geopak Standards`	9
Units	GPK Job Number:	Q User Preferen	ces
Project Components Rainfall Parameters	Drainage Cell Library:	C:\Users\Public\MicroStation Stand;	Q
Land Use Options		C:\Users\Public\Geopak Standards`	Q
Frequency Options Intensity Option	DDB:	•	à
Junction Losses		C: \Users \rubiic \Geopak Standards	
Inlet Options	Water and Sewer Project:		Q
Node Options Link Options	Superelevation Shapes File:	DVSR1SEShapes.dgn	Q
Profile Options	Site Project:		9
Plan Symbology	Original Ground		
Updates Saus Options	TIN File 💌		Q
Save Options	Design Surface		
	TIN File	final.tin	Q

## The following items are set to the defaults and NO CHANGES need to be made:

Drainage Library File (DLB) – C:\Users\Public\Geopak Standards\TDOTEnglish.dlb

**User Preferences** – These settings are already set for you for this exercise.

Drainage Cell Library - C:\Users\Public\MicroStation Standards\cell\STDS.CEL

Criteria Directory - C:\Users\Public\Geopak Standards\Criteria

GEOPAK DDB: C:\Users\Public\Geopak Standards\tdot.ddb

## For each Library and Directory file location, select the explorer button and go to the following file locations:

**GPK Job Number** – Pick the GPK file and it will automatically set the correct number (this only happens if it goes to the correct User Preferences)

**Superelevation Shapes File** – Choose DVSR1SEShapes.dgn from the project directory

**Design Surface** – Choose final.tin from the project directory. This final tin is a combination of the proposed tin and existing tin. The final tin includes the proposed areas inside the slopes and the existing area outside the slopes. The tin file has been created for your use in class. Refer to the <u>Geopak Road Course Guide</u> Chapter 22 for instruction on how to create a final tin file for your project.

## **Exercise 1**

#### d) Rainfall Parameters:

File	
Options Units Project Components Rainfall Parameters Land Use Options	Rational Method Rainfall Source: Lebanon
Earl Ose Options Frequency Options Intensity Option Junction Losses Inlet Options Node Options Link Options Profile Options Plan Symbology Updates Save Options	SCS Method Rainfall Source: None Available Antecedent Moisture Condition I Antecedent Moisture Condition III Antecedent Moisture Condition III Hydrograph Time Interval: 0.000

Select the appropriate rainfall source for the city closest to the project site.

See the <u>TDOT Drainage Manual</u>, Chapter 4, Figure 4A-1 or Appendix I.

**NOTE:** The Tennessee Department of Transportation Roadway Design Division uses the Rational Method for drainage design.

#### e) Land Use Options:

File				
Options	Rational Method			
Units	Single Land Use Item:	Rural Steep 💌		
Project Components	Multiple Land Use Item:			
Rainfall Parameters	Land Use Item	Level Color Weight Style		
Land Use Options				
Frequency Options Intensity Option Junction Losses Inlet Options Node Options Link Options Profile Options Plan Symbology	Urban SCS Method	Symbology:		
Jpdates	Land Use Item	Level Color Weight Style		
OK Cancel	Urban	Symbology:		

Set the Land Use Option to **Single Land Use Item: Rural Steep** for this class. The Roadway Design Division **does not** use the option for Multiple Land Use Items. All definitions for land use must come from a specific category.

## f) Frequency Options:

File			
Options Units Project Components Rainfall Parameters Land Use Options	Drainage Library (DLB):\G Rational Frequency Option Computation	Runoff Coefficient	English.dlb
Frequency Options Intensity Option Junction Losses Inlet Options Node Options Link Options Profile Options	Frequency: 50 Year SCS Frequency Options Cumulative Frequency:	Peaking Factor: 1.0000 Runoff Coefficient Peaking Factor: 1.0000	
Plan Symbology Updates Save Options OK Cancel			

## g) Intensity Options:

File	
Options Units Project Components Rainfall Parameters Land Use Options Frequency Options Intensity Option Junction Losses Inlet Options Node Options Link Options	Drainage Library (DLB):\Geopak Standards\TDOTEnglish.dlb Minimum Time of Concentration: 5.0000 Accumulate Pipe Flow Time by: Uniform Flow Velocity Intensity Options © Compute Intensity from Library Rainfall Data Source © Absolute Intensity: 0.0000 © Weight Time of Concentration
Profile Options Plan Symbology Updates Save Options	Inlet Computation Only           Absolute Intensity:         0.0000

h) Junction Losses Options:

ile			
ptions	📄 📄 Disable	e All Junction Loss Computatio	ns
nits oject Components	Loss Ve	elo <mark>c</mark> ity: Actual 💌	
ainfall Parameters		Description	Loss Coefficient - K
and Use Options equency Options	###	Pressure Expansion:	0.3000
ensity Option	÷::	Free Surface Expansion:	0.1000
iction Losses et Options	t∋	Pressure Contraction:	0.5000
ode Options nk Options	式当	Free Surface Contraction:	0.3000
ofile Options	5	Bend Loss:	Method 1 💌
an Symbology odates		Terminal Inlet/Junction:	1.0000
ave Options	₹ <b>T</b> E	Simple Junction:	Method 1 -
OK Cancel		Complex Junction:	

## i) Inlet Options:

<u>F</u> ile	
Options Units Project Components Rainfall Parameters Land Use Options Frequency Options Intensity Option Junction Losses Inlet Options Node Options Profile Options Profile Options Plan Symbology Updates Save Options OK Cancel	Inlet By Pass Options: By Pass as Total Discharge   Link By Pass Flow Options: Do Not Allow Inlet By Pass in Link Discharges   Default Spread n Value: 0.0160  Extend Superelevation Shapes to Inlet at Shape Slope

### j) Node Options:

File				
Options Units Project Components Rainfall Parameters Land Use Options Frequency Options Intensity Option Junction Losses Inlet Options Node Options Link Options Profile Options Plan Symbology Updates Save Options OK Cancel	Default Node ID Prefix:	Scale Factor:	]	

### k) Link Options:

<u>File</u>	
Options Units Project Components Rainfall Parameters Land Use Options	Default Link ID Prefix: SS- Link Profile Options Design Optimization: Minimize Depth of Cover Elevation Option: at Actual Link End
Frequency Options Intensity Option Junction Losses Inlet Options Node Options	Link Design Options      O Design for Maximum Capacity      Design for Full Capacity      Design Partial Capacity (d/D) Ratio: 1.0000
Link Options Profile Options Plan Symbology Updates Save Options	<ul> <li>Design Partial Capacity (q/Q) Ratio: 1.0000</li> <li>Link Slope Decimal: No Rounding </li> </ul>
	Link Criteria File File Name:
OK Cancel	Hydraulic GradeLine Options Hydraulic Gradeline Basis: Equal Hydraulic Gradeline 💌

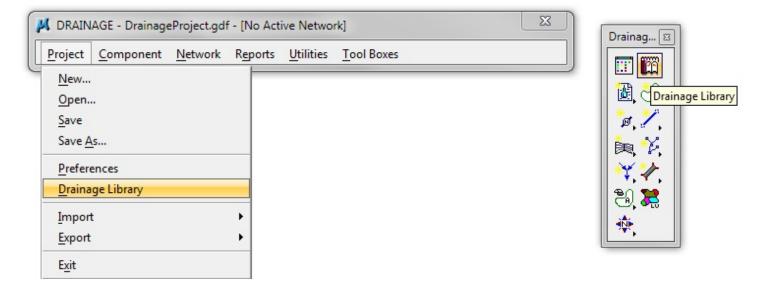
**NOTE:** Do **not** set the **Link Slope Decimal** to rounding. This setting is for control of Pipe Design not annotation. If set it will be impossible to design for minimum depth drainage structures.

- I) Profile Options, Plan Symbology, Updates and Save Options should be kept at the default settings. Do not make any changes.
- m) Click OK to save changes and dismiss the dialog.

## 1.7 Drainage Library

The Drainage Library is used to store hydraulic, hydrologic, and construction standards, which may be shared by different projects and designers. Each GEOPAK Drainage project accesses items from the *Drainage Library* for use on the specific project.

a) Select **Project > Drainage Library**. The library stored in the Preferences will be opened by default.



The Drainage Library currently contains five (5) tabs as shown below:

File Edit		

- Rainfall .. ..... Rainfall Data Source
- Land Use ...... Land Uses, their corresponding "C" values and symbology
- Nodes ...... Inlets, Junctions, Manholes, Outlets, etc.
- Links...... Circular Pipes, Elliptical Pipes, Pipe-Arch pipes, Boxes, etc.
- Spread Section ..... Inventory of varying Spread Cross Sections

The **Rainfall** tab stores the rainfall data information to be used on GEOPAK Drainage Projects. GEOPAK Drainage supports rainfall sources in the form of intensity duration frequency (IDF) tables, or as coefficients for intensity-durationequation formats. **b)** Select the **Rainfall** tab, highlight Lebanon, and select **Modify** to review the various options:

Rainfall Land Use Node:	s Links Spread Section	
Element ID	Description	
Shelbyville	IDF Curve Data	
Manchester	IDF Curve Data	2
Lebanon	IDF Curve Data	
Lawrenceburg	IDF Curve Data	
Knoxville	IDF Curve Data	Modify Library
Johnson City	IDF Curve Data	Children Provide Starty
Jackson	IDF Curve Data	_
Cookeville	IDF Curve Data	
Clarksville	IDF Curve Data	₽
Chattanooga	IDF Curve Data	

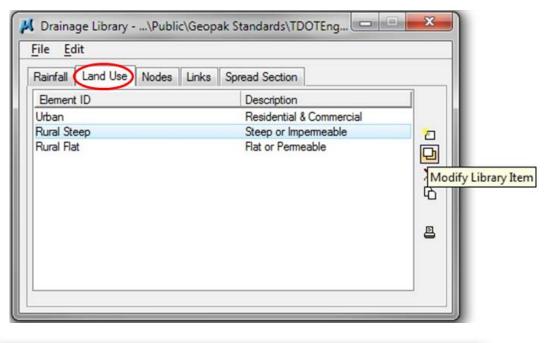
**NOTE**: See Appendix I for IDF Zone Location Map.

tem ID: Le	banon	Description	n: IDF Cu	rve Data	Data	Type: Ta	able	
	User Defin	ned Frequer	ncies		2.24			
Duration:	2.00	5.00	10.00	25.00	50.00	100.00		
5.0000	5.5100	6.3400	6.9800	7.7600	8.3600	8.9400		2
10.0000	4.4000	5.0700	5.5800	6.1900	6.6700	7.1000		
15.0000	3.6900	4.2800	4.7100	5.2300	5.6200	5.9800		Ð
30.0000	2.5500	3.0400	3.4100	3.8700	4.2400	4.5800		
60.0000	1.6000	1.9500	2.2200	2.5800	2.8700	3.1600	-	×
1440.000	0.150	0.180	0.210	0.250	0.280	0.310	1	
		_	Populate	Table By:			7.	
OK	Cancel		Import A	SCIL	HYDRO-3	5	TP 40.	

The table contains the Duration-Frequency Table for the Lebanon area.

The **Land Use** tab is used to store runoff coefficients ("C" values) and corresponding graphic symbology for each land use. Land uses can then be delineated automatically using the selected symbology.

c) Select the Land Use tab, highlight the Rural Steep item and select **Modify** to review the various options:



Item ID: Rural Steep		Description: Steep or Impermeable		
Land Use Description	Runoff C	Symbology		
Conc/Asphalt Pvmt	0.90	Lv:DESIGN - SCRATCH - User 1, Co:1, Lc:(		
AsphaltMacadem Pvmt	0.80	Lv:DESIGN - SCRATCH - User 1, Co:5, Lc:(		
Gravel	0.60	Lv:DESIGN - SCRATCH - User 1, Co:2, Lc:(		
Bare Earth	0.90	Lv:DESIGN - SCRATCH - User 1, Co:13, Lc		
Steep Grass (2:1)	0.70	Lv:DESIGN - SCRATCH - User 1, Co:14, Lc		
Turf Meadows	0.40	Lv:DESIGN - SCRATCH - User 1, Co:8, Lc:(		
Forested Areas	0.30	Lv:DESIGN - SCRATCH - User 1, Co:28, Lc		
Cultivated Fields	0.40	Lv:DESIGN - SCRATCH - User 1, Co:7, Lc:(		

Note the various land uses and their associated symbology. Chapter 2 will discuss how to make a land use file.

The **Nodes** tab contains standard configurations for Grates, Curbs and Slotted drain inlets, as well as Junctions, Outlets and Other nodes. The description, plan view representation and dimensional information are stored for each node.

d) Select the **Nodes** tab, highlight a Grate inlet and select **Modify** to review the various options:

ile <u>E</u> dit		
Rainfall Land Use Nodes	Links Spread Section	
Node Types: Grate	•	
Element ID	Description	A
CB#52 9X9	#52	E
CB#51 9X9	#51	2
CB#51 7X7	#51	
B#51 5'2"X5'2"	#51	
B#46 9X9	#46	Modify Library
B#45 8X4	#45	
B#44 9X9	#44	
B#43 8X5'2"	#43	
:B#43 8X4	#43	₽
B#43 8' DIA	#43	
CB#42 8' DIA	#42	-

Item ID:	CB#51 5'2")	×5'2"	OK
Description:	#51		
Payltem:	51		Cancel
Criteria File:		٩	Plan View Cell:
Plan View Cell:	CB62X62R	Select	
Node Type:	Grate	•	
Profile Type:	On Grade	•	
Data for On Grad	le		
Grate Type:	Curved Van	• •	
Length:	3.021		
Width:	1.813		
Data for Sag			
	Area:	5.477	
Area Redu	iction Factor:	0.542	
	Perimeter:	6.647	
Perimeter Redu	ction Factor:	0.000	

Note the various geometric values required for the nodes.

## **Exercise 1**

The **Links** tab contains all culverts to be used on drainage projects. Each link type is categorized by three properties: Shape, Material and Type (for some combinations of Shape & Material); and contains information regarding specific culvert geometry, default roughness coefficient and material combination.

e) Select the Links tab, select Circular from the Shape dialog box and Concrete from the Material dialog box. Highlight the first Circular Concrete pipe, and select Modify to review the various options:

Shape: Circula	r 🔻 Material: (	Concrete		
Element ID		Description	<u>^</u>	
102 Inch Dia. C		PROP. 102" RCP		
108 Inch Dia. C		PROP. 108" RCP	_ 🖸 📗	
114 Inch Dia. C		PROP. 114" RCP		
120 Inch Dia. C 126 Inch Dia. C		PROP. 120" RCP PROP. 126" RCP		
132 Inch Dia. C		PROP. 128 RCP	Modify Libra	ary
138 Inch Dia. C		PROP. 138" RCP	40	
15 Inch Dia. Cir	CONTRACTOR CONTRA	PROP. 15" RCP		
18 Inch Dia. Cir	cular	PROP. 18" RCP	8	
24 Inch Dia. Cir		PROP. 24" RCP		
30 Inch Dia. Cir	cular	PROP. 30" RCP	·	
Drainage Library - be Properties Item ID: 15 Inch escription: PROP.	Dia. Circular			
be Properties Item ID: 15 Incr escription: PROP. Payltem: 607-02 Shape: Circular	1 Dia. Circular 15" RCP 02			
be Properties Item ID: 15 Inch escription: PROP. Payltem: 607-02	1 Dia. Circular 15" RCP 02			
be Properties Item ID: 15 Incr escription: PROP. Payltem: 607-02 Shape: Circular	Dia. Circular 15" RCP .02			
be Properties Item ID: 15 Inchescription: PROP. Payltem: 607-02 Shape: Circular Material: Concre	Dia. Circular 15" RCP .02		Hise -	
Properties Item ID: 15 Inchescription: PROP. Payltem: 607-02 Shape: Circular Material: Concre Roughness: Thickness:	Dia. Circular 15" RCP .02			
Properties Item ID: 15 Inchescription: PROP. Payltem: 607-02 Shape: Circular Material: Concre Roughness: Thickness:	Dia. Circular 15" RCP 02 02 002 0.0130 0.092 1.250			
Properties Item ID: 15 Incr escription: PROP. Payltem: 607-02 Shape: Circular Material: Concre Roughness: Thickness: Rise:	Dia. Circular 15" RCP 02 02 0.0130 0.092 1.250 0.000			
Properties Item ID: 15 Incr escription: PROP. Payltem: 607-02 Shape: Circular Material: Concre Roughness: Thickness: Rise: Span: RadiusA:	Dia. Circular     15" RCP     02     ▼     0.0130     0.092     1.250     0.000     0.000			
be Properties Item ID: 15 Incr escription: PROP. PayItem: 607-02 Shape: Circular Material: Concre Roughness: Thickness: Rise: Span: RadiusA: RadiusB:	Dia. Circular 15" RCP 02 ▼ te ▼ 0.0130 0.092 1.250 0.000 0.000 0.000			
be Properties Item ID: 15 Incr escription: PROP. Payltem: 607-02 Shape: Circular Material: Concre Roughness: Thickness: Rise: Span: RadiusA: RadiusB: RadiusC:	Dia. Circular 15" RCP .02 ▼ 16 0.0130 0.092 1.250 0.000 0.000 0.000 0.000 0.000			
be Properties Item ID: 15 Incr escription: PROP, Payltem: 607-02 Shape: Circular Material: Concre Roughness: Thickness: Rise: Span: RadiusA: RadiusA: RadiusE: RadiusD:	Dia. Circular 15" RCP .02 ▼ 16 0.0130 0.092 1.250 0.000 0.000 0.000 0.000 0.000			
be Properties Item ID: 15 Incr escription: PROP. Payltem: 607-02 Shape: Circular Material: Concre Roughness: Thickness: Rise: Span: RadiusA: RadiusB: RadiusB: RadiusD: ench Details	Dia. Circular 15" RCP .02 ▼ 16 0.0130 0.092 1.250 0.000 0.000 0.000 0.000 0.000			
Properties Item ID: 15 Incr escription: PROP, Payltem: 607-02 Shape: Circular Material: Concre Roughness: Thickness: Rise: Span: RadiusA: RadiusA: RadiusB: RadiusC: RadiusD:	Dia. Circular 15" RCP .02 ▼ 16 0.0130 0.092 1.250 0.000 0.000 0.000 0.000 0.000			

Note the various geometric values required for the links.

The **Spread Section** tab stores standard spread cross sections for roadway, shoulders and gutter that can be used on drainage projects.

f) Select the **Spread Section** tab, highlight any section, and select **Modify** to review the various options:

<u>File E</u> dit			
Rainfall Land Use Nodes	Links Spread Section		
Element ID	Description	*	
5Lane12S	5 lane with 12' shld		
5Lane10S	5 lane with 10' shld		2
5Lane	5 lane with no shld		
4Lane8S	4 lane with 8' shld		
4Lane12S	4 lane with 12' shld		Y
4Lane10S	4 lane with 10' shld	=	Modify Librar
4Lane	4 lane with no shld		
3Lane8S	3 lane with 8' shld		
3Lane12S	3 lane with 12' shid		2
3Lane10S	3 lane with 10' shld		
3Lane	3 lane with no shld		
2Lane8S	2 lane with 8' shld	-	

Item ID:	3Lane		OK
Description:	3 lane w	ith no shld	Cancel
Width	% Slope	Roughness	
2.000	8.500	0.016	0
18.000	2.000	0.016	
			묘
			×

Note the spread cross section characteristics for the spread item.

## 2. Land Use DGN Files

This chapter is provided for REFERENCE ONLY. We have provided the land use file for you so that all class participants will have the same areas.

For your own project, these exercises would have to be done prior to beginning GEOPAK drainage.

This exercise allows the user to create a Land Use file.

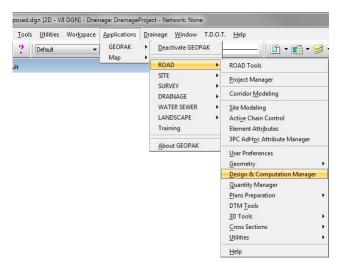
## 2.1 Land Use DGN Creation

The shapes created in the land use DGN file are used to specify run-off coefficients (C value) for different land use areas. These values are then used to calculate the composite run-off coefficient. This composite value is used in conjunction with rainfall data in the rational formula to calculate the Q discharge for the drainage area. This composite run-off coefficient can be manually calculated and entered as a value but by creating these shapes this can be done automatically for any drainage area specified on your project.

- a) Create a new DGN file for placement of land use shape elements from DGN seed file SEED2D.DGN and open it. Reference your proposed file, which contains proposed edges of pavement and slope lines. Also reference your survey topo file.
  - Land use.dgn

**NOTE:** For further guidance in creating a new DGN file see **Exercise 2** of the <u>MicroStation V8 Manual</u>

b) Access D & C Manager from the MicroStation menu bar drop down location Applications>GEOPAK> Road>Design & Computation Manager or from task navigation with Geopak's Civil Workflows, it is the second icon from the end on the right.





c) In D & C Manager go to the land use category under Drafting Standards\Exist. Drainage\Land Use.

There you will see the three categories of land use items used by T.D.O.T.

<u>File Edit Settings Favorites Help</u>	
🖅 id 🔲 🚧 🧬 💷 🐂 🔛 🖆	
C:\Users\Public\Geopak Standards\tdot.ddb	^
C Drafting Standards	
Tools	
Cross Sections Roadway Horizontal Alignments	
Roadway Vertical Alignments	=
Exist Profiles	1
Survey Control	
Pres. R.O.W.	
Property Lines	
Parcels	
Political Boundaries	
Prop. R.O.W.	
Prop. Easements	
Roadway Linework Private Drives	
Private Drives Private Drives Private Drives	
C Land Use	
Bural-Flat/Permeable	
Rural-Steep/Impermeable	
and the standard the standard the	

d) Open the desired category and click on the land use item you wish to define on the project. Click on **Place Influence** in the D & C Manager control strip.

		oint Text
L Design	and Computation Manager	
<u>File</u>	it <u>S</u> ettings F <u>a</u> vorites <u>H</u> elp	
ē id	🔲 🚧 🕫 📾 🐂 🔛	
Ē	Land Use Rural-Flat/Permeable Pavement-FP concrete or asphalt paveme Macadem-FP asphalt macadem paveme Gravel-FP gravel roadways or should Earth-FP bare earth Steep Grass-FP steep grassed area (2:1) Meadow-FP turf meadows Forest-FP forested areas, woods Fields-FP cultivated fields Rural-Steep/Impermeable	nt
	<ul> <li>Pavement-SI concrete or asphalt pavere asphalt macadem pavere gravel roadways or should bare earth</li> </ul>	nents ent
E	<ul> <li>Steep Grass-SI steep grassed area (2:1)</li> <li>Meadow-SI turf meadows</li> <li>Forest-SI forested areas, woods</li> <li>Fields-SI cultivated fields</li> <li>Urban</li> <li>Residential-F30 flat residential, 30% imperiate residential, 60% imperiate residential, 60% imperiate residential, 50% imperiate residential, 60% imperiate residenti</li></ul>	ervious ntial, 50% impervious ip area, 70% impervious

**NOTE:** You should only use types from one section (i.e. Rural-Flat/Permeable or Urban).

e) Use any MicroStation <u>shape</u> command to draw shapes around the areas. You may wish to copy graphics from the reference files to create complex shapes. This could be the proposed edge of pavement lines from the proposed file to shape the pavement area or perhaps the edge lines from a parking lot or woods area from the survey topo file. Anytime you wish to change to a different land use type just click on it in D & C Manager. If you have shapes already defined simply use the MicroStation Change Element Attributes command to change their symbology.

### NOTES:

Shapes must be continuous and closed. Set fill type to None.

It is not necessary to place shapes to cover all areas absolutely. Any areas not delineated by a land use shape will use the **Base C value** entered in the **Drainage Area Definition** dialog.

f) Once shapes have been set up simply reference the DGN file to your proposed DGN file and they will be read when you use **Delineate Subareas** in the **Drainage Area Definition** dialog.

## 3. DTM Drainage Tools

GEOPAK supports a wide range of tools that allows you to analyze and evaluate the drainage patterns of a GEOPAK Digital Terrain Model or TIN file. These tools are useful for delineating and distinguishing watersheds, flow paths, flow directions, and hydrographic features.

This exercise allows the user to become familiar with the Digital Terrain Model (or DTM) Drainage Tools.

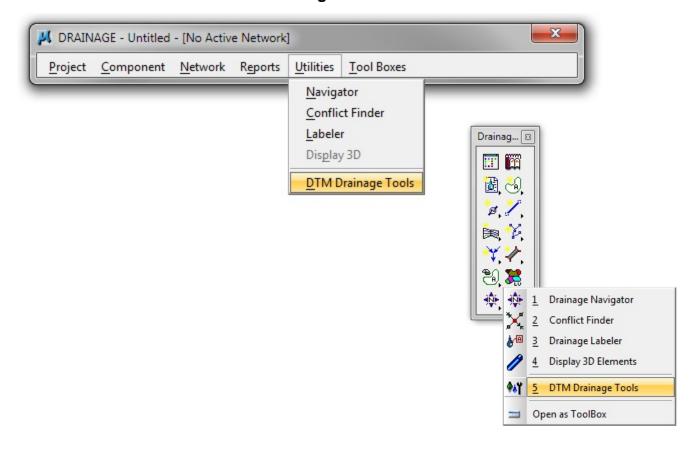
See Exercise 22 in the <u>TDOT GEOPAK Road Course Guide</u> for guidance in creating a final merged TIN file.

## 3.1 Accessing DTM Drainage Tools

a) Open the file DVSR1proposed.dgn file.

**Note:** The landuse.dgn file has already been referenced into this file for your use. Refer to the previous exercise (Exercise 2) or to the <u>Land Use DGN Creation</u> document for instructions on creating the land use file.

b) Open GEOPAK Drainage and select from the Drainage Menu Bar:



### Utilities > DTM Drainage Tools

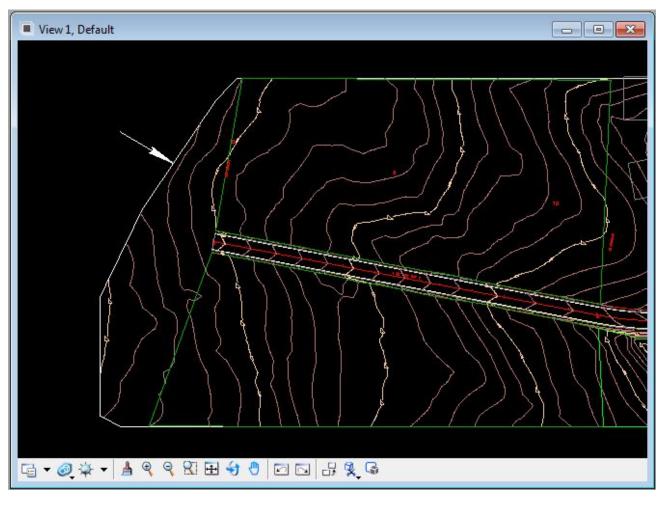
## 3.2 Delineate Watershed

The Delineate Watershed tool outlines and defines a watershed at any location within the TIN surface. The pour point of the watershed is the most downstream point of a desired watershed. Once a data point representing the pour point of the watershed is indicated the contributing watershed area is computed and delineated. Pour points must be located near sumps (i.e. low points) in the terrain since a point lying on the side of a hill does not actually have a contributing area.

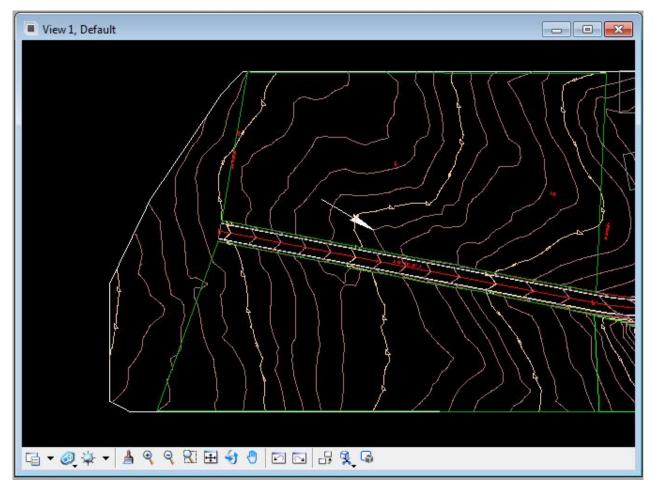
a) Use the Select File button to select the final merged TIN for the project. Then select the DTM Drainage Icon **Delineate Watershed**.

ershed		3
nal.tin		q
8 5	5111	
) <mark>elineate Wate</mark>	rshed,	
DP Pour Point	DP Create Shape	
	nal.tin	nal.tin

**b)** Click the **Pick Boundary Elements** button and select the element representing the tin hull (the boundary of the TIN file) as shown in the screenshot below. Data Point to accept.

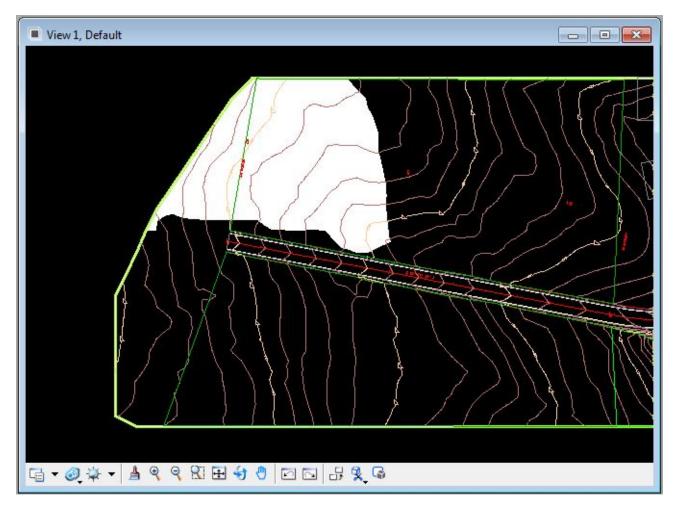


c) Click the **DP Pour Point**. Data Point in the dgn file in the approximate location shown below:



d) Click the DP Create Shape button and data point <u>inside</u> the drainage area delineation from the previous step. This procedure will place a temporary fill in the drainage area. Data Point to accept this shape and Update the Microstation View to remove the temporary fill. The Drainage Area Shape has been drawn in the dgn file.

**NOTE:** Scrolling or zooming between Step 3 and Step 4 will cause the temporary watershed delineation to disappear. However, the information is still present and following Step 4 will still create the Drainage Area Shape.



## 3.3 Drainage Patterns

The Drainage Patterns tool evaluates the flow paths contained within the TIN. This tool performs a downstream trace from the centroid of each triangle.

a) Select the DTM Drainage Icon **Drainage Patterns**. Toggle ON Display Only and click the **Apply** button to exhibit the Drainage Patterns for the tin file.

**NOTE:** Throughout this exercise, Display Only will be chosen, if available, so that the graphics will delete when the view is refreshed.

	TIN File: final.tin	 Q
- 00	tions	
	A A B S S I A Drainage Patterns	
	Display Only Load Within Fence Set Graphic Group	
	Apply	

**NOTE**: Pressing the Escape button (on the keyboard) will terminate the current process before completion.



## **3.4 Downstream Trace**

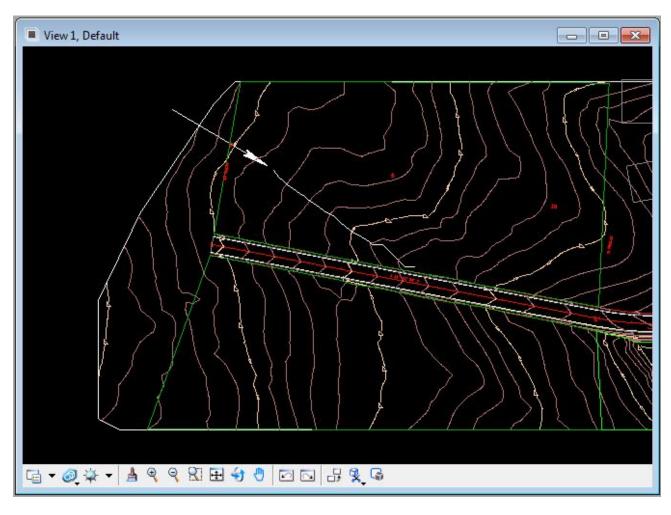
The Downstream Trace tool delineates the flow path downstream from a given point in the TIN. The indicated path follows the steepest descent from the point through the TIN terminating at a low point or the edge of the TIN.

a) Select the DTM Drainage Icon **Downstream Trace**. Toggle ON Display Only and click the **Apply** button.

📕 Downstream Trace 📃 💷 💌	
TIN File: final.tin	
Options	
📥 🛆 🛞 <u>≶</u> Ś 1//	
-Downstream Trace	
Display Only	
Minimum Low	
Point Depth: 0.000	
Apply	
, 453	

**NOTE:** Setting the Minimum Low Point Depth to a value above 0.00 will allow the downstream trace to pass through small, localized depressions and continue downstream.

**b)** Click in the design file within the limits of the tin hull. A downstream trace will appear from the cursor data point location to the nearest low point to which the water will drain.



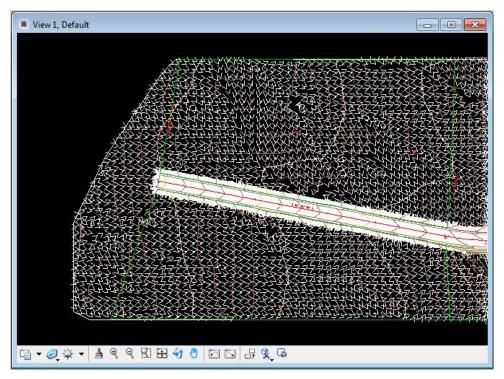
## 3.5 Flow Arrows

The Flow Arrows tool indicates the direction of flow within the triangles of the TIN.

a) Select the DTM Drainage Icon Flow Arrows. Toggle ON Display Only, set the arrow size as shown, and click the Apply button.

Flow Arrows	
TIN File: final.tin	۹ م
Options	
🔹 🕹 🕸 🍣 🍝 S	
<b>₩</b> ~&&~	Flow Arrow
V Display Only	
Load Within Fence     Set Graphic Group Arrow Size:	22.000
Apply	

The Drainage Flow Arrows are drawn in the design file.



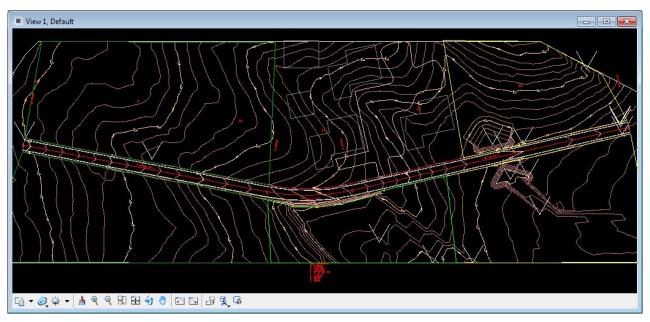
## **3.6 Delineate Low Points**

The Delineate Low Points tool locates all low points within a region of a TIN. A flow arrow is placed and the text "LP" is placed at the triangle vertex. This is an excellent tool to use when choosing an initial location for catch basins on sag points as well as locations in ponding areas.

a) Select the DTM Drainage Icon Delineate Low Points. Toggle ON Display Only, set the arrow size as shown, and click the Apply button.

	TIN File: final.tin	۹
Optio	ns	
	<u>8</u>	
	<mark>ቍ ∽ 🎄 🌢 🔶 ⊷</mark>	
	Delineate Low Points	
V Di	play Only	
Lo	ad Within Fence	_
	Graphic Group Arrow Size: 100.00	
	m Low	
Point [	lepth: 0.000	
	Apply	

The Low Points are drawn in the design file.



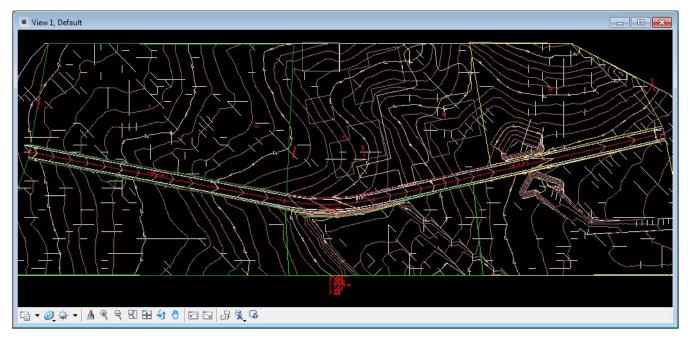
## 3.7 Ridge Lines

The Ridge Lines tool indicates the ridgelines within a TIN. A ridge line is defined as a triangle edge where the flow on each side of the edge is away from the edge

a) Select the DTM Drainage Icon Ridge Lines. Toggle ON Display Only, and click the Apply button.

📕 Ridge Lines	×
TIN File: final.tin Options	ď
Apply	

The Ridge Lines are drawn in the design file.



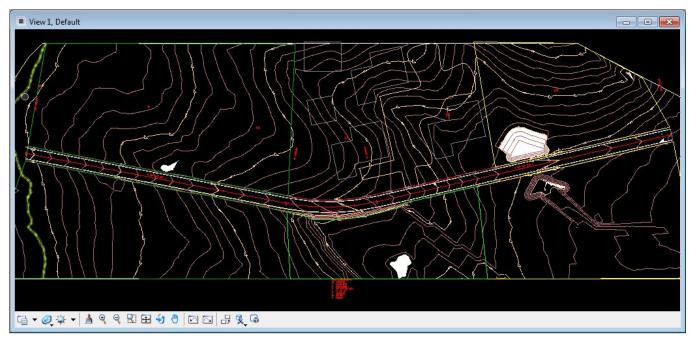
## 3.8 Surface Ponds

The Surface Ponds tool delineates the area(s) of ponded water within the specified TIN.

a) Select the DTM Drainage Icon **Surface Ponds**. Toggle ON Display Only, and click the **Apply** button.

Surface Ponds	
TIN File: final.t	in Q
Options	
🛛 📥 🔕 🔕	855111
*****	è 🔶 🗕 😓
Display Only	Ponds: Surface Ponds
	Islands:
Set Graphic Group	
	Arab
	Apply

The surface ponds are drawn in temporary fill as shown below:



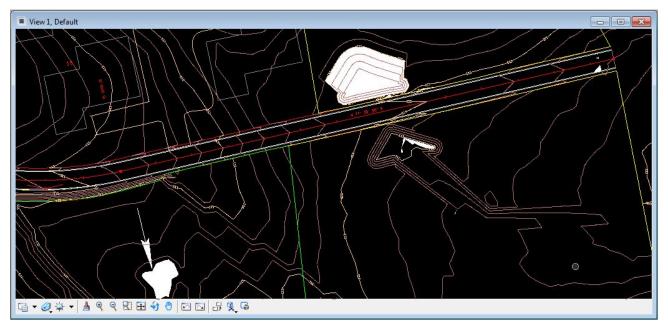
## 3.9 Pond Analysis

The Pond Analysis tool traces a point downstream to a low point and fills it giving the volume, maximum depth, and maximum elevation. In addition, the pond delineation is graphically displayed

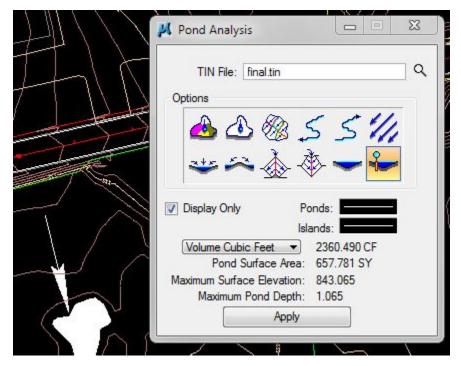
a) Select the DTM Drainage Icon **Pond Analysis**. Toggle ON Display Only, and click the **Apply** button.

Pond Analysis	
TIN File: final.tin	٩
Options	3
📤 🕭 🛞 ≲	54/1
	~ ~ ~ ~
** ≈ 🎄 🕸	· 🔶 🍋
	Pond Analys
Display Only Ponds	
Volume Cubic Feet	
Pond Surface Area: n/	/a
Maximum Surface Elevation: n/	
Maximum Pond Depth: n/	/a
Apply	

b) Data Point near the location shown below:



c) The Pond is filled and pond characteristics computations performed:



**NOTE:** Other DTM Tools are available from **Applications> GEOPAK> ROAD>DTM TOOLS**. Surface analysis tools are the second from the end. All of these tools are available under task navigation through **DTM Tools** when Geopak's Civil Workflows is active.

DTM	8		UTM Tools	
		1		
		Height/Slope	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
		Profile	≌≌≌∀⊻	
		Volumes		
	<u>4</u> E	Elevation Difference		
*	<u>5</u> 9	Slope Area	× × × × •	<b>*</b>
2	<u>6</u> 1	Themes		levation Differe
۲å	<u>7</u> [	Drainage Tools		
<b>**</b>	<u>8</u> \	Visibility	<u>유</u> ໝ № ⊽ 🏞	+ -
4		Trace Slope Path	+ - @ @ 🍌	<b>R</b> 144
₽	<u>0</u> [	DTM Camera		🕰 🎌
a As	QI	Trench Volumes	XML MX MX DTM TIN	MX MX ↑ ↓
=	Open	n as ToolBox	1	A 160 (048)

# 4. Culverts

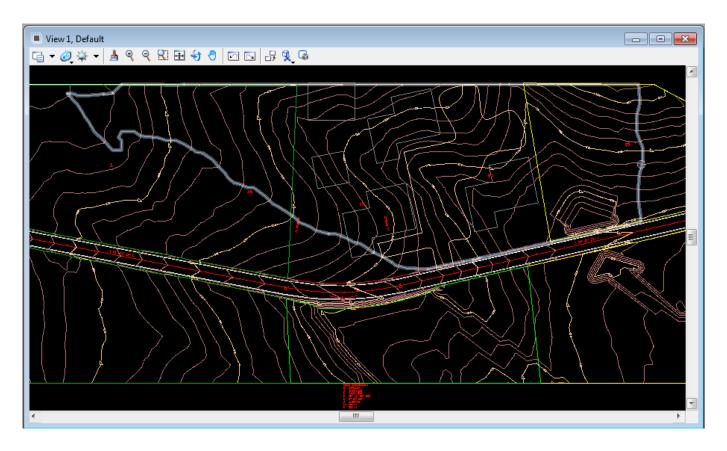
This exercise shows the user how to use the culvert module to design a culvert. The culvert module acts as a standalone component of GEOPAK Drainage, meaning it does not directly interact with Drainage Areas, Nodes, Links or Networks.

# 4.1 Delineate the Drainage Area

a) Use DTM tool Delineate Watershed to create the drainage area shown below. If necessary, refer back to exercise 3.2 to create the drainage area.

The following shape will be used below as the drainage area for this exercise.

**NOTE:** The area shown below on level SURVEY - DRAINAGE - Area Shapes extends to the limits of the current TIN file. Inspection of the contours will reveal that the drainage area most likely extends beyond these limits. **Appendix B** will discuss options to approximate the full extent of the drainage area.

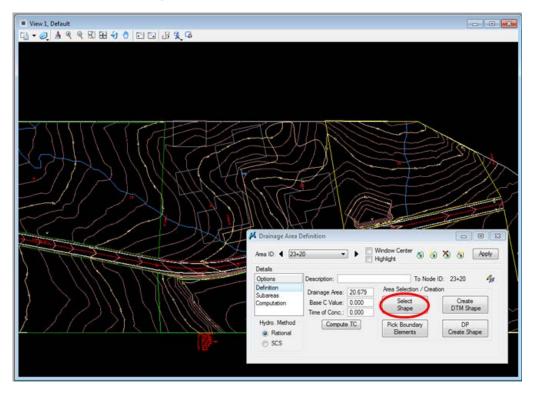


- 23 K DRAINAGE - DrainageProject.gdf - [No Active Network] Drainag... 🗵 Project Component Network Reports Utilities Tool Boxes 📰 🎬 Area F Add. 0 1 Node . Edit Drainage Areas: Add Drainage Area Link ۲ ID ø. Delete Profile . 風俗 Rename Culvert ۲ ¥, 4 Update All Routing H, 🎇 Land Uses <u>اية</u> **Miscellaneous Utilities** ۲
- b) From the GEOPAK Drainage menu bar select Component>Area>Add.

Type in 23+20 for the Area ID. Click OK.

Area ID:	23+20
Description:	

c) Click the Select Shape button. Select and data point to accept the shape shown in the first step. The area is automatically calculated.



📕 Drainage Area D	efinition		
Area ID: 4 23+2		Window Center Highlight	🖄 🖓 🗛 Apply
Details			
Options	Description:	To Node I	D: 23+20 🏼 💋
Definition Subareas Computation	Drainage Area: 20.679 Base C Value: 0.350 Time of Conc.: 5.000	Area Selection / Creation	on Create DTM Shape
Hydro. Method	Compute TC	Pick Boundary Elements	DP Create Shape

d) Set the Base C Value to 0.350 and click on Compute TC

When the following Dialog will appears, use the explorer button to select the correct TIN file.

📕 Time of Concentration 🛛 🗖 💌 💌
Drainage Area ID: 23+20
TIN File ▼ final.tin Q
Define Path Trace () ID - Segments
Method: FHA  Length: 0.000
n Value: 0.000 Slope: 0.000
Shallow How
Length: 0.000
Inter. K: 0.000 Slope: 0.000
Concentrated Flow
Method: Continuity  Length: 0.000
Velocity: 0.000
Accum. Distance: 0.000 Accum. Avg. Slope: 0.000
Tc= 0.000 Compute Apply

e) Expand window to show details and set Max Sheet Flow Distance to 300' and Max Shallow Flow Distance to 100'.

📕 Time of Concentration		x
	Details	
Drainage Area ID: 23+20	Distance Slope Avg. Slope Flow	
TIN File Final tin Q		_
Define Path		2
Trace [] ID - Segments		Ð
Sheet Flow		×
Method: FHA  Length: 0.000		0
n Value: 0.400 Slope: 0.000		
Shallow Row		
Length: 0.000		
Inter. K: 0.457 Slope: 0.000		
Concentrated How	Distance: Slope:	
Method: Continuity Length: 0.000	Distance: Slope: 0.000 0.000 Adjust Flow	
Velocity: 5,000	0.000	
	Max Sheet Flow Distance: 300.000	
Accum. Distance: 0.000	Max Shallow Flow Distance: 100.000	
Accum. Avg. Slope: 0.000		
Tc= 0.000 Compute Apply	Apply	

Collapse the window, toggle ON Sheet Flow, Shallow Flow and Concentrated Flow and fill in the values as follows:

n Value: 0.400 Inter. K: 0.457

Velocity: 5.000

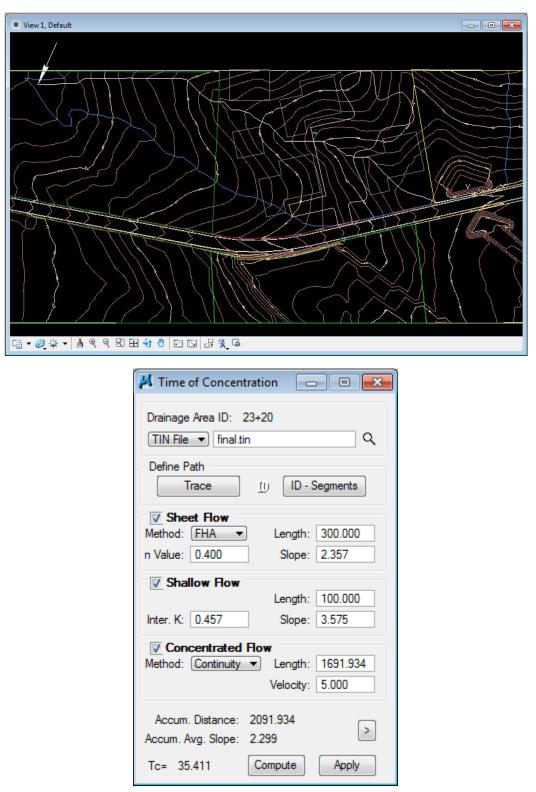
**n Values** for different surface types are available in the <u>TDOT Drainage Manual</u>, Table 4-3 *Manning's n Values for Overland Flow* 

**Intercept K** values are below:

Land Cover / Flow Regime	k
Grassed waterway (shallow concentrated flow)	0.457
Unpaved (shallow concentrated flow)	0.491
Paved area (shallow concentrated flow); small upland gullies	0.619

**NOTE:** See Appendix D for additional Manning's N and Intercept K Values.

f) Click **Trace** and data point at the furthest hydraulic point. Once values are calculated, click **Compute**. Then click **Apply**.



The Drainage Area Definition is now filled out.

Drainage Area D Area ID: <b>4</b> 23+2	0 🗸 🖌 🕅 Wi	indow Center ghlight 🖄 🔞	
Details			
Options	Description:	To Node	ID: 23+20 🦓
Definition Subareas Computation	Drainage Area: 20.679 Base C Value: 0.350 Time of Conc.: 35.411	Area Selection / Creat Select Shape	Create DTM Shape
Hydro. Method Rational SCS	Compute TC	Pick Boundary Elements	DP Create Shape

#### NOTES:

Minimum Time of Concentration is 5 minutes. If computed time is less than **5 minutes** input 5 manually.

For urban areas adjust maximum sheet flow as required.

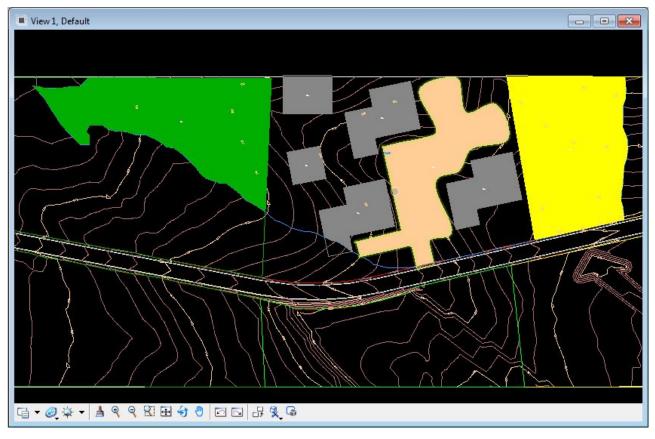
For areas that drain directly from sheet flow to concentrated flow, uncheck the Shallow Flow box. Leaving this box checked and setting it to zero will not allow TC to be calculated correctly.

After the drainage area has been set up, runoff coefficients can be automatically computed with the use of *Land Use Items* from the Drainage Library. Click on **Subareas** in the Details list on the left.

Area ID: 4 23+20	Highligh	r Center 🐴 🔞 🕅	Apply
Details			
Options		To Node ID:	23+20 💋
Definition	Subarea C Value Descri	ption	
Subareas			Automatic
Computation		E	Delineation
111111111		-	Display Only
Hydro. Method		1000	
Rational		×	<
<ul> <li>National</li> </ul>			

**g)** Toggle ON **Display Only** and then click the **Automatic Delineation** button. The file is scanned for closed shapes matching the Land Use symbology specified in the Drainage Library (Land Use Tab).

🗸 Drainage Area S	ubareas				
Area ID: 4 23+2	0	• •	] Window Center ] Highlight	a Xa	Apply
Details	_				
Options			To Node	e ID: 2	23+20 🖉
Definition	Subarea	C Value	Description		
Subareas	3.3941	0.900	Conc/Asphalt Pvmt		Automatic
Computation	2.8738	0.600	Gravel	1	Delineation
	4.4692	0.300	Forested Areas		Display Only
Hydro. Method	4.3610	0.400	Cultivated Fields		
Rational				$ \times $	
<u> </u>					
SCS	4.361	0.400	Cultivated Fields	1	
	4.001	0.400	Cultivated Helds		



h) Click the **Apply** button to apply the land uses (and their "C" values) to the Drainage Area.

 We want to compute the discharge for a 50-year storm so if that is not already set; select Project>Preferences>Frequency Options and change the Frequency to the 50-year storm. Click the OK button to accept the new preference setting.

e
itions its iject Components infall Parameters and Use Options equency Options ensity Option action Losses et Options de Options k Options file Options in Symbology dates ve Options OK Cancel

j) Return to the Drainage Area Computations>Computation dialog box and click the Compute Discharge button:

📕 Drainage Area Co	omputations					
Area ID: 4 23+20	•	Window Center	종 🙆	8	8	Apply
Details						
Options		Area	C Value	ſ	Con	mpute
Definition Subareas	Total Subareas:	15.098	0.521			charge
Computation	Remainder:	5.581	0.350			
Hydro. Method -	Composite:	20.679	0.475			
Rational	Computed Intensity:	3.993				
SCS	Computed Discharge:	39.200				

Verify the Computations; then click **Apply** to add the Area to the Project.

- **k)** Jot down the Computed Discharge from the 50-year storm computed in the step above here: \_\_\_\_\_
- Recompute the drainage area discharge for the 100 Year storm. Select Project>Preferences>Frequency Options and change the Frequency to the 100 year storm. Click the OK button to accept the new preference setting.

<u>F</u> ile		
Options Units Project Components Rainfall Parameters Land Use Options Frequency Options Intensity Option Junction Losses Inlet Options Link Options Profile Options Plan Symbology Updates Save Options OK Cancel	Drainage Library (DLB):\Geopak Standards\TDOTEnglish.dlb Rational Frequency Options Computation Runoff Coefficient Frequency: Peaking Factor: 100 Year 1.0000 SCS Frequency Options Cumulative Runoff Coefficient Frequency: Peaking Factor: 1.0000	

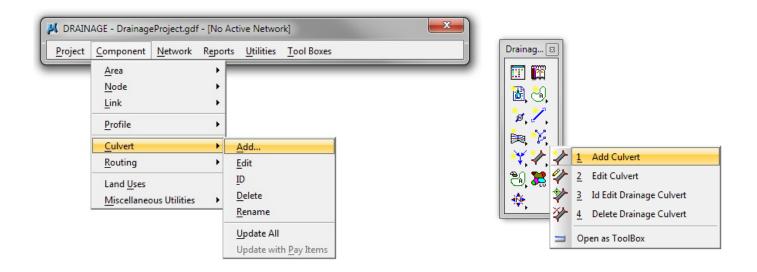
**m)** Return to the Drainage Area Definition dialog box and click the **Compute Discharge** button:

📕 Drainage Area Co	omputations					
Area ID: 4 23+20	•	Window Center	ත ක	8	8	Apply
Details						
Options		Area	C Value	Γ	Cor	mpute
Definition Subareas	Total Subareas:	15.098	0.521			charge
Computation	Remainder:	5.581	0.350			
Hydro. Method -	Composite:	20.679	0.475			
Rational	Computed Intensity:	4.324				
SCS	Computed Discharge:	42.449				

- n) Jot down the Computed Discharge from the 100-year storm computed in the step above here: \_\_\_\_\_
- o) Close the Drainage Area Definition dialog box.
- **p)** Change the Frequency back to the 50 Year storm

# 4.2 Design the Culvert

a) From the Drainage main menu, select Component > Culvert> Add.



b) Click on the Add button to add a new culvert. Enter the Culvert Name as 23+20 (station of the culvert) and Click OK.

Name:	23+20
Description:	

Culvert ID: 4 23+20 Description:	<b>-</b> ►	* *	Apply
Details			N
Culvert Profile		Overtopping	Computations
Parameters	C	onfiguration	Headwall Location
User Supplied  Design Discharge 0.000	а Ф Х	User Supplied  Tailwater Elevatio	

c) The Culvert dialog will open as seen below:

d) Enter the culvert discharges from Steps 11 and 14 in the previous exercise. Key-in the discharges in the key-in field and click the **Add List Item** button for each discharge

etails			
Culvert Profile	(	Overtopping	Computations
Parameters	Co	onfiguration	Headwall Location
User Supplied  Design Discharge 39.200 42.449		User Supplied  Tailwater Elevation 0.000	

e) Highlight the 50-yr storm and click **Select Discharge**. This will be the Discharge that the culvert is designed for.

Description:	• •	* * *	
Culvert Profile		Overtopping	Computations
Parameters		Configuration	Headwall Location
Discharge User Supplied  Design Discharge X 39.200 42.449 39.200	*□ ₽ <b>×</b>	Tailwater User Supplied Tailwater Elevation 0.000	₩ ₽ ×

You could also just double **click** to set the desired Design Discharge that the culvert is designed for.

f) Define the tailwater. Set the **Tailwater** option to **Compute** and key-in the slope and N Value.

#### NOTES:

This slope is the longitudinal slope of the downstream channel. This slope can be determine utilizing the **Analysis** tool: **Height/Slope** located in **Applications>GEOPAK>ROAD>DTM Tools** 

N Values for different surface channels are available in the <u>TDOT Drainage Manual</u>, Table 5A-1 Values of Roughness (See Appendix E).

ዞ Culvert		
Culvert ID: 4 23+20 Description:	• •	🐦 🤌 🎓 🖬 🖬 Apply
Details Culvert Profile Parameters		Overtopping Computations Configuration Headwall Location
Discharge User Supplied ▼ Design Discharge X 39.200 42.449 39.200	<sup>™</sup> ₽ ×	Tailwater     Extract Cross Section       Slope %:     0.800     N Value:     0.040       Adjust Tailwater Depth:     0.000     0.000

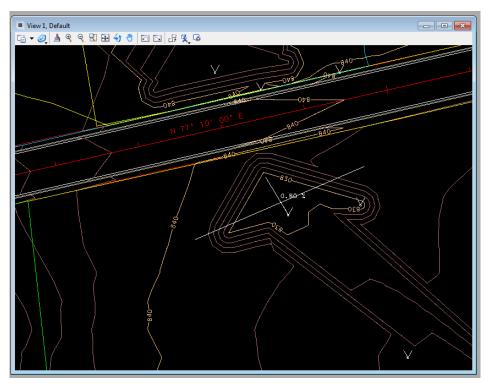
Set the Slope % to 0.800 and the N Value to 0.040 and click the Extract Cross Section button.

g) The Define Culvert Tailwater Cross Section dialog will open. Set to Drape Element on Model/TIN and TIN File.

ction Symbology	ОК	Cancel	
Drape Element on Model / TIN	TIN File     Inal.tin		Q
Select Element Place Eleme	nt		Se
Extracted Profile			
Profile ID: 23+20	Description:		
	Horiz. Scale:	10.000	
	Vert. Scale:	1.000	R
	Max. Elevation:	662.169	e
	Min. Elevation:	650.689	s e
	Max. Station:	97.020	t
	Min. Station:	0.000	

Click on the Select Files button and select final.tin.

h) Click the Place Element button to locate the postion of the tailwater <u>cross section</u> that is to be extracted (this is notated as the 'Extracted Profile' on the dialog).:



i) The **Define Culvert Tailwater Cross Section** dialog will now contain the profile along the element placed representing the channel cross section at this location.

ection Symbology			ОК	Cancel	
Drape Element on	Model / TIN 💌	TIN File 🔹	final.tin		
Select Element	Place Element				
Extracted Profile					
Profile ID: 23+20		Description:			
			Horiz. Scale:	10.000	
1.22			Vert. Scale:	1.000	R
			Max. Elevation:	842.050	e
		/	Min. Elevation:	826.854	e s
	/		Max. Station:	331.690	t
	/		Min. Station:	0.000	
-				e Profile	-

**j)** Click the **OK** button and the main culvert dialog will open again. The values for the tailwater section will now be populated.

Uvert II Descri		3+20	• •	* *	* * 2 0	Apply
etails						
	Culve	rt Profile		Overtopping	Com	putations
	Param	neters		Configuration	Headwa	Il Location
0	ischarge User Supj Design X	Discharge 39.200 42.449	D	Slope %: 0.800 Adjust	N Value: Tailwater Depth:	
			×	Distance 0.000 7.689 13.092	Elevation 839.536 839.442 839.375	
		39.200		0.000	0.000	

- K Culvert X Culvert ID: - 1 23+20 \* \* \* 5 Apply Description: Details **Culvert Profile** Overtopping Computations Parameters Configuration **Headwall Location** Entrance Type Shape: Circular Material: Concrete -Culvert Size Design Size • Headwater Elevation -836.500 Maximum Rise: 5.000 Minimum Rise: 1.500 Number of Barrels: 1 -Design Barrels Headwall bevel = 45<sup>^</sup> Roughness: 0.013 Select Entrance... Entrance Ke: 0.200
- k) Select the Configuration tab to define the type of Culvert. Make settings as listed below.

#### Shape: Circular

(Culvert Shape: Circle, Box, Ellipse, Etc.)

#### Material: Concrete

(Culvert Material: Concrete, Steel, Plastic, Etc.)

#### Headwater Elevation: 836.50

(The maximum elevation the water can reach at the upstream end of the culvert). By default this option is set to Allowable Headwater which uses a height value, click to change to Headwater Elevation.

#### Maximum Rise: 5.000

(The maximum diameter, height of the culvert)

#### Minimum Rise: 1.500

(The minimum diameter, height of the culvert)

#### Design Barrels: Toggle ON

(Allows the program to design multiple barrels, if required)

#### Number of Barrels: 1

#### Roughness: 0.013

(Determined by the type of Material, See the <u>TDOT Drainage Manual</u> Section 6.04.2.4.3, *Culvert Roughness Coefficients*)

**NOTE:** If you know the size of culvert you need beforehand you may set Culvert Size to 'Library Item' and pick from the list of defined items.

 Click Select Entrance and select the appropriate entrance condition. The most commonly used for TDOT projects is Headwall beveled 45<sup>^</sup>. Select this condition and click ok. This will automatically set the Entrance Ke value.

Select Entrance Type		
	6	
Headwall square edge	Projected	Mitered
Headwall beveled 45 <sup>^</sup> Headwall beveled 33.7 <sup>^</sup> OK		incel

m) Select the Headwall Location tab to define the location of the Upstream Headwall and Downstream Headwall (nodes). Make settings as listed below.

ulvert ID: <u>23+20</u> Description:	<b>•</b>	* *		Apply
etails	70			
Culvert Profile	Ove	ertopping	Computati	ons
Parameters	Conf	iguration	Headwall Loc	ation
Upstream Headwall Reference Chain: CL Node ID: 23+20- Library Item: Culvert				•
Tangent to Ref. Chain	• #	Tangent to Ref.	Chain 🔹 💉	
Chain Sta.:	Mirror Cell	Chain Sta.:	M	irror Cell
Offset: 0.000	+ Angle: 0.000	Offset: 0.00	0 + Angle:	180.000
Invert Elev.: TIN / Mode	• 0.000	Invert Elev.: TIN	1/Model ▼ 0.0	000
		-	ce Keyin F	

Type: Plan View

Reference Chain: <u>CL</u> (Roadway Centerline)

TIN File: final.tin

Library Item: Culvert Endwall

Alignment: Tangent to Ref. Chain

+ Angle.: <u>0 or 180</u>

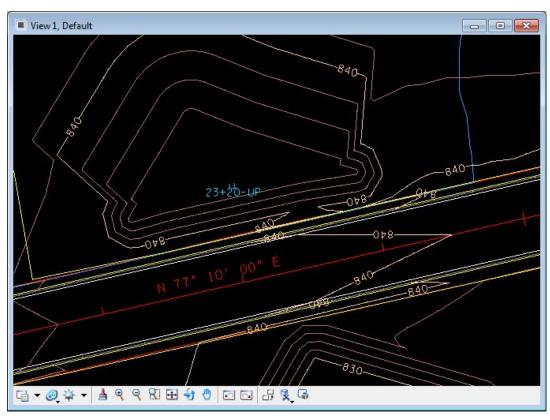
(For headwalls parallel to the roadway on the right side use an angle adjustment of 180 and on the left use 0. In this case the upstream is on left so that value should be set to 0.)

**NOTE:** Another option is to use Mirror Cell. Set angles to 0 and Toggle ON for headwalls on the right of the roadway and Toggle Off for headwalls on the left of the roadway. Do <u>NOT</u> use Mirror Cell along with Angle Rotations as this adds confusion.

#### Invert Elev.: TIN / Model

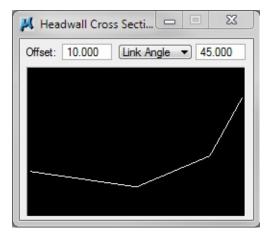
(Reads TIN elevations. Use 'User Supplied' inverts are known or are different than TIN file.)

n) Locate the Upstream Headwall by clicking the Dynamic Place button and setting the upstream headwall at a location similar to that shown below:



Watch the **Headwall Cross Section** dialog box appear upon mouse-movement. Use this viewer to place the Headwall at the upstream **low point**.

Station and offset values for the headwall location should change dynamically in the dialog as you move your mouse. If not, reset the chain name and try **Dynamic Place** again. It may be necessary to close the tool and reopen.

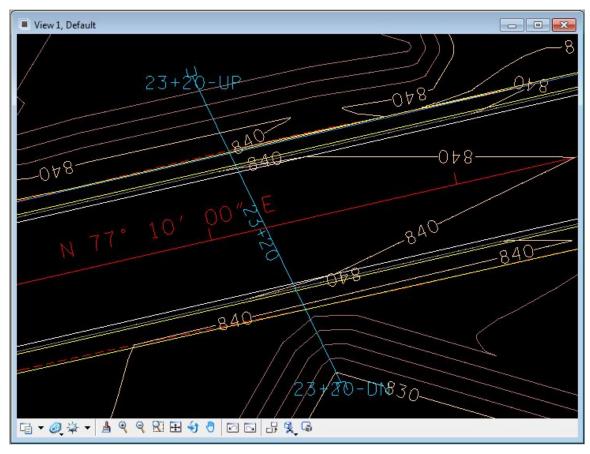


#### NOTES:

To set the headwall locations for 90 degree cross drains, you can enter the centerline crossing station with a given offset and click the Keyin Place button.

You may wish to utilize the **DTM Tools>Low Point Tool** as discussed in the DTM Tools Section 3 in order to predetermine the low point locations.

o) Locate the downstream headwall by clicking **Dynamic Place** under the **Downstream Headwall** group.



Ilvert ID:	• •	*	× × :	Apply
etails				
Culvert Profile	Ove	rtopping		Computations
Parameters	Config	guration	H	eadwall Location
Upstream Headwall Reference Chain: CL Node ID: 23+20-UP Library Item: Culvert Endwal				
Chain Sta.: 23+07.99	# Mirror Cell ngle: 0.000 832.847	Tangent to I Chain Sta.: 2 Offset: 6 Invert Elev.:	23+36.61 63.525	
	eyin Place	Dynamic		Keyin Place

**p)** Select the **Overtopping** tab to define the limits of roadway overtopping. Make settings as listed below and click **Extract PGL Profile**.

**NOTE:** This step is only necessary if your culvert is in a **sag** condition. If you are not in a sag condition you may proceed to **Step 17.** 

Culvert ID: 4 2 Description:	3+20 🔹 ]		* *	* 2 0	Apply
Details					
Para	meters	Config	guration	Headwall Locati	ion
Culvert	Profile	Overto	pping	Computations	
Width: 48	.000 V Paven Extract PGL Profile		Distance	Elevation	
Reference Chain:	CL -	1			면
	DESIGNCL -				×
Begin Station:	22+00.00	DP			
End Station:	25+00.00	DP	0.000	0.000	
X Increment:	5.000		0.000	0.000	

#### Overtopping Source: PGL

(This option sets the roadway profile as the controlling surface elevation for overtopping. Other options include 'User Supplied' or constant elevation and 'DTM')

Width: <u>48.00</u>

(This is the width of your roadway)

Pavement: Toggle ON

(This should be checked unless your road is not paved)

Reference Chain: CL

(Roadway Centerline)

Ref. PGL: DESIGNCL

(Roadway Profile)

Begin Station: <u>22+00.00</u>

(Use the **DP** button to select a point before the Culvert.)

#### End Station: 25+00.00

(Use the **DP** button to select a point after the Culvert.)

#### X Increment: 5.000

(This may be automatically adjusted depending on the distance between the begin station and end station.)

- **q)** Once the Nodes have been located, and the elevations appropriately calculated, the Culvert can be added to the project. Click the **Apply** button and the culvert will be drawn and labeled according to the symbology in the Preferences.
- r) The information to this point is enough to check the culvert computations. Select the Computations tab. Toggle on the option to view the Culvert calculations. Click the Compute Culvert button to perform the calculations.

Culvert		
Culvert ID:  23+20 Description:	<b>⊻</b> ► * *	🔸 💝 🗹 🛛 Apply
Details		
Parameters	Configuration	Headwall Location
Culvert Profile	Overtopping	Computations
Culvert Design Results for Circular Concrete Suggested Design 36 Inch Dia. Circular Rise = 3.000 Output Compute Culvert Culvert Overtopping	23+20     Output to ASCII:     23+20.out	Create View

**NOTE:** You may include Tailwater and Overtopping calculations (if you need them) by toggling ON the option to view them.

To view the Culvert Design Results, simply press the "View" button on the lower right of the "Culvert" menu to access the output file or you could open the file "23+20.out" from your Project Folder. View and/or print the Culvert Design Results that the Geopak Drainage software has calculated for you. Alternate design options have been found that may be considered.

The report also includes hydraulic computations such as Maximum Head Water Depth and Outlet Velocity for Q50 and Q100 which are helpful in analyzing the culvert design.

Culvert	Allow.	MAX	Inlet	Outlet	Tailwater
Discharge	HW	HW	HW	HW	Elev.
39.200	836.500	835.926	835.926	835.926	829.770
44.429	836.500	836.240	836.240	836.240	829.800

For the 50 year storm, the Head Water Depth is 835.926 ft. Using the DTM Height/Slope tool, a shape may be drawn at that elevation which represents the water surface for this storm event. This is the white shape in the picture below.



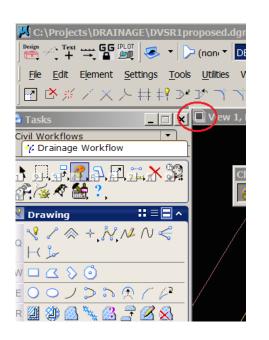
The Microstation Change Element Fill Type tool can be used to illustrate the ponded water for visual analysis. Use the Change Attributes tool to change the color to blue if desired.

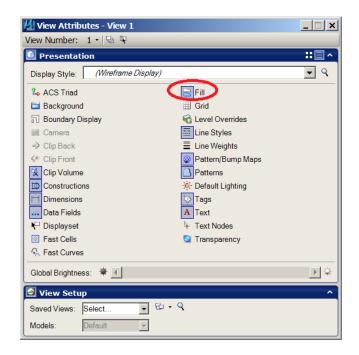
Change Attributes - MainX	🐐 Change Element Fill	_ 🗆 🗙
💽 💳 🔁 🏁 🛷 e <sup>g</sup> e <sup>g</sup>	Fill Type: Opaque 🔻	
Change Element Fill Type	Fill Color: Element	

# **Exercise** 4

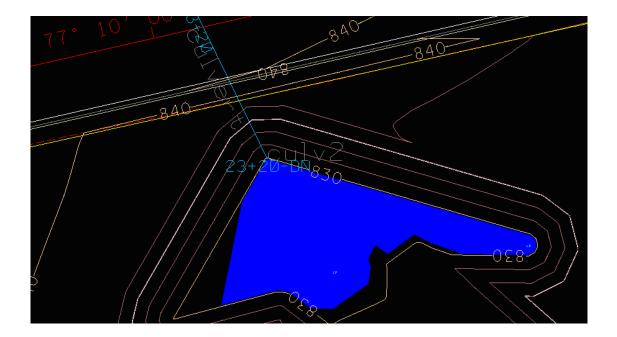
🐐 Change Attribu	tes 📃 🗆 🗙		DTM
Use Active Attrib	outes		
Level:	DESIGN - SCRATC		840
Color:	<b>6</b> 9 <b>-</b>		
Style:	3 🔻		
Weight:		0500	
Transparency:	0 🗸	° /	
Priority:	≙ 0 ऱ		
Class:	Primary 🔻		oulvi
Template:	None		0008
Use Fence:	nside 🔻		840 078-
Make Copy		048	Of C
Change Entire E	lement		0' 00'ZE 240

Be sure that your Fill is toggled On in the View Attributes menu.





Similarly, a visualization of the Tail Water pond may be created.



The Drainage Manual states that outlet velocities on Culverts should be based on the 50 year storm. In our file 23+20.out, we see that Geopak Drainage has calculated the Outlet Velocity for the 50 year storm at 13.567 fps.

39.20013.5671.2842.0380.0050.02444.42914.0241.3782.1720.0060.024	Culvert Discharge					
	39.200 44.429	13.567 14.024	1.284 1.378	2.038 2.172	0.005 0.006	

The use of riprap as scour protection at a culvert outlet is discussed in Section 6.04.3.3 of the Drainage Manual. It says that riprap can be used to provide protection at a culvert outfall for velocities between 5 fps and 12 fps. Since our velocity is greater than 12 fps, we would either need to lessen the slope of the culvert, thereby reducing the velocity at the outlet, or we would need to design a stilling basin or some other type of energy dissipator. See the Drainage Manual for guidance.

Before the next step, go back to "Configurations", **change Culvert Size to "Library** Item" - 36 Inch Dia Circular. Then, select the Culvert Size drop down and switch it to Design Size and set the Maximum Rise to 3.

ulvert ID:  23+20 Description:	*	🕈 🌾 🗹 🖬 🛛 Apply
etails		
Culvert Profile	Overtopping	Computations
Parameters	Configuration	Headwall Location
	Material: <u>Concrete</u>	Dia. Circular
Headwall bevel = 45^	Num Roughness: 0.013	ber of Barrels: 1

### **4.3 Culvert Profile**

At this point, the designer has the pipe size that will be required and can use regular Geopak proposed cross section tools to set up a culvert section to finalize the length & inverts for the cross drain.

The next several steps illustrate the functionality available through Geopak Drainage to set up a culvert section in profile format along the cross drain.

a) On the Headwall Location tab click on Create Profile to set up a culvert section and finalize headwall locations. The Create Plan View Culvert Profile dialog will open up. Make settings as shown below.

#### Set Horiz scale 10 and Vert scale 10.

Change max and min elevations to be the next even 10' up or down.

Use default values for Max and Min station.

ection Symbology	ОК	Cancel
Drape Element on Model / TIN	final.tin	9
Select Element Place Element		
Extracted Profile		
Profile ID: 23+20 Description:		
	Horiz. Scale:	10.000
	Vert. Scale:	10.000 R
	Max. Elevation:	850.000 e
	Min. Elevation:	820.000 e
	Max. Station:	152.986 t
	Min. Station:	0.000
	Place	e Profile

b) Click on the Symbology tab and make the following settings:

ection Symbology	
Ground Line Symbology	Boundary Symbology
Vertical Grid	Horizontal Grid
Major Interval: 10.000	Major Interval: 10.000
Minor Interval: 2.500	Minor Interval: 0.250
Major Symb.:	Major Symb.:
Minor Symb.:	Minor Symb.:
Major Text.:	Major Text.:

Ground Line Symbology (Proposed Roadway):

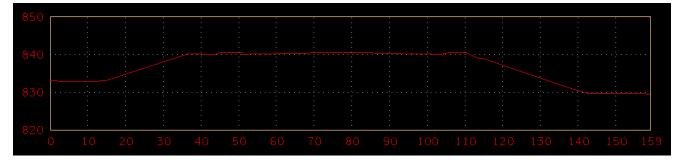
LV= DESIGN - TYPICAL - Finished Grade and Subgrade CO= 6, Style=0, WT=4

**Boundary Symbology:** 

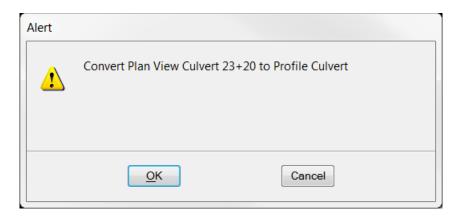
LV= DESIGN – SHEET – Light Grid CO=2, Style=0, WT=4

```
Vertical Grid Major Interval:
                        ON, Value=10
Vertical Grid Minor Interval:
                        OFF
Vertical Grid Major Symbology:
                        LV= DESIGN – SHEET – Light Grid
                        CO=0, Style=1, WT=1
Vertical Major Text:
                        LV= DESIGN – SHEET – Corner Text
                        CO=6, WT=10, TH=2, TW=2, FT=LEROYMON(3)
                        Click the Top Center to set Justification
Horizontal Grid Major Interval:
                        ON, Value=10
Horizontal Grid Minor interval:
                        OFF
Horizontal Grid major symbology:
                        LV= DESIGN – SHEET – Light Grid
                        CO=0 Style=1 WT=1
Horizontal Major Text:
                        LV= DESIGN – SHEET – Corner Text
                        CO=6, WT=10, TH=2, TW=2, FT=LEROYMON(3)
                        Click the Middle Right to set Justification
```

c) Once symbologies are set click on the Section tab and click on Place Profile in the lower right of the dialog. Culvert Section graphics will appear on the cursor, Data Point out in the open somewhere to place the graphics. Click OK on Create Plan View Culvert Profile dialog to dismiss and reopen the Culvert Edit dialog. Click Apply to store the culvert information.



d) Now that we have placed our culvert section we can finalize our inlet and outlet locations. On the Headwall Location tab change Type from Plan View setting to Profile View. When prompted to "Convert Plan View Culvert to Profile Culvert" click OK:



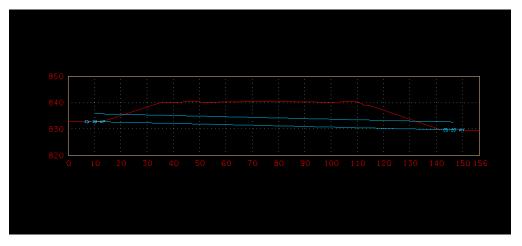
e) The Headwall location tab will change to show Profile view controls.

Culvert ID: 4 23+20 Description:	<ul><li>▶</li><li>▶</li></ul>	Apply
Details		
Culvert Profile	Overtopping	Computations
Parameters	Configuration	Headwall Location
Type: Profile View  TIN Upstream Headwall Reference Chain: CL Node ID: 23+20-UP Library Item: Culvert Endwall Drape Angle: 295.2613 + An Invert Sta.: 12.190 Invert Sta.: 12.190 Chain Sta.: 23+08.46 Chain Offset: -64.206		hain: CL ▼ D: 23+20-DN m: Culvert Endwall ▼ : 295.2613 + Angle: 77.572 : 145.643 .: 829.669 Sta.: 23+37.18

f) Under Upstream Headwall controls click Station DP button. Move cursor over culvert section profile near the upstream end of pipe. That end will start dynamically tracking with cursor movement. Relocate inlet so that the upstream invert of the pipe coincides with roadway side slope.

**NOTE:** This location could be located previously with Microstation commands or calculated and input as values in the Invert Sta. & Invert Elev. Keyin fields.

**g)** Repeat this procedure on the **Downstream Headwall** by clicking on **Station DP** and locating in culvert section profile.



h) Once Headwall locations have been reset click on Apply in the upper right corner of the Culvert Edit dialog. Now go back to the Computation tab and this time before clicking on Compute Culvert, toggle ON option for Output to ASCII, keyin name 23+20.txt and set file to Create option.

When **Compute Culvert** is clicked the output data in dialog is updated and text output file is created.

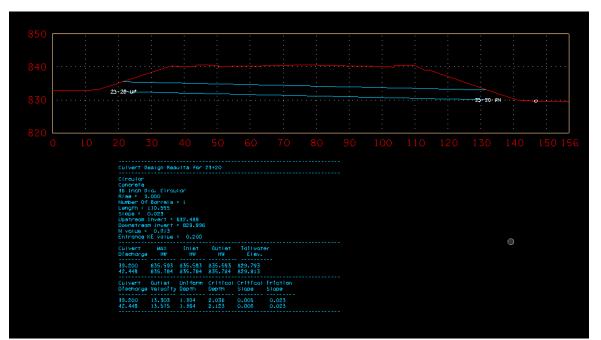
Uvert ID: 4 23+20 Description:	• • •	🔶 🌾 🛃 🖬 🛛 Apply
etails		
Parameters	Configuration	Headwall Location
Culvert Profile	Overtopping	Computations
Culvert Design Results	for 23+20	E
Circular Concrete 36 Inch Dia. Circular Rise = 3.000 Number Of Barrels = 1 Length = 110.555 Slope = 0.022 Output		
Circular Concrete 36 Inch Dia. Circular Rise = 3.000 Number Of Barrels = 1 Length = 110.555	for 23+20 ✓ Output to ASCII: 23+20.bt	Create View

i) To place drainage info with culvert section profile :

Set active text settings by going to TDOT>Cross Sections>XS Text Styles Plus, set Scale to 10 and select XS Drainage - Prop.:

Click to set Text s Level, Weight & Co	
XS Bridge Limits - Pro	р. 🔺
XS Drainage - Exist. XS Drainage - Prop.	
XS Finished Grade - I XS Finished Grade SI XS Pavement - Exist XS Retaining Wall - F XS ROW - Exist. XS ROW - Prop. Scratch XS Subgrade Slopes	opes - Prop. Irop.
Set Alternate STD	Place Label with Leader Line
Text Size	

Go to Microstation's **File>Import>Text** and pick the file **23+20.txt** in your project directory. Data Point in the DGN file for placement near the culvert section profile. This data can now be used when filling out TDOT Standard Drainage Data cells or can be edited to show additional data needed with the culvert section.



# 5. Storm Drainage Nodes

This exercise shows the user how to create surface drainage components for storm drainage. The user will add drainage areas, inlets, and outlets as necessary for proper roadway drainage design. Unless designing for the interstate, TDOT typically uses a 10-yr storm to design (See Appendix J).

Typically, each segment of the roadway drainage system will have an outlet to a side ditch, natural river or stream, or an adjacent storm drainage system. Possibilities of these outlets should be considered when determining catch basin locations.

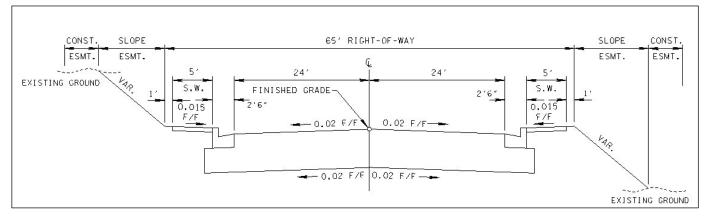
Initial locations for catch basins (inlets) should be based on the following criteria:

- 1.) At all low points (sag points) in the gutter grade or low points behind curbs, shoulders or sidewalks
- 2.) At the location down grade from the highpoint of a vertical curve where the spread is equal to the allowable spread
- 3.) At areas where off-site flow will flow across the top of curbs
- 4.) Upstream of median breaks, entrance/exit ramp gores, cross walks, street intersections, and bridges
- 5.) At side streets upgrade from the intersection
- 6.) At least every 400 feet (required for maintenance)

Once these primary locations are determined, adjustments or additions can be made to ensure that a safe travel way is maintained.

# 5.1 Design Drainage Node CB – 1

a) Determine the location of the Proposed Inlet. The proposed roadway is 4 lanes with no shoulders and a 6" non-mountable curb with curb and grate inlets.



We will assume for this project that the curb and gutter begins at 0+00.00. We have also determined that our maximum allowable spread is 8.0 feet (See <u>TDOT</u> <u>Drainage Manual Chapter 7</u> Section 7.03.3.7). Using sound engineering judgment we will assume our first inlet to be at Station **4+00.00** Offset **-26.00**.

b) From the Drainage Main Menu Bar, select Component > Node > Add OR from the Main Toolbar, select Add Drainage Node.

	IAGE - DrainageProject.gdf -	[No	Active Network]	<u> </u>	Drainag
Project	Component Network	Repo	rts <u>U</u> tilities <u>T</u> ool Boxes		
	<u>A</u> rea <u>N</u> ode	+	Add		
	Link	•	<u>E</u> dit		<b>ø</b> , <b>/</b> , <b> </b>
	<u>P</u> rofile	•	ID Delete		Drainage Nodes: Add Drainage Node
	<u>C</u> ulvert <u>R</u> outing	•	<u>R</u> ename		9, <b>2</b>
	Land <u>U</u> ses <u>M</u> iscellaneous Utilities	•	Re <u>n</u> umber Update All	l	₩,
			Update with Pay Items		

c) Type in CB-1 for the node ID. Leave the Description blank. Click OK. Over the next several steps, we will progress through the Node Configuration until everything has been set successfully.

Node ID:	CB-1	
Description:		

d) Properties > With the Node Id set to CB-1, set the properties as shown below:

Node Type: Grate

Profile: On Grade

Library Item: CB #12 4X3

(See Standard Drawing D-CB-12S for details.)

Node ID 🖣 CB-1	• •	Window Ce	enter 🙍 🕽	ø 🏹 ' <mark>ø</mark> 🚯	Apply
Details					
Options	Description:				
Properties	Node Type:	Grate	•		
Location	Profile:	On Grade	-		
Spread Criteria Elevations	Library Item:	CB#12 4X3	•		
Junction Loss	By Pass to Node:		10		-
Discharge Options	Max By Pass:	0.000			
Computations	Node Bottom:	None Available	•		Alian

**NOTE:** This project calls for a 6" nonmountable curb and gutter inlet. A type 12 catch basin is used since it is the most common for this type of gutter. The 4X3 is chosen because it requires the least amount of depth for the type 12's. <u>It is common practice to choose the smallest catch basin at the beginning of the system.</u> Refer to the TDOT GEOPAK Drainage Nodes shown in Appendix A to see other sizes and types of nodes.

e) Location > Describe the inlet's location in the design file as shown below:

Reference Chain: <u>CL</u>
Profile: <u>DESIGNCL</u>
Align: <u>Tangent to Chain</u>
Angle: <u>0.00</u>
Station: <u>4+00.00</u>

Offset: <u>-26.00</u>

📕 Node Configuratior	n - Location 📃 🗉 💌
Node ID	<ul> <li>Window Center</li> <li>Image: Image: Imag</li></ul>
Details	
Options	
Properties	Coordinates / Stationing
Location	Align: Tangent to Chain 🔻 💉 + Angle: 0.000
Spread Criteria Elevations	Station: 4+00.00 + X: 2980.808
Junction Loss	✓ Offset: -26.000 Y: 3214.900
Discharge Options Computations	Mirror Node Offset from Gutter to Inlet: 0.000

#### NOTES:

Once the location options are set, hit enter on your keyboard or data in one of the fields to add the catch basin. The angle of the catch basin is automatically set to match the centerline.

If a line or some other MicroStation element is located at the desired station and offset, the **Station DP** is button can be used. If Station DP is active and the location is set, **DO NOT** move out of the dialog because the station range will change. Hit enter on your keyboard or data in one of the fields to add the catch basin.

#### Other Align Options:

- **Tangent to Chain:** Allows independent station and offset while matching a specified chain's angle.
- **Tangent to Element:** Allows independent station and offset while matching an elements angle.
- **Tangent on Element:** Allows independent station (within limits of the element) while matching elements offset and angle. (Mirror Node is often required when using this option)

At Point: Allows independent station, offset and angle.

f) Spread Criteria > Describe the roadway cross sectional characteristics directly in front of the inlet. These values will be utilized to calculate inlet capacity and resulting by-pass flow. Turn <u>ON</u> the display for the reference file: DVSR1SEshapes.dgn and choose the following options:

Longitudinal Slope Source: Reference PGL

Spread Source: Shape & Lib. Item - 4Lane

Max Pond Depth: 0.50 feet

Max Pond Width: 8.00 feet

Node ID 4 CB-1	•		Vindow Cer lighlight	nter 🏂	e a ta ta ta	Apply
Details			-			
Options	Longitudinal Spread Cros	Slope Source	: Referer	nce PG	L 🔹 2.515	
Properties Location		urce: Shape	and Lib. It	em 🔻	] [4Lane	•
Spread Criteria	Width	% Slope	Roughne	* *		
Elevations	2.000	8.500	0.016	Ξ	Maximum	
Junction Loss	24.000	2.000	0.016		Pond Depth:	0.500
Discharge Options	12.000	2.000	0.016	-		
Computations	0.000	0.000	0.000		Pond Width:	8.000

Change **Spread Source** back to **User Supplied** to remove extra links created by the combination of the Shape and Library Item. The 24' link is defined in the library item but is not required since we have superelevation shapes for the pavement area, one shape for each 12' lane. **Delete the item with 24 for the width, and change the last item width from 11.993 to 12 and slope percent from 2.001 to 2**.

g) Spread Criteria > In the previous step, we set the spread section using a combination of the project's superelevation shapes and a standard drainage library spread section to illustrate that if a final TIN file has not yet been made, other methods could be used. <u>The</u> recommended method is to use a final TIN file which should represent the roadway accurately at any given inlet location.

Change the **Spread Source** to Reference TIN.

h) Elevation > Assign the inlet vertical elevation and vertical pipe alignment options. The Reference Surface: Tin File should already be set.

Reference Surface: <u>TIN File - final.tin</u> Elevation Source: <u>Reference TIN</u> Node Elevation Option: <u>Same as Source</u> Vertical Alignment: <u>Min. Fixed Drop, 0.17</u> Minimum Depth: <u>2.38 feet (See first note at top of next page)</u> Maximum Depth: <u>20.00 feet</u>

ዞ Node Configuration	n - Elevations	
Node ID		Window Center 📁 🍺 🏂 🎲 🖓 Apply Highlight
Details	_	
Options	Reference Surface:	TIN File  Final.tin Q
Properties Location	Elevation Source:	Reference TIN   880.196
Spread Criteria	Node Elevation Option:	Same as Source   880.196
Elevations	Vertical Alignment:	Min. Fixed Drop    O.170
Junction Loss Discharge Options	Minimum Depth:	2.380
Computations	Maximum Depth:	20.000
	Add Sump Depth:	0.000

### NOTES:

Refer to the <u>TDOT GEOPAK Drainage Nodes</u> listing in Appendix A of this manual or online for **Minimum Depth**, **Maximum Depth** and **Min. Fixed Drop** or **Drop Across Bottom of Structure** values for a given catch basin type and pipe size.

In Node Configuration, Minimum Depth refers to the Minimum Depth of Cover. It does not refer to the minimum depth of the catch basin. Both numbers are provided as shown below in a segment of the table taken from Appendix A.

Drainage	Node	Cell	Drop	Max.	Pipe Sizes			
Node	Description	Name	Across	Depth		15		18
Name			Bottom		Min.	Min.	Min.	Min.
			of		Depth	Depth	Depth	Depth
Type: Grate			Structure			of Cover		of Cover
CB#10 32"X26"	Lowered 6-30 Curb & Grate Inlet	CB32X26S	0.12	5.00			3.74	2.12
CB#10 4X3	6" NonMount. Curb & Grate Inlet	CB4X3S	0.17	20.00			3.88	2.21
CB#10 4' DIA	6" NonMount Curb & Grate Inlet	CB4DIAS	0.17	20.00			3.88	2.21
CB#10 4X4	6" NonMount. Curb & Grate Inlet	CB4X4S	0.17	28.00			3.88	2.21
CB#12 32"X32"	6" NonMount. Curb & Grate Inlet	CB32X32	0.12	4.58			3.74	2.12
CB#12 4X3	6" NonMount. Curb & Grate Inlet	CB4X3	0.17	20.00			3.88	2.21

#### NOTES:

In the TDOT GEOPAK Drainage Nodes table in Appendix A "**Minimum Depth of Cover = Minimum Depth - Pipe Size - Drop Across Bottom of Structure**" for catch basins with <u>both inlet and outlet pipes</u>. To determine Minimum Depth of Cover for catch basins with an <u>outlet only</u>: add **Drop Across Bottom of Structure** to **Minimum Depth of Cover**. The first catch basin in the system is considered an outlet only because there are no other pipes (inlets) coming into it.

For the initial design, use the value given under the 18 in. pipe size. If larger pipes are designed, reset the Minimum Depth of Cover to the value for the pipe designed on and re-design the network. Steps for this procedure are given in chapter 9 on Drainage Navigator /Querying.

Catch Basins – Inlet and Outlet:

Min. Depth of Basin – Pipe Size – Drop Across Bottom of Structure = Minimum Depth

**CB#12 4x3**: 3.88' - 18"/12 - 0.17' = 2.21'

### Catch Basins – Outlet Only:

Drop Across Bottom of Structure + Min. Depth of Cover = Minimum Depth

**CB#12 4x3**: 0.17' + 2.21' = 2.38'

i) Junction Losses > Set to Use **Defined Equations** (This defaults to the project preference settings that were set in Exercise 1):

Node ID 4 CB-1	Vindow Center	i 🖉 🎢 🖞 🖓 🗛 i
Details		
Options	Operation Defined Equations	
Properties	Equations x Loss Reduction:	0.000
Location	Absolute Loss:	0.000
Spread Criteria Elevations	Supplied K - Outlet Velocity:	0.000
Junction Loss	Supplied K - Change in Velocity:	0.000
Discharge Options Computations	⊘ None	

**j) Discharge Options >** Specify the source of the discharge contributing to this inlet. Toggle **Use Computed Discharge**:

Node ID	Window Center 😼 😼 🏂 📸 Apply     Highlight
Details	
Options	O Use Computed Discharge
Properties Location Spread Criteria Elevations Junction Loss	Supplied Discharge: 0.000     Disable Inlet Calculations Capacity: 0.0000     Link Base Flow Area      None Available
Discharge Options Computations	

**k)** Computations > Verify the inlet's hydraulic computations:

**NOTE:** The Drainage Area for this node hasn't been added; therefore, the computations for the node can't be completed until a discharge is known.

Node ID 4 CB-1	Window Center 📁 😿 🧏 🍖 🚯 Apply     Highlight
D <mark>eta</mark> ils	
Options Properties Location Spread Criteria Elevations Junction Loss Discharge Options Computations	Inlet CB-1 - Error Performing Inlet Computations Drainage Area CB-1 Not Found

I) Add this Node to the project by pressing the **Apply** button.

## 5.2 Delineate Drainage Area CB – 1

 a) According to the <u>TDOT Drainage Manual Chapter 4</u> Table 4-1 (see Appendix J) *Hydrologic Design Criteria*, the drainage area for CB-1 should be calculated for a <u>10 year</u> frequency. Select **Project>Preferences** and **change the Frequency Options to the 10 Year Storm**. Click the **OK** button to accept the new preference settings.

<u>File</u>	
Options Units Project Components Rainfall Parameters Land Use Options Frequency Option Intensity Option Junction Losses Inlet Options Node Options Link Options Profile Options Plan Symbology Updates Save Options OK Cancel	Drainage Library (DLB):\Geopak Standards\TDOTEnglish.dlb Rational Frequency Options Computation Runoff Coefficient Prequency: Peaking Factor: 10 Year 1.0000 SCS Frequency Options Cumulative Runoff Coefficient Frequency: Peaking Factor: 1.0000

b) From the Node Configuration dialog select Edit Area. When asked if you want to create a new drainage area click Yes.

Node ID  CB-1	→ Computations	
Details		Edit Area
Options Properties Location Spread Criteria Elevations Junction Loss Discharge Options Computations	Inlet CB-1 - Error Performing Inlet Computations Drainage Area CB-1 Not Found	Alert Drainage area [CB-1] not in project. Do you wish to create a new drainage area?
		Yes No

**NOTE:** If you have closed the Node Configuration Dialog you may create a new Drainage Area by going to the Drainage Main Menu Bar, and selecting **Component > Area > Add** *OR* from the Main Toolbar and selecting **Add Drainage Area.** 

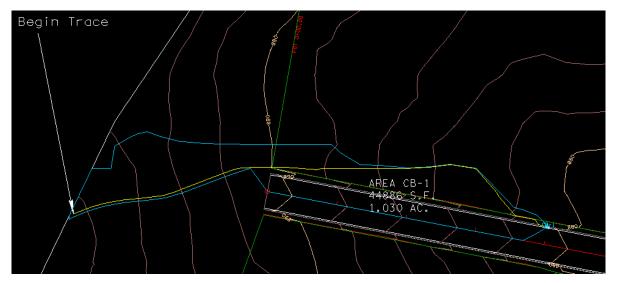
📕 DRAINA	GE - DrainageProject.gdf -	[No A	Active Network	]			
Project	<u>Component</u> <u>N</u> etwork	Repo	rts <u>U</u> tilities	Tool Boxes			
_	<u>A</u> rea	•	<u>A</u> dd			-	
	<u>N</u> ode <u>L</u> ink	+ +	<u>E</u> dit ID		Drain 🖾		
	<u>P</u> rofile	•	<u>D</u> elete <u>R</u> ename			) ฏ <u>1</u>	Add Drainage Area
	<u>C</u> ulvert <u>R</u> outing	+ +	Update All		P	6) <u>2</u> 6) <u>3</u>	Id Edit Drainage Area
	Land <u>U</u> ses Miscellaneous Utilities	•				6) <u>4</u> 6) <u>5</u>	
	_		1				Update All Areas Drainage Area Report
					-	0	pen as ToolBox

The following Add a New Area dialog box will pop up. Click **OK**.

Area ID:	CB-1
Description:	

c) Follow the steps in Exercise 3.2 to delineate and define the drainage area for Catch Basin 1. (You may use the following images as reference points. It is ok if your numbers do not match exactly.) Attach reference file DA\_CB-1.

Delineate Drainage Area:



d) Define Drainage Area:

Use Select Shape to identify the drainage area. Our Base C Value was set previously in the culvert exercise.

📕 Drainage Area D	efinition		
Area ID:		Window Center 🐴 👌	a 摘 🐴 🗛 Apply
Details	_		
Options	Description:	To Nod	le ID: CB-1 🦓
Definition Subareas Computation Hydro. Method	Drainage Area: 1.030 Base C Value: 0.350 Time of Conc.: 5.000	Area Selection / Cre Select Shape	Create DTM Shape
<ul> <li>Rational</li> <li>SCS</li> </ul>	Compute TC	Pick Boundary Elements	DP Create Shape

This Base C Value should be set to the most common land use item within your project area then only the remaining areas would need land use shapes developed for them.

e) Calculate Time of Concentration:

	Details				
Drainage Area ID: CB-1	Distance	Slope	Avg. Slope	Flow	
TIN File  Final.tin Q	18.93	2.29	2.29	Sheet	
	15.01	2.98	2.59	Sheet	
Define Path	17.94	2.55	2.58	Sheet	
Trace (I) ID - Segments	9.82	2.80	2.61	Sheet	
	22.50	2.56	2.60	Sheet	
Sheet Flow	6.92	2.78	2.61	Sheet	
Method: FHA  Length: 300.000	25.39	2.90	2.68	Sheet	
	3.41	2.81	2.68	Sheet	
n Value: 0.400 Slope: 2.918	12.19	3.65	2.77	Sheet	
	12.96	3.85	2.87	Sheet	
Shallow Row	5.61	3.14	2.88	Sheet	
Length: 100.000	19.52	3.07	2.90	Sheet	
Inter. K: 0.491 Slope: 2.655	14.81	3.10	2.92	Sheet	
	10.26	3.14	2.93	Sheet	Ŧ
Concentrated How	Distance:	Slope	e: _		
Method: Continuity V Length: 410.569	18.930	2.2	0	Adjust Flo	w
Velocity: 5.000 Accum. Distance: 810.569 Accum. Avg. Slope: 2.535 Tc= 31.361 Compute Apply		llow Flow		300.000	)

Note that the n value for the sheet flow and the Inter. K value for the shallow flow has changed and will remain the same throughout this exercise unless noted.

Sheet Flow – When water flows at a depth of 0.1 feet (1.2 inches) or less

**Shallow Flow** – Sheet flow usually becomes shallow flow and flows at a depth above 0.1 feet (1.2 inches)

**Concentrated Flow** – Water flowing in a ditch, gutter, channel, or other drainage structure

The calculated Time of Concentration is **GREATER** than the minimum of 5 minutes; therefore the Time of Concentration will automatically be filled in after hitting Apply with NO further steps required.

📕 Drainage Area D	efinition		- • •
Area ID:	<b>T</b>	Window Center 🔬 🔏	) 摘 👸 🗛 Apply
Details			
Options	Description:	To Node	ID: CB-1 🏻 💋
Definition Subareas Computation	Drainage Area: 1.030 Base C Value: 0.350 Time of Conc.: 31.347	Area Selection / Creat Select Shape	Create DTM Shape
Hydro. Method Rational SCS	Compute TC	Pick Boundary Elements	DP Create Shape

f) Delineate Subareas utilizing the Land Use DGN:

📕 Drainage Area Su	ıbareas						
Area ID: 4 CB-1		• •	] Window Center ] Highlight	9 20	8	۵	Apply
Details							
Options			To	Node I	D: C	:B-1	l <sub>øs</sub>
Definition	Subarea	C Value	Description				
Subareas	0.2298	0.900	Conc/Asphalt Pv	mt			omatic neation
Computation	0.3243	0.300	Forested Areas		2	Dell	neation
						🔽 Dis	splay Only
Hydro. Method					×		
Rational					$\sim$		
SCS							
0 000	0.324	0.300	Forested Areas				

g) Compute Discharge and Apply:

📕 Drainage Area C	omputations					
Area ID:	•	Window Center	<u>1</u>	8	8	Apply
Details						
Options		Area	C Value	Γ	Cor	npute
Definition Subareas	Total Subareas:	0.554	0.549			charge
Computation	Remainder:	0.476	0.350			
Hydro. Method	Composite:	1.030	0.457			
Rational	Computed Intensity:	3.357				
◎ SCS	Computed Discharge:	1.580				

 h) Back in the Node Configuration dialog box click on Properties, then click again on Computations. This allows the program to update and run calculations. Review the Computations.

Node ID	v المربي Window Center المربي	🏂 🍃 🚷 🛛 Apply
Details		
Options	Discharge = 1.5804	
Properties Location Spread Criteria Elevations Junction Loss Discharge Options Computations	Spread Width from Gutter = 5.4112 Total Ponded Width = 5.4112 Ponded Depth = 0.2382 Spread Left Intercept = 0.0000 Spread Right Intercept = 5.4112 Grate Length = 3.0210 Grate Width = 1.8130 Grate Capacity = 1.2753 ByPass Flow = 0.3051 Efficiency = 0.8070	

Don't be alarmed if your results are off by a few 100<sup>th</sup>'s. It could just be a tolerance issue.

**NOTE:** Upon review of the computations the **Spread Width from Gutter** is within our limit of 8.0 feet, therefore the inlet is in good position.

### 5.3 Design Inlet CB – 2

It has been determined that another standard CB#12 4X3 will be used.

See Standard Drawing D-CB-12S for details.

CB- 2 will be at nearly the same location as CB-1 but will be on the right side of the road. Many of the parameters will be defaulted to those used to place CB-1.

 a) Select from the Main Menu Bar: Component > Node > Add; or from the Main Toolbar: Add Drainage Node; or click the Add Node button within the Node Configuration Dialog.

Node Configuration	- Computations	
Node ID	<ul> <li>Window Center</li> <li>Highlight</li> </ul>	a 🝺 🐔 🛛 Apply
Details		
Options Properties Location Spread Criteria Elevations Junction Loss Discharge Options Computations	Discharge = 1.5804 Spread Width from Gutter = 5.4112 Total Ponded Width = 5.4112 Ponded Depth = 0.2382 Spread Left Intercept = 0.0000 Spread Right Intercept = 5.4112 Grate Length = 3.0210 Grate Width = 1.8130 Grate Capacity = 1.2753 ByPass Flow = 0.3051 Efficiency = 0.8070	

- **b)** Click **OK** to add CB-2. CB-2 will automatically take the place of CB-1 in the Node Configuration dialog which is already open.
- c) Properties > Verify the Node Properties are defaulted from the previous Node (CB-1) such that no user-input is required for this similar curb inlet.

Node ID 4 CB-2	▼ ►	Window Ce	nter 🙍 🤉	1 🏂 🖥 🖓	Apply
Details					
Options	Description:				
Properties	Node Type:	Grate	•		1
Location		On Grade	<b>-</b>		
Spread Criteria Elevations	Library Item:		•		
Junction Loss	By Pass to Node:		্য ব		
Discharge Options	Max By Pass:	0.000			
Computations	Node Bottom:	None Available	-		

d) Location > All Reference information is defaulted from the previous Node (CB-1) such that only the station,+ Angle (OR Mirror Node but NOT both) and the Offset needs to be changed. Change the

**Station:** <u>3+70</u>

Angle: <u>\*180 (or toggle on Mirror Node)</u>

Offset: 26.00

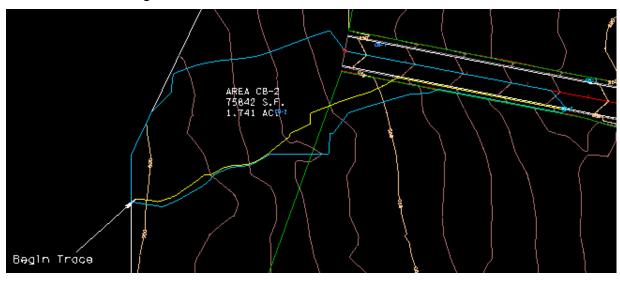
\*(180 for Right side, 0 for the Left), (Mirror Node ON for the Right, OFF for the Left)

Node ID	<ul> <li>Window Center</li> <li>Window C</li></ul>
Details	
Options	Chain: CL
Properties	Coordinates / Stationing
Location	
Spread Criteria Elevations Junction Loss	Align:         Tangent to Chain         + Angle:         180.000           Station:         3+70.00         X:         2941.569           Ø Offset:         26.000         Y:         3169.465
Discharge Options Computations	Mirror Node Offset from Gutter to Inlet: 0.000

e) Click Apply to include this node in the Drainage Project.

### 5.4 Delineate Drainage Area CB – 2

- a) From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-2** should automatically appear, click **OK**.
- b) Follow the steps in Exercise 3.2 to delineate and define the drainage area for Catch Basin 2. (You may use the following images as reference points. It is ok if your numbers do not match exactly.) Attach reference file DA\_CB-2 and turn off DA\_CB-1.



Delineate Drainage Area:

c) Define Drainage Area:

📕 Drainage Area D	efinition		- • •
Area ID: 4 CB-2	<b>T</b>	Window Center 🐁 🥇	a 🍇 🐴 🗛
Details	_		
Options	Description:	To Node	e ID: CB-2 🦓
Definition Subareas Computation	Drainage Area: 1.741 Base C Value: 0.350 Time of Conc.: 5.000	Area Selection / Crea Select Shape	Create DTM Shape
Hydro. Method	Compute TC	Pick Boundary Elements	DP Create Shape

#### d) Calculate Time of Concentration:

	Details					
Drainage Area ID: CB-2	Distance	Slope	Avg. Slope	Flow		
TIN File  final.tin Q	24.80	2.96	2.96	Sheet		
······································	10.43	1.49	2.52	Sheet		Č
Define Path	22.85	2.69	2.59	Sheet		
Trace (I) ID - Segments	2.83	1.50	2.54	Sheet		Ę
	6.19	0.98	2.39	Sheet		
Sheet Flow	40.86	1.09	1.90	Sheet		>
Method: FHA  Length: 300.000	15.79	2.04	1.92	Sheet		6
	10.21	1.59	1.89	Sheet		1
n Value: 0.400 Slope: 2.358	24.02	2.25	1.95	Sheet		
Shallow Flow	11.20	1.29	1.90	Sheet		
	17.22	4.13	2.11	Sheet		
	15.07	4.49	2.29	Sheet		
Inter. K: 0.491 Slope: 2.180	11.65	1.66	2.25	Sheet		
	20.32	3.22	2.34	Sheet	*	
Concentrated How	Distance:	Slope	e: _			
Method: Continuity Length: 367.535	24.800	2.96	50	Adjust Flo	W	
Velocity: 5.000				300.000	5	
Accum. Distance: 767.535	Max Sha	llow Flow	Distance	100.000	ン	
Accum. Avg. Slope: 2.550		_	Apply			

The calculated Time of Concentration is **GREATER** than the minimum of 5 minutes; therefore the Time of Concentration will automatically be filled in after hitting Apply with NO further steps required.

Max. Sheet and Max. Shallow Flow Distance values should be the same.

e) Delineate Subareas utilizing the Land Use DGN:

📕 Drainage Area Su	bareas				- • •
Area ID: 4 CB-2		• •	] Window Center ] Highlight 🏾 🖄 🥇	a Xa	Apply Apply
Details					
Options			To Node	e ID: C	B-2 💋
Definition	Subarea	C Value	Description		
Subareas	0.2136	0.900	Conc/Asphalt Pvmt		Automatic Delineation
Computation	0.1746	0.300	Forested Areas	*	Deineation
					Display Only
Hydro. Method				$\mathbf{X}$	
Rational					
SCS					
0 000	0.175	0.300	Forested Areas		

f) Compute Discharge and Apply:

📕 Drainage Area Co	omputations					
Area ID: 4 CB-2	•	Window Center	송 治	8	٩	Apply
Details						
Options		Area	C Value		Com	au ta
Definition Subareas	Total Subareas:	0.388	0.630		Disch	
Computation	Remainder:	1.353	0.350			
Hydro. Method -	Composite:	1.741	0.412			
Rational	Computed Intensity:	3.270				
⊚ SCS	Computed Discharge:	2.348				

g) Back in the Node Configuration dialog box click on Properties, then click again on Computations. This allows the program to update and run calculations. Review the Computations.

Vode Configuration	n - Computations	- • • 🔀
Node ID 4 CB-2	▼ ► Window Center	a ja 🎢 🙀 🍓 🗛 Apply
Details		
Options Properties Location Spread Criteria Elevations Junction Loss Discharge Options Computations	Discharge = 2.3481 Spread Width from Gutter = 6.8632 Total Ponded Width = 6.8632 Ponded Depth = 0.2673 Spread Left Intercept = 0.0000 Spread Right Intercept = 6.8632 Grate Length = 3.0210 Grate Width = 1.8130 Grate Capacity = 1.7043 ByPass Flow = 0.6439 Efficiency = 0.7258	

Don't be alarmed if you results are off by a few 100<sup>th</sup>'s. It could just be a tolerance issue.

**NOTE:** Upon review of the computations the **Spread Width from Gutter** is within our limit of 8.0 feet, therefore the inlet is in good position.

### 5.5 Design Inlet CB – 3

It has been determined that another standard CB#12 4X3 will be used.

See Standard Drawing D-CB-12S for details.

 a) Select from the Main Menu Bar: Component > Node > Add; or from the Main Toolbar: Add Drainage Node; or click the Add Node button within the Node Configuration Dialog.

Click OK to set the name CB-3

**Properties >** Verify the Node Properties are defaulted from the previous Node such that no user-input is required:

Node ID 4 CB-3	<b>•</b> •	Window Ce	enter 🙍 🗴	1 🏹 😼 🚳	Apply
Details					
Options	Description:				
Properties	Node Type:	Grate	•		
Location		On Grade	•		
Spread Criteria Elevations	Library Item:	CB#12 4X3	•		
Junction Loss	By Pass to Node:		10	-	70
Discharge Options	Max By Pass:	0.000			
Computations	Node Bottom:	None Available	•		
	Override Librar	y Payitem:			Align

b) Location > All Reference information is defaulted from the previous Node (CB-2) such that only the Angle, Station and the Offset needs to be changed. After a few iterations it was determined that CB-3 should be placed at Station 6+20.00:

Node ID 🖣 CB-3	🗾 🕨 📄 Window Center 👘 🍺 🎢	ାଜ 🚳 [	Apply
Details			
Options	🔽 Chain: CL 🔹 🔽 Profile: DES	GIGNCL	•
Properties	Coordinates / Stationing		
Location	Align: Tangent to Chain	0.000	
Spread Criteria Elevations		3196.887	
Junction Loss	✓ Offset: -26.000 Y:	3173.550	
Discharge Options Computations	Mirror Node Offset from Gutter to Inlet:	0.000	

c) Elevation > Reset Minimum Depth for a <u>node with both inlet and outlet pipes</u>.

### Minimum Depth: 2.21 FT

NOTE: SEE Appendix H – Storm sewer sketch, inlet and outlet on the right.

Node ID 4 CB-3		Window Center . Highlight	w w H	"ø 🚯	Apply
Details					
Options	Reference Surface:	TIN File 🔻	final.tin		Q
Properties Location	Elevation Source: Node Elevation Option:		•	872.705 872.705	
Spread Criteria Elevations	Vertical Alignment:			0.170	1
Junction Loss Discharge Options	Minimum Depth:			0.170	
Computations	Maximum Depth:	20.000			
	Add Sump Depth:	0.000			

d) Click the Apply button to include this node in the Drainage Project.

#### Catch Basins – Inlet and Outlet:

Min. Depth of Basin – Pipe Size – Drop Across Bottom of Structure = Minimum Depth

**CB#12 4x3**: 3.88' - 18"/12 - .17' = 2.21'

## 5.6 Delineate Drainage Area CB – 3

- a) From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-3** should automatically appear, click **OK**.
- b) Follow the steps in Exercise 3.2 to delineate and define the drainage area for Catch Basin 3. (You may use the following images as reference points. It is ok if your numbers do not match exactly.) Attach reference file DA\_CB-3 and turn off DA\_CB-2.

Delineate Drainage Area:

c) Define Drainage Area:

📕 Drainage Area D	Definition		- • -
Area ID: 4 CB-3	<b>T</b>	Window Center 🖄 🔞	🔏 🖓 🗛 Apply
Details	_		
Options	Description:	To Node I	D: CB-3 🏼 🖓
Definition Subareas Computation	Drainage Area: 0.182 Base C Value: 0.350 Time of Conc.: 5.000	Area Selection / Creation	Create DTM Shape
Hydro. Method Rational SCS	Compute TC	Pick Boundary Elements	DP Create Shape

d) Calculate Time of Concentration:

	Details				
Drainage Area ID: CB-3	Distance	Slope	Avg. Slope	Flow	
TIN File  final.tin Q	9.38	1.70	1.70	Sheet	
	25.62	1.13	1.28	Sheet	= 7
Define Path	3.40	1.13	1.27	Shallow	
Trace (I) ID - Segments	2.47	1.43	1.28	Shallow	
	2.18	1.36	1.28	Shallow	
Sheet Flow	1.81	1.85	1.31	Shallow	>
Method: FHA  Length: 35.000	1.02	1.85	1.32	Shallow	6
	0.96	2.24	1.34	Shallow	
n Value: 0.400 Slope: 1.283	7.70	2.24	1.46	Shallow	
Shallow Flow	3.02	2.24	1.50	Shallow	
	0.00	53.36	1.50	Shallow	
	0.96	50.07	2.30	Shallow	
Inter. K: 0.491 Slope: 4.975	0.00	50.06	2.30	Shallow	
	0.01	3.21	2.30	Shallow	Ŧ
Concentrated Flow	Distance:	Slope			
Method: Continuity  Length: 205.750	9.380	1.70		Adjust Flow	
Velocity: 5.000	0.000	1.79		-	
	Max Sh	neet Flow	Distance.	35.000	N
Accum. Distance: 275.750	Max Sha	llow Flow	Distance	35,000	)
<	Max on a		Distance.	00.000	
Accum. Avg. Slope: 2.671					

The calculated Time of Concentration is **GREATER** than the minimum of 5 minutes; therefore the Time of Concentration will automatically be filled in after hitting Apply with NO further steps required.

The maximum length for sheet flow and shallow flow has changed and will vary depending upon the drainage area. For this area, **set Max. Sheet Flow and Max. Shallow Flow to 35.** 

e) Delineate Subareas utilizing the Land Use DGN:

📕 Drainage Area Su	ibareas					- • •
Area ID: 4 CB-3		• •	] Window Center ] Highlight	ෂ	8	Apply Apply
Details						
Options			To N	ode I[	D: C	:В-3 💋
Definition	Subarea	C Value	Description			
Subareas	0.1312	0.900	Conc/Asphalt Pvmt			Automatic Delineation
Computation	0.0183	0.300	Forested Areas		1	Delineation
						Display Only
Hydro. Method					×	
Rational					$\sim$	
SCS						
0 000	0.018	0.300	Forested Areas			

f) Compute Discharge and Apply:

Area ID:	•	Window Center	🔞 🔕	🔏 👸 🗛 Apply
Details				
Options		Area	C Value	Compute
Definition Subareas	Total Subareas:	0.150	0.827	Discharge
Computation	Remainder:	0.033	0.350	
Hydro. Method	Composite:	0.182	0.741	
Rational	Computed Intensity:	5.818		
SCS	Computed Discharge:	0 785		

**g)** Back in the **Node Configuration** dialog box click on **Properties**, then click again on **Computations**. This allows the program to update and run calculations. Review the Computations.

Node Configuration	n - Computations	
Node ID	🔹 کې 🚽 Window Center کې کې کې	r 😼 🚳 🛛 Apply
Details		
Options	Discharge = 0.7852	
Properties Location Spread Criteria Elevations Junction Loss Discharge Options Computations	Spread Width from Gutter = 3.0179 Total Ponded Width = 3.0179 Ponded Depth = 0.1904 Spread Left Intercept = 0.0000 Spread Right Intercept = 3.0179 Grate Length = 3.0210 Grate Width = 1.8130 Grate Capacity = 0.7491 ByPass Flow = 0.0361 Efficiency = 0.9540	

Don't be alarmed if your results are off by a few  $100^{th}$ 's. It could just be a tolerance issue.

**NOTE:** Upon review of the computations the **Spread Width from Gutter** is within our limit of 8.0 feet, therefore the inlet is in good position.

### 5.7 Design Inlet CB – 4

It has been determined that another standard CB#12 4X3 will be used.

See Standard Drawing D-CB-12S for details.

 a) Select from the Main Menu Bar: Component > Node > Add; or from the Main Toolbar: Add Drainage Node; or click the Add Node button within the Node Configuration Dialog. Click OK to set the name CB-4.

**Properties >** Verify the Node Properties are defaulted from the previous Node such that no user-input is required:

Node ID 4 CB-4	• •	Window Ce	nter 🝺 🔊	' 🏂 😼 🚳	Apply
Details					
Options	Description:				
Properties	Node Type:	Grate	•		
Location	Profile:		-		
Spread Criteria Elevations	Library Item:				
Junction Loss	By Pass to Node:		্র 🖞		-
Discharge Options	Max By Pass:	0.000			
Computations	Node Bottom:	None Available	•		Align

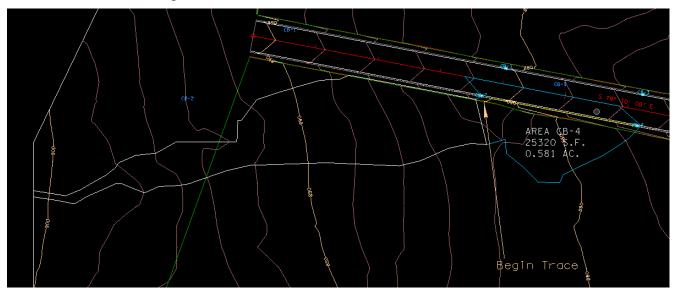
b) Location > All Reference information is defaulted from the previous Node (CB-3) such that only the + Angle, Station and the Offset needs to be changed. We will set this catch basin at the same Station as CB-3.:

Node ID 4 CB-4	🔹 🕨 🦳 Window Center 📁 🖉 🖉 🎢 Apply
Details	
Options	Chain: CL    Profile: DESIGNCL
Properties	Coordinates / Stationing
Location	Align: Tangent to Chain V # + Angle 180.000
Spread Criteria	
Elevations	Station: 6+20.00 X: 3187.114
Junction Loss	V Offset: 26.000 Y: 3122.477
Discharge Options Computations	Mirror Node Offset from Gutter to Inlet: 0.000

c) Click the Apply button to include this node in the Drainage Project.

## 5.8 Delineate Drainage Area CB – 4

- a) From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-4** should automatically appear, click **OK**.
- b) Follow the steps in Exercise 3.2 to delineate and define the drainage area for Catch Basin 4. (You may use the following images as reference points. It is ok if your numbers do not match exactly.) Attach reference file DA\_CB-4 and turn off DA\_CB-3.



Delineate Drainage Area:

**NOTE:** After a first iteration the spread for the entire contributing drainage area was found to exceed the spread limit. After consideration it was determined an area drain could collect the water before it spills over the back of the curb. The white shape shows the drainage area to be captured by that area drain. (See next Exercise 5.9)

a) Define Drainage Area:

📕 Drainage Area D	efinition		- • 💌
Area ID:		Window Center 🐁 🦄	🔏 🖓 🗛 Apply
Details			
Options	Description:	To Node	ID: CB-4 🏻 💋
Definition Subareas Computation Hydro. Method Rational SCS	Drainage Area: 0.581 Base C Value: 0.350 Time of Conc.: 5.000 Compute TC	Area Selection / Creat Select Shape Pick Boundary Elements	Create DTM Shape DP Create Shape

**b)** Calculate Time of Concentration:

Drainage Area ID: CB-4	17.1					
	Distance	Slope	Avg. Slope	Flow	-	
TIN File 🔻 final.tin 🔍	3.52	1.52	1.52	Sheet		
	1.76	2.73	1.92	Sheet	Ξ	
Define Path	0.25	2.73	1.96	Sheet	-	
Trace () ID - Segments	0.01	6.27	1.96	Sheet		
	0.04	6.27	1.99	Sheet		
Sheet How	0.07	6.27	2.04	Sheet		
lethod: FHA  Length: 10.000	0.00	6.27	2.04	Sheet		
	0.10	12.92	2.23	Sheet		1.
Value: 0.400 Slope: 2.660	0.12	5.12	2.28	Sheet		
Shallow Flow	0.09	13.15		Sheet		
Length: 10.000	0.13	2.71	2.46	Sheet		
	3.16	0.19	1.69	Sheet		
nter. K: 0.491 Slope: 8.405	0.19	50.04	2.66	Sheet		
	0.00	3.21	2.66	Sheet	*	
Concentrated Flow	Distance:	Slope				
lethod: Continuity V Length: 232.777	3.520	1.52	0	Adjust Flor	W	
Velocity: 5.000				10.000	]	
Accum. Distance: 251.638 ccum. Avg. Slope: 2.740	Max Sha	llow Flow	Distance.	10.000	]	

The calculated Time of Concentration is less than the minimum of 5 minutes, therefore **5 must be manually typed** in the Drainage Area Definition dialog **after hitting apply** in the Time of Concentration Window.

The maximum length for sheet flow and shallow flow has changed and will vary depending upon the drainage area. For this area, **set Max. Sheet Flow and Max. Shallow Flow to 10.** 

c) Delineate Subareas utilizing the Land Use DGN:

🕌 Drainage Area Su	ıbareas				[	- • •
Area ID: 4 CB-4		• •	] Window Center ] Highlight	ක	8	Apply Apply
Details						
Options			To N	ode ID	: CB	-4 💋
Definition	Subarea	C Value	Description		ſ	
Subareas	0.1531	0.900	Conc/Asphalt Pvmt			Automatic
Computation	0.3753	0.300	Forested Areas		2 (	Delineation
				[		Display Only
Hydro. Method					×	
Rational						
© SCS						
0 000	0.375	0.300	Forested Areas			
			-			

d) Compute Discharge and Apply:

📕 Drainage Area C	omputations					
Area ID:	•	Window Center	19 <b>1</b> 9	8	۵	Apply
Details						
Options		Area	C Value	Γ	Cor	npute
Definition Subareas	Total Subareas:	0.528	0.474			harge
Computation	Remainder:	0.053	0.350			
Hydro. Method	Composite:	0.581	0.463			
Rational	Computed Intensity:	6.980				
SCS	Computed Discharge:	1.877				

e) Back in the Node Configuration dialog box click on Properties, then click again on Computations. This allows the program to update and run calculations. Review the Computations.

Node ID 4 CB-4	▼ ► Window Center 😿 😿 🥳 🆓 Apply
Details	
Options	Discharge = 1.8768
Properties Location Spread Criteria Elevations Junction Loss Discharge Options Computations	Spread Width from Gutter = 6.0289 Total Ponded Width = 6.0289 Ponded Depth = 0.2506 Spread Left Intercept = 0.0000 Spread Right Intercept = 6.0289 Grate Length = 3.0210 Grate Width = 1.8130 Grate Capacity = 1.4481 ByPass Flow = 0.4287 Efficiency = 0.7716

Don't be alarmed if your results are off by a few 100<sup>th</sup>'s. It could just be a tolerance issue.

**NOTE:** Upon review of the computations the **Spread Width from Gutter** is within our limit of 8.0 feet, therefore the inlet is in good position.

### 5.9 Design Inlet CB – 5

a) After a first iteration, it has been determined that an area drain needs to be installed behind the curb at Station 3+70.00, Offset 35.00' RT in order to catch flow that would otherwise enter the roadway and cause the roadway spread to exceed the allowable limit.

One way to determine the appropriate catch basin to be used is to review <u>TDOT</u> <u>Drainage Manual Chapter 7</u> Table 7-3 *Standard Inlet Types and Applications.* 

It has been determined that a CB#42 4X4 will be used. See Standard Drawing D-CB-42SB for details.

b) Properties > Change Profile to Sag and change Library Item to CB#42 4X4:

Node ID 4 CB-5	• •	Window Cente	" to o To	" <mark>ø</mark> 🚯 [	Apply
Details					
Options	Description:				
Properties	Node Type:	Grate	<b>–</b> –		
Location	Profile:	1000	-		
Spread Criteria					
Elevations	Library Item:	CB#42 4X4	<u> </u>		
Junction Loss					
Discharge Options					
Computations		None Available	-		

c) Location > All Reference information is defaulted from the previous Node such that only the +Angle, Station and the Offset needs to be changed:

Node ID 4 CB-5	🔹 🕨 📄 Window Center 📁 🖉 🥳 🦓 Apply
Details	
Options	Chain: CL    Profile: DESIGNCL
Properties	Coordinates / Stationing
Location	Align: Tangent to Chain  Align: Align
Spread Criteria Elevations	Station: 3+70.00 X: 2939.878
Junction Loss	V: 3160.625
Discharge Options Computations	Mirror Node Offset from Gutter to Inlet: 0.000

**NOTE:** Since CB-5 is an area drain, it does not matter if the angle is 0 or 180, even though it is on the right side of the roadway.

d) Spread Criteria > For an inlet in a sag, we must specify certain spread criteria for each side of an inlet.

**% Slope Left:** <u>1.00 % (From DTM Tools>Analysis>Height/Slope)</u>

% Slope Right: <u>1.00 % (From DTM Tools>Analysis>Height/Slope)</u>

% Discharge Left: <u>98.00%</u> (Estimated based on placement within drainage area)

% Discharge Right: 2.00% (Leftover area)

**NOTE:** Left and Right should be defined based on an inlet at angle = 0.

In other words:

Left of inlet is Viewed Left for all inlets at angles <90 and >270.

Right of inlet is Viewed Right for all inlets at angles <90 and >270.

Left of inlet is Viewed Right for all inlets at angles >90 and <270.

Right of inlet is Viewed Left for all inlets at angels >90 and <270.

Node ID 4 CB-5	•		Vindow Cer lighlight	nter 😿	e a' a &	Apply
Details						
Options		Slope Left:	1.000	Right:		
Properties Location	Spread Cro	charge Left: oss Section: urce: Refere			2.000	
Spread Criteria	Spread So	urce: [Heren	ence surra	ce 🔻	1011-001	
Elevations	Width	% Slope	Roughne	es 🔺	Maximum	144
Junction Loss	2.287	-1.580	0.016	E	Pond Depth:	0.500
Discharge Options	0.063	-6.265	0.016			
Computations	0.005	-6.265	0.016	-	Pond Width:	8.000
	0.000	0.000	0.000	10.00		

e) Elevations > Elevation Data must be changed to match a CB#42. From the <u>TDOT</u> <u>GEOPAK Drainage Nodes</u> Document set the following:

> Vertical Alignment: Min. Fixed Drop, 0.17 Minimum Depth: 2.30 feet (See note at top of page 5-7) Maximum Depth: 28.00 feet

Node ID 4 CB-5	• •	Window Center	🖌 🍺 🍘 🚺 🗛
Details			
Options	Reference Surface:	TIN File   final.tin	٩
Properties Location Spread Criteria	Elevation Source: Node Elevation Option:		) 001.007
Elevations	Vertical Alignment:	Min. Fixed Drop 🗸	0.170
Junction Loss Discharge Options	Minimum Depth:	2.300	
Computations	Maximum Depth:	28.000	
	Add Sump Depth:	0.000	

f) Click the Apply button to include this node in the Drainage Project.

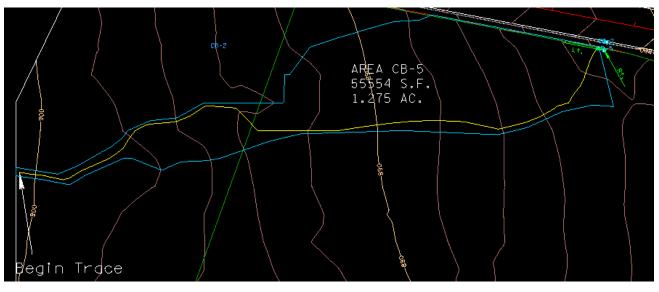
### Catch Basins - Outlet Only:

Drop Across Bottom of Structure + Min. Depth of Cover = Minimum Depth

**CB#42 4x4:** 0.17' + 2.13' = 2.30'

## 5.10 Delineate Drainage Area CB – 5

- a) From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-5** should automatically appear, click **OK**.
- b) Follow the steps in Exercise 3.2 to delineate and define the drainage area for Catch Basin 5. (You may use the following images as reference points. It is ok if your numbers do not match exactly.) Attach reference file DA\_CB-5 and turn off DA\_CB-4.



Delineate Drainage Area:

c) Define Drainage Area:

🦊 Drainage Area D	efinition		- • •
Area ID: 4 CB-5	• • [	] Window Center ] Highlight	🔏 🖓 🗛 Apply
Details	_		
Options	Description:	To Node I	D: CB-5 🦓
Definition Subareas Computation	Drainage Area: 1.275 Base C Value: 0.350 Time of Conc.: 5.000	Area Selection / Creation Select Shape	Create DTM Shape
Hydro. Method	Compute TC	Pick Boundary Elements	DP Create Shape

d) Calculate Time of Concentration:

	Details					
Drainage Area ID: CB-5	Distance	Slope	Avg. Slope	Flow	*	
TIN File  final.tin Q	14.05	2.84	2.84	Sheet		
	14.02	2.96	2.90	Sheet	Ξ	7
Define Path	25.20	1.49	2.23	Sheet		
Trace (1) ID - Segments	7.76	2.69	2.29	Sheet		
	16.60	1.50	2.12	Sheet		
Sheet Flow	36.26	0.98	1.76	Sheet		>
Method: FHA  Length: 300.000	12.23	1.09	1.69	Sheet		6
	8.66	2.04	1.72	Sheet		1
Value: 0.400 Slope: 2.247	14.92	1.51	1.70	Sheet		
Challen Dam	10.36	3.16	1.79	Sheet		
Shallow Flow	13.31	2.25	1.83	Sheet		
Length: 100.000	6.21	1.29	1.81	Sheet		
Inter. K: 0.491 Slope: 2.205	22.86	4.13	2.07	Sheet		
	9.38	4.49	2.18	Sheet	+	
Concentrated How	Distance:	Slope	a:			
Method: Continuity Length: 387.326	14.050	2.84		Adjust Flo	w	
Velocity: 5.000	14.000	2.04				
	Max Sh	neet Flow	Distance	300.000		
Accum, Distance: 787.326			Distance.		5)	
4	max sha	now Flow	Distance.	100.000		
Accum, Avg. Slope: 2.431						

The calculated Time of Concentration is **GREATER** than the minimum of 5 minutes; therefore the Time of Concentration will automatically be filled in after hitting Apply with NO further steps required.

The maximum length for sheet flow and shallow flow has changed and will vary depending upon the drainage area. For this area, **set Max. Sheet Flow to 300** and Max. Shallow Flow to 100.

e) Delineate Subareas utilizing the Land Use DGN:

🦊 Drainage Area Su	ibareas						
Area ID: 4 CB-5		• •	] Window Center ] Highlight	9 <del>2</del> 9	8	۹	Apply
Details							
Options			То	Node	ID: C	:B-5	l <sub>pd</sub>
Definition	Subarea	C Value	Description				
Subareas	1.0267	0.300	Forested Areas				tomatic ineation
Computation					を	Del	ineation
					Ð	V D	isplay Only
Hydro. Method					X		
Rational							
SCS							
0 303	1.027	0.300	Forested Areas				

#### f) Compute Discharge and Apply:

🦊 Drainage Area Co	omputations			
Area ID: 4 CB-5	• •	Window Center	摘 🔏	🖄 🐴 🛛 Apply
Details				
Options		Area	C Value	Compute
Definition Subareas	Total Subareas:	1.027	0.300	Discharge
Computation	Remainder:	0.249	0.350	
Hydro. Method	Composite:	1.275	0.310	
Rational	Computed Intensity:	3.245		
SCS	Computed Discharge:	1.282		

**g)** Back in the **Node Configuration** dialog box click on **Properties**, then click again on **Computations**. This allows the program to update and run calculations. Review the Computations.

Node ID 4 CB-5	▼ Window Center → Highlight →	o 🏂 😼 🐔 🗛 Apply
Details		
Options	Discharge = 1.2820	A
Properties Location Spread Criteria Elevations Junction Loss Discharge Options Computations	Total Ponded Width = 3.0729 Ponded Width Left = 3.8796 Ponded Width Right = 1.5144 Ponded Depth Left = 0.2126 Ponded Depth Right = 0.0635 Grate Area = 3.6000 Area Reduction = 0.5000 Grate Perimeter = 7.6000 Perimeter Reduction = 0.0000 Grate Capacity = 6.8407	

Don't be alarmed if your results are off by a few 100<sup>th</sup>'s. It could just be a tolerance issue.

**NOTE:** Upon review of the computations the **Spread Width from Gutter** is within our limit of 8.0 feet, therefore the inlet is in good position.

### 5.11 Design Inlet CB – 6

 a) Select from the Main Menu Bar: Component > Node > Add; or from the Main Toolbar: Add Drainage Node; or click the Add Node button within the Node Configuration Dialog. Click OK to set the name CB-6

Properties > Change the Node Properties back to On Grade and to a CB#12 4X3:

Node ID 4 CB-6	• •	Window Cer	nter 😿 ø	<b>*</b> # *#	Apply
Details					
Options	Description:				
Properties	Node Type:	Grate	•		1
Location		On Grade	-		
Spread Criteria					
Elevations	Library Item:	CB#124X3	-		
Junction Loss	By Pass to Node:		TO I		
Discharge Options	Max By Pass:	0.000			
Computations	Node Bottom:	None Available	•		
	Override Librar	v Pavitem:			Align

b) Location > All Reference information is defaulted from the previous Node (CB-5) such that only the + Angle, Station and the Offset needs to be changed. Discussion for the reason this station was chosen is presented in Step 2 of 5.11.:

Node ID ┥ CB-6	🗾 🔹 🖡 Window Center 👘 🖉 🎢 🖓 Apply
Details	
Options	Chain: CL
Properties	Coordinates / Stationing
Location	Align: Tangent to Chain
Spread Criteria Elevations	Station: 9+30.00 + X: 3501.362
Junction Loss	✓ Offset: -26.000 Y: 3115.285
Discharge Options Computations	Mirror Node Offset from Gutter to Inlet: 0.000

**NOTE:** The **Spread Criteria** defaults back automatically when the node is changed back to **ON GRADE**, therefore no changes are necessary.

**c)** Elevations > Be sure to change the elevation data back to that which is required for a Type 12 catch basin.

Node ID 4 CB-6	<b>•</b> •	Window Center	🏂 😼 🍓 🛛 Apply
Details			
Options	Reference Surface:	TIN File	٩
Properties	Elevation Source:	Reference TIN	868.548
Location Spread Criteria	Node Elevation Option:	Same as Source	868.548
Elevations	Vertical Alignment:	Min Fixed Drop	0.170
Junction Loss	Minimum Depth:		
Discharge Options Computations	Maximum Depth:	20.000	
1	Add Sump Depth:	0.000	

d) Click the Apply button to include this node in the Drainage Project.

### Catch Basins – Inlet and Outlet:

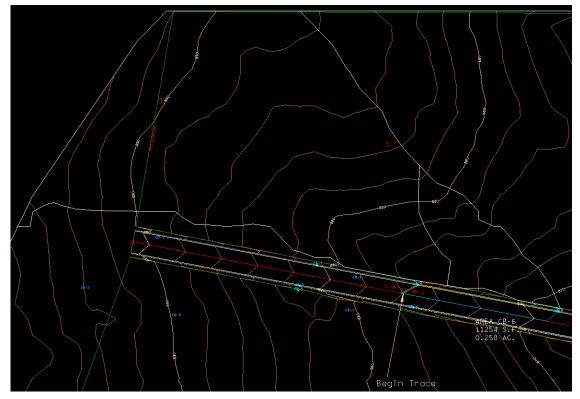
Min. Depth of Basin – Pipe Size – Drop Across Bottom of Structure = Minimum Depth

**CB#12 4x3:** 3.88' - 18"/12 - .17' = 2.21'

## 5.12 Delineate Drainage Area CB – 6

- a) From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-6** should automatically appear, click **OK**.
- b) Follow the steps in Exercise 3.2 to delineate and define the drainage area for Catch Basin 6. (You may use the following images as reference points. It is ok if your numbers do not match exactly.) Attach reference file DA\_CB-6 and turn off DA\_CB-5.

Delineate Drainage Area:



**NOTE:** Upon inspection of the entire drainage area, it has been determined that area drains need to be installed to collect runoff before it enters the roadway. The white area shapes show the area to be collected by these drains which will be input in subsequent exercises.

c) Define Drainage Area:

Area ID: 4 CB-6	5 <b>•</b> • [	] Window Center ] Highlight	) 🔏 👸 🛛 Apply
Details			
Options	Description:	To Node	ID: CB-6 🏻 🏂
Definition	Drainage Area: 0.257	Area Selection / Crea	
Computation Base C Value:	Base C Value: 0.350 Time of Conc.: 5.000	Select Shape	Create DTM Shape
Hydro. Method Rational SCS	Compute TC	Pick Boundary Elements	DP Create Shape

d) Calculate Time of Concentration:

	Details				
Drainage Area ID: CB-6	Distance	Slope	Avg. Slope	Flow	~
TIN File  final.tin Q	1.15	3.21	3.21	Sheet	=
	3.81	3.21	3.21	Sheet	=
Define Path	2.58	3.21	3.21	Sheet	
Trace (I) ID - Segments	2.22	3.21	3.21	Sheet	
	4.17	3.21	3.21	Sheet	
Sheet Flow	0.63	3.21	3.21	Sheet	
Method: FHA  Length: 20.000	1.91	3.21	3.21	Sheet	
	2.89	3.21	3.21	Sheet	
Value 0.012 Slope: 3.213	0.96	3.21	3.21	Conc	
Shallow Flow	1.91	3.21	3.21	Conc	
Length: 0.000	4.48	3.21	3.21	Conc	
	2.25	3.21	3.21	Conc	
Inter. K: 0.491 Slope: 0.000	4.14	3.21	3.21	Conc	
	0.66	3.21	3.21	Conc	Ψ.
Concentrated Flow	Distance:	Slope	e: _		
Method: Continuity Length: 325.164	1.150	3.21	0	Adjust Flo	w
Velocity: 5.000	1.100	0.2		-	_
	Max S	neet Flow	Distance/	20.000	
Accum, Distance: 345,164	Max Sha	low Flow	Distance.	0.000	<b>i</b> )
<	Max on a		Distance.	0.000	/
Accum. Avg. Slope: 2.147					

The calculated Time of Concentration is less than the minimum of 5 minutes, therefore <u>5 must be manually typed</u> in the Drainage Area Definition dialog <u>after</u> hitting apply in the Time of Concentration Window.

Since the flow appears to go directly from sheet to concentrated flow we unchecked shallow flow. For this area, **set Max Sheet Flow to 20**. Also note that the **n Value changes to 0.012** (Asphalt).

e) Delineate Subareas utilizing the Land Use DGN:

📕 Drainage Area Su	ibareas				- • •
Area ID: 4 CB-6		• •	Window Center 🐁 🔞	8	Apply
Details					
Options			To Node	ID: C	:В-6 💋
Definition	Subarea	C Value	Description		
Subareas	0.1877	0.900	Conc/Asphalt Pvmt	1	Automatic Delineation
Computation	0.0136	0.300	Forested Areas	1	Deineation
					Display Only
Hydro. Method				$\times$	
Rational				$  \frown  $	
SCS					
0 000	0.014	0.300	Forested Areas		

#### f) Compute Discharge and Apply:

📕 Drainage Area Co	omputations				
Area ID: 4 CB-6	•	Window Center	10 10 1	8 8	Apply
Details					
Options		Area	C Value	Con	npute
Definition Subareas	Total Subareas:	0.201	0.859		harge
Computation	Remainder:	0.056	0.350		
Hydro. Method -	Composite:	0.257	0.749		
Rational	Computed Intensity:	6.980			
SCS	Computed Discharge:	1.343			

**g)** Back in the **Node Configuration** dialog box click on **Properties**, then click again on **Computations**. This allows the program to update and run calculations. Review the Computations.

📕 Node Configuration	- Computations	
Node ID 4 CB-6	Window Center     Highlight	to t
Details		
Options	Discharge = 1.3432	
Properties Location Spread Criteria Elevations Junction Loss Discharge Options Computations	Spread Width from Gutter = 5.5181 Total Ponded Width = 5.5181 Ponded Depth = 0.2404 Spread Left Intercept = 0.0000 Spread Right Intercept = 5.5181 Grate Length = 3.0210 Grate Width = 1.8130 Grate Capacity = 1.1155 ByPass Flow = 0.2277 Efficiency = 0.8305	

Don't be alarmed if your results are off by a few 100<sup>th</sup>'s. It could just be a tolerance issue.

**NOTE:** Upon review of the computations the **Spread Width from Gutter** is within our limit of 8.0 feet, therefore the inlet is in good position.

## 5.13 Design Inlet CB – 7

It has been determined that a CB#43 8X4 will be used.

See Standard Drawing D-CB-43SB for details.

 a) Select from the Main Menu Bar: Component > Node > Add; or from the Main Toolbar: Add Drainage Node; or click the Add Node button within the Node Configuration Dialog. Click OK to set the name CB-7

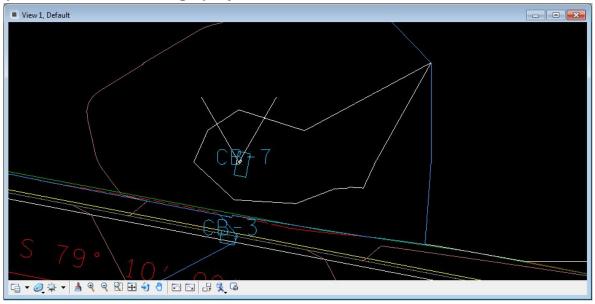
**Properties >** Change the Node **Properties** to **Sag** and to a **CB#43 8X4** (a type #43 catch basin was chosen due to the fact that this will collect a significant amount of water not on the roadway):

Node ID 4 CB-7		Window Cent	er 🗑 🝺 🏂	1 😼 🚳 (	Apply
Details					
Options	Description:				
Properties	Node Type:	Grate	<b>→</b> r		
Location	Profile:		-		
Spread Criteria	Library Item:	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	<b>-</b>		
Elevations Junction Loss	boldiy itom.	00110 0/4			
Discharge Options					
Computations	Node Battom:	None Available	-		
	Those bollom.	Inone Available		market and	Align

b) Location > All Reference information is defaulted from the previous Node (CB-6) such that only the + Angle, Station and the Offset needs to be changed. Pay special attention to the placement and rotation of this catch basin. It has been rotated to intercept as much runoff as possible:

Node ID 4 CB-7	🔹 🕨 Window Center 📁 😿 🏂 🎲 Apply
Details	
Options	Chain: CL    Profile: DESIGNCL
Properties	Coordinates / Stationing
Location	Align: Tangent to Chain  Align: Tangent to Chain  Align: Tangent to Chain
Spread Criteria	
Elevations	Station: 6+20.00 X: 3201.398
Junction Loss	V Offset: -50.000 Y: 3197.122
Discharge Options Computations	Mirror Node Offset from Gutter to Inlet: 0.000

**NOTE:** The following image shows why this location was chosen for CB-7. Upon inspection of the TIN File, utilizing the DTM Drainage Tools discussed in Chapter 3, a ponded area was discovered at this location. CB-7 was set at the low point of the ponded area. To simplify the design and minimize land disturbance, CB-3 and CB-4 were set at the same station. **The iterative steps required for this determination were not shown in this manual, but would be required in an actual design project.** 



c) Spread Criteria > Enter the Spread Criteria as shown below.

% Slope Left: <u>5.00 % (From DTM Tools>Analysis>Height/Slope)</u>

% Slope Right: 3.50 % (From DTM Tools>Analysis>Height/Slope)

% Discharge Left: <u>10.00% (Estimated based on placement within drainage area)</u>
% Discharge Right: <u>90.00% (Leftover area)</u>

**NOTE:** Left and Right are defined by a node at angle 0. To gain your bearing, remember this node has been rotated 270 degrees or 90 degrees clockwise.

Node ID 🖣 CB-7			Vindow Cent ligh <mark>light</mark>	ter 埦	ø <b>%</b> "ø &	Apply
Details					La seconda da	
Options	] '	Slope Left:	5.000	Right:	3.500	
Properties Location	Spread Cro	oss Section:	10.000	Right:	90.000	
Spread Criteria	Spread So	urce: Refer	ence Surrac	e 🔻		
Elevations	Width	% Slope	Roughne		Maximum	
Junction Loss	0.088	2.685	0.016		Pond Depth:	0.500
Discharge Options	0.181	4.897	0.016			
Computations	0.103	4.897	0.016	-	Pond Width:	8.000

d) Elevations > Elevation Data must be changed to match a CB#43 8x4. From the <u>TDOT</u> <u>GEOPAK Drainage Nodes</u> Document set the following:

> Vertical Alignment: Min. Fixed Drop, 0.33 Minimum Depth: 2.38 feet (See note at top of page 5-7) Maximum Depth: 20.00 feet

Node ID 4 CB-7	<b>•</b> •	Window Center	ya 🕼 🚯 🚺
Details			
Options	Reference Surface:	TIN File 🔹 final.tin	٩
Properties Location Spread Criteria	Elevation Source: Node Elevation Option:		2 0
Elevations	Vertical Alignment:	Min, Fixed Drop	0.330
Junction Loss Discharge Options Computations	Minimum Depth: Maximum Depth:	2.380	
computations	Add Sump Depth:		

e) Click the Apply button to include this node in the Drainage Project.

Catch Basins - Outlet Only:

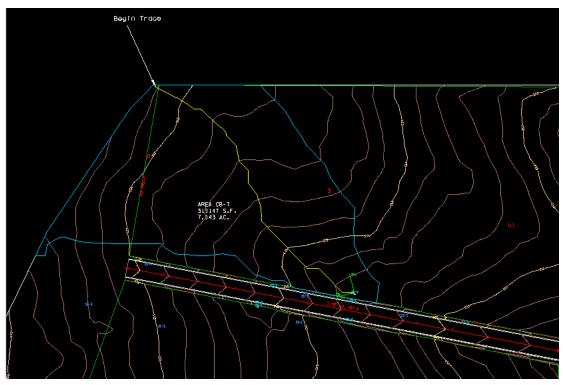
Drop Across Bottom of Structure + Min. Depth of Cover = Minimum Depth

**CB#43 8x4**: .33' + 2.05' = 2.38'

NOTE: See Appendix A, pg. A-4

## 5.14 Delineate Drainage Area CB – 7

- a) From the Node Configuration dialog select Edit Area. When asked if you want to create a new drainage area click Yes. The name CB-7 should automatically appear, click OK.
- b) Follow the steps in Exercise 3.2 to delineate and define the drainage area for Catch Basin 7. (You may use the following images as reference points. It is ok if your numbers do not match exactly.) Attach reference file DA\_CB-7 and turn off DA\_CB-6.



Delineate Drainage Area:

**NOTE:** As discussed in Exercise 5.12 *Delineate Drainage Area CB-6* this area will catch a large amount of runoff prior to it entering the roadway.

c) Define Drainage Area:

ዞ Drainage Area D	efinition		- • •
Area ID:		Vindow Center 🔬 🔕 fighlight	🔏 👸 🗛 Apply
Details			
Options	Description:	To Node	ID: CB-7 🦓
Definition Subareas Computation	Drainage Area: 7.143 Base C Value: 0.350 Time of Conc.: 5.000	Area Selection / Creati Select Shape	Create DTM Shape
Hydro. Method Rational SCS	Compute TC	Pick Boundary Elements	DP Create Shape

d) Calculate Time of Concentration:

28.87       2.86       2.86       Sheet         Trace       ID       ID - Segments       28.87       2.86       2.86       Sheet         V Sheet Row       ID - Segments       7.77       2.53       2.74       Sheet         V Sheet Row       Length:       300.000       32.34       2.42       2.63       Sheet         Value:       0.400       Slope:       1.959       2.12       2.56       Sheet         Value:       0.400       Slope:       1.959       2.53       2.44       Sheet         Value:       1.959       0.25       2.53       2.44       Sheet         Value:       1.00.000       37.65       1.33       2.11       Sheet	1	Details				
Define Path         Trace       ID         Sheet Row         Method:       FHA         Length:       300.000         Value:       0.400         Slope:       1.959         Shallow Flow       Length:         Length:       100.000         Netrod:       FHA         Length:       100.000         Shallow Flow       Length:         Concentrated How         Method:       Continuity         Length:       437.279         Distance:       Slope:         0.670       2.810	Drainage Area ID: CB-7	Distance	Slope	Avg. Slope	Flow	
Define Path       28.43       2.67       2.77       Sheet         Trace       ID - Segments       7.77       2.53       2.74       Sheet         Sheet Row       Length: 300.000       32.34       2.42       2.63       Sheet         Value:       0.400       Slope:       1.959       2.53       2.44       Sheet         Value:       0.400       Slope:       1.959       2.53       2.44       Sheet         Value:       0.400       Slope:       1.959       2.53       2.44       Sheet         Value:       0.400       Slope:       1.537       1.58       2.27       Sheet         Value:       0.491       Slope:       1.537       10.29       0.95       2.06       Sheet         Vocconcentrated How       Length:       437.279       0.670       2.810       Adjust Flow	TIN File  final.tin Q	0.67	2.81	2.81	Sheet	
Trace       ()       ID - Segments       7.77       2.53       2.74       Sheet         ✓ Sheet Row		28.87	2.86	2.86	Sheet	
Image: Sheet How       Length: 300.000         Value: 0.400       Slope: 1.959         Shallow Flow       Length: 100.000         Image: Shallow Flow       Length: 100.000	Define Path	28.43	2.67	2.77	Sheet	Ξ
Sheet How         Method:       FHA         Length:       300.000         Value:       0.400         Slope:       1.959         Anallow Flow       Length:         Length:       100.000         Method:       Concentrated How         Length:       100.000         Method:       Concentrated How         Length:       437.279         Distance:       Slope:         0.670       2.810	Trace (1) ID - Segments	7.77	2.53	2.74	Sheet	
Value:       0.400       Slope:       1.959         Value:       0.400       Slope:       1.537         Value:       0.491       Slope:       1.537         Value:       Concentrated How       Value:       Value:         Vethod:       Continuity       Length:       437.279         Value:       0.670       2.810       Adjust Flow		5.13	2.57	2.73	Sheet	
Method:       FHA       Length:       300.000         Value:       0.400       Slope:       1.959         Value:       0.400       Slope:       1.959         Shallow Flow       Length:       100.000         nter. K:       0.491       Slope:       1.537         Concentrated Flow       Length:       437.279         Distance:       Slope:       Slope:         0.670       2.810       Adjust Flow	Sheet Flow	32.34	2.42	2.63	Sheet	
Value:       0.400       Slope:       1.959         Value:       0.400       Slope:       1.959         Shallow Row       Length:       100.000         Inter. K:       0.491       Slope:       1.537         Concentrated How       Slope:       1.537         Image: Continuity The Length:       437.279         Distance:       Slope:         0.670       2.810		17.99	2.12	2.56	Sheet	
Y Shallow Flow       Length: 100.000         At the structure       At the structure		17.83	1.68	2.44	Sheet	
Shallow Flow         Length:         100.000           Inter. K:         0.491         Slope:         1.537           Concentrated How         Image: Slope:         1.537           Concentrated How         Length:         437.279           Distance:         Slope:           0.670         2.810	Value: 0.400 Slope: 1.959	0.25	2.53	2.44	Sheet	
Length:         100.000           nter. K:         0.491           Slope:         1.537           ✓         Concentrated How           Method:         Continuity ▼           Length:         437.279           0.670         2.810		43.26	1.78	2.29	Sheet	
Inter. K:         0.491         Slope:         1.537         2.11         Sheet           Image: Ope interval of the state of the s	and a second sec	4.76	1.58	2.27	Sheet	
✓ Concentrated How         6.50         1.91         2.06         Sheet         ▼           Ø Concentrated How         Distance:         Slope:         0.670         2.810         Adjust Flow	Length: 100.000	37.65	1.33	2.11	Sheet	
✓ Concentrated How         Distance:         Slope:           Method:         Continuity ▼         Length:         437.279         0.670         2.810         Adjust Flow	nter. K: 0.491 Slope: 1.537	10.29	0.95	2.06	Sheet	
Method: Continuity  Length: 437.279 Distance: Slope: 0.670 2.810 Adjust Flow		6.50	1.91	2.06	Sheet	-
0.6/0 2.810 Aujust now	Terrard States and States an	Distance:	Slope	e:		
	Method: Continuity  Length: 437.279	0.670	28	10	Adjust Flo	w
	Velocity: 5.000	0.070	2.0			_
	Acour Distance: 027 270					Ŧ.
Max Sheet Flow Distance: 300.000	<	Max Sha	NOW FIOW	Distance.	100.000	_
Accum. Distance: 837.279 Max Shallow Flow Distance: 100.000	Accum. Avg. Slope: 2.162					

The calculated Time of Concentration is **GREATER** than the minimum of 5 minutes; therefore the Time of Concentration will automatically be filled in after hitting Apply with NO further steps required.

**NOTE:** The maximum length for sheet flow has changed and will vary depending upon the drainage area. For this area, the **Max Sheet Flow changes to 300 and the Max Shallow Flow changes to 100**. The **n Value for Sheet Flow** changes back to **0.400** 

e) Delineate Subareas utilizing the Land Use DGN:

🕻 Drainage Area Su	ubareas					
Area ID:  CB-7		• •	] Window Center ] Highlight	6	8	Apply
Details						
Options			To I	Node IE	): C	:B-7 🛛 🖧
Definition	Subarea	C Value	Description			
Subareas	5.7452	0.300	Forested Areas			Automatic
Computation		0.000			2	Delineation
					П,	Display Only
Hydro. Method -					_	Pispidy only
Rational					$\times$	
0						
SCS	5.745	0.300	Forested Areas			
	3.743	0.000	Toroacou Areas			

f) Compute Discharge and Apply:

📕 Drainage Area Co	omputations			
Area ID:	•	Window Center	🖄 🖄	🔏 🖓 🗛 Apply
Details				
Options		Area	C Value	Compute
Definition Subareas	Total Subareas:	5.745	0.300	Compute Discharge
Computation	Remainder:	1.398	0.350	
Hydro. Method -	Composite:	7.143	0.310	
Rational	Computed Intensity:	3.166		
© SCS	Computed Discharge:	7.006		

g) Back in the Node Configuration dialog box click on Properties, then click again on Computations. This allows the program to update and run calculations. Review the Computations.

Node ID 4 CB-7	► Window Center yor yor yor yor yor yor yor yor yor yo	🎢 🕼 🚯 Apply
Details		
Options	Total Ponded Width = 5.7866	A
Properties Location Spread Criteria Elevations Junction Loss Discharge Options	Ponded Width Left = 2.6732 Ponded Width Right = 6.5055 Ponded Depth Left = 0.1290 Ponded Depth Right = 0.3167 Grate Area = 7.2000 Area Reduction = 0.5000 Grate Perimeter = 15.2000 Perimeter Reduction = 0.0000	E
Computations	Grate Capacity = 13.6814 Computed Head = 0.2815	

Don't be alarmed if your results are off by a few 100<sup>th</sup>'s. It could just be a tolerance issue.

**NOTE:** Review the Computed Data. Items to review specifically are:

Total Ponded Width, Grate Capacity compared with Computed Discharge and Computed Head

## 5.15 Design Inlet CB – 8

It has been determined that a **CB#42 4X4** will be used. See Standard Drawing D-CB-42SB for details.

 a) Select from the Main Menu Bar: Component > Node > Add; or from the Main Toolbar: Add Drainage Node; or click the Add Node button within the Node Configuration Dialog. Click OK to set the name CB-8

Properties > Change the Node Properties to Sag and to a CB#42 4X4:

Node ID 4 CB-8	• •	Window Cen	ter 🙍 ø 🤇	<b>e</b> a a	Apply
Details					
Options	Description:				
Properties	Node Type:	Grate	•		
Location	Profile:		-		
Spread Criteria Elevations	Library Item:	Second Section 1997	<b>•</b>		
Junction Loss	20rdiy nom.				
Discharge Options					
Computations	Nada Dattana	Nege Augilable			
	Node Bottom:	None Available	•		Align
	Node Bottom:           Override Librar		<b>*</b>		

**b)** Location > All Reference information is defaulted from the previous Node (CB-7) such that only the **+** Angle, Station and the Offset needs to be changed:

Node ID 4 CB-8	🗾 🕨 Window Center 📁 🖉 🥳 🎢 Apply
Details	
Options	Chain: CL
Properties	Coordinates / Stationing
Location	Align: Tangent to Chain  Align: Tangent to Cha
Spread Criteria	
Elevations	Station: 9+30.00 X: 3503.054
Junction Loss	V Offset: -35.000 Y: 3124.124
Discharge Options Computations	Mirror Node Offset from Gutter to Inlet: 0.000

c) Spread Criteria > Enter the Spread Criteria as shown below.

% Slope Left: <u>1.00 % (From DTM Tools>Analysis>Height/Slope)</u>

% Slope Right: <u>1.00 % (From DTM Tools>Analysis>Height/Slope)</u>

- % Discharge Left: 2.00% (Estimated based on placement within drainage area)
- % Discharge Right: <u>98.00% (Leftover area)</u>

**NOTE:** Left and Right are defined by a node at angle 0.

📕 Node Configuratio	n - Optional Sprea	ad Criteria f	or Sags	
Node ID	-	Wind	ow Center ght	19 'by 'by 'by 'by 'by 'by' by'
Details				
Options		e Left: 1.0		Right: 1.000
Properties Location	Spread Cross S			kight: 98.000
Spread Criteria	Spread Source:	Reference	Surface	<b>▼</b>
Elevations	Width %	Slope R	oughne: 🔺	Maximum
Junction Loss	0.005 -	1.976 0	.016 🗐	Pond Depth: 0.500
Discharge Options	1.127 -	1.976 0	.016	
Computations	0.175 🗟	3.080 0	.016 🔻	Pond Width: 8.000
	0.000 0.	000 0.	000	

d) Elevations > Elevation Data must be changed to match a CB#42 4X4. From the <u>TDOT</u> <u>GEOPAK Drainage Nodes</u> Document set the following:

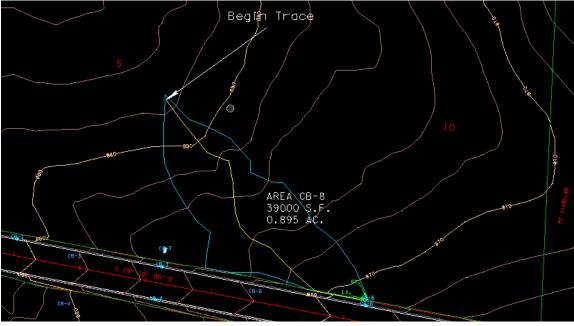
Node ID ┥ CB-8	• •	Window Center Highlight	ø yø	" 🍺 🚳 [	Apply
Details					
Options	Reference Surface:	TIN File	al.tin		Q
Properties Location Spread Criteria	Elevation Source: Node Elevation Option:		•	869.188 869.188	
Elevations	Vertical Alignment:	Min Fixed Drop	•	0.170	
Junction Loss Discharge Options	Minimum Depth:	2.300			
Computations	Maximum Depth:	28.000			
	Add Sump Depth:	0.000			

e) Click the Apply button to include this node in the Drainage Project.

**CB#42 4x4:** 0.17' + 2.13' = 2.30'

## 5.16 Delineate Drainage Area CB – 8

- a) From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-8** should automatically appear, click **OK**.
- b) Follow the steps in Exercise 3.2 to delineate and define the drainage area for Catch Basin 8. (You may use the following images as reference points. It is ok if your numbers do not match exactly.) Attach reference file DA\_CB-8 and turn off DA\_CB-7.



Delineate Drainage Area:

**NOTE:** As discussed in Exercise 5.11 *Create Drainage Area CB-6* this area will catch runoff prior to it entering the roadway.

c) Define Drainage Area:

📕 Drainage Area D	efinition	- • •
Area ID: 4 CB-8		dow Center 🐴 🚵 🖄 🗛 Apply
Details		
Options	Description:	To Node ID: CB-8 🥠
Definition Subareas Computation Hydro. Method	Drainage Area: 0.895 Base C Value: 0.350 Time of Conc.: 5.000 Compute TC	Area Selection / Creation Select Create DTM Shape Pick Boundary DP Elements Create Shape

d) Calculate Time of Concentration:

	Details				
Drainage Area ID: CB-8	Distance	Slope	Avg. Slope	Flow	
TIN File ▼ final.tin Q	29.62	3.31	3.31	Sheet	
	19.65	3.14	3.24	Sheet	=
Define Path	23.08	3.23	3.24	Sheet	
Trace (I) ID - Segments	27.49	3.30	3.25	Sheet	
	30.96	6.73	4.08	Sheet	
Sheet Flow	3.47	6.27	4.13	Sheet	
Method: FHA  Length: 300.000	33.32	0.81	3.47	Sheet	
	6.67	3.52	3.47	Sheet	
Value: 0.400 Slope: 3.167	26.61	3.40	3.46	Sheet	
Challen Dan	9.73	3.70	3.47	Sheet	
Shallow Flow	24.67	3.17	3.44	Sheet	
Length: 100.000	22.27	1.43	3.27	Sheet	
nter. K: 0.491 Slope: 3.016	31.67	2.49	3.18	Sheet	
	4.83	2.33	3.17	Sheet	-
Concentrated How	Distance:	Slope	e:		
Method: Continuity Length: 62.295	29.620	3.3		Adjust Flo	w
Velocity: 5.000	23.020	5.5		-	
	Max Sh	neet Flow	Distance:	300.000	1
Accum Distance: 462.295					ĩ
<	Max Sha	NOW FIOW	Distance:	100.000	1
Accum, Avg. Slope: 2.907					

The calculated Time of Concentration is **GREATER** than the minimum of 5 minutes; therefore the Time of Concentration will automatically be filled in after hitting Apply with NO further steps required.

The maximum length for sheet flow has changed and will vary depending upon the drainage area. Keep Max Sheet Flow at 300 and Max Shallow Flow at 100.

e) Delineate Subareas utilizing the Land Use DGN:

🗸 Drainage Area Su	ıbareas				
Area ID: 4 CB-8		• •	] Window Center ] Highlight	<u>8</u>	Apply Apply
Details					
Options			To No	ode ID: (	св-8 💋
Definition	Subarea	C Value	Description		
Subareas Computation	0.8928	0.300	Forested Areas		Automatic Delineation
Hydro. Method					📝 Display Only
<ul> <li>Rational</li> </ul>				$ \times $	
SCS				_	
	0.893	0.300	Forested Areas		

#### f) Compute Discharge and Apply:

📕 Drainage Area Co	omputations			
Area ID: 4 CB-8	•	Window Center	ත ක	🔏 👌 🗛
Details				
Options		Area	C Value	Compute
Definition Subareas	Total Subareas:	0.893	0.300	Discharge
Computation	Remainder:	0.003	0.350	
Hydro. Method -	Composite:	0.895	0.300	
Rational	Computed Intensity:	3.500		
⊘ SCS	Computed Discharge:	0.941		

g) Back in the Node Configuration dialog box click on Properties, then click again on Computations. This allows the program to update and run calculations. Review the Computations.

Node ID 4 CB-8	🔹 🕨 🔲 Window Center 🐄 😿 🏂 📸 🗛 🗛 Apply
Details	
Options	Total Ponded Width = 4.1499
Properties Location Spread Criteria Elevations Junction Loss Discharge Options Computations	Ponded Width Left = 1.4442 Ponded Width Right = 4.5782 Ponded Depth Left = 0.0369 Ponded Depth Right = 0.1536 Grate Area = 3.6000 Area Reduction = 0.5000 Grate Perimeter = 7.6000 Perimeter Reduction = 0.0000
computations	Grate Capacity = 6.8407 Computed Head = 0.1171

Don't be alarmed if your results are off by a few 100<sup>th</sup>'s. It could just be a tolerance issue.

NOTE: Review the Computed Data. Items to review specifically are:

Total Ponded Width, Grate Capacity compared with Computed Discharge and Computed Head

### 5.17 Design Inlet CB – 9

It has been determined that another standard **CB#12 4X3** will be used.

See Standard Drawing D-CB-12S for details.

 a) Select from the Main Menu Bar: Component > Node > Add; or from the Main Toolbar: Add Drainage Node; or click the Add Node button within the Node Configuration Dialog. Click OK to set the name CB-9

Properties > Change the Node Properties to On Grade and to a CB#12 4X3:

Node ID 4 CB-9	• •	Window Ce	nter 🙍 🔊	' 🎢 👘 🖓	Apply
Details					
Options	Description:				
Properties	Node Type:	Grate	•		
Location		On Grade	-		
Spread Criteria Elevations	Library Item:		<b>_</b>		
Junction Loss	By Pass to Node:		াঁর্য		2
Discharge Options	Max By Pass:	0.000			
Computations	Node Bottom:	None Available	-		

b) Location > All Reference information is defaulted from the previous Node (CB-8) such that only the + Angle, Station and the Offset needs to be changed. The reasoning for the location of CB-9 will be given in the drainage area discussion:

Node ID 4 CB-9	🗾 🕨 Window Center 📁 🖉 🖉 🦌 Apply
Details	
Options	Chain: CL
Properties	Coordinates / Stationing
Location	Align: Tangent to Chain  Align: Align
Spread Criteria	
Elevations	Station: 8+00.00 X: 3363.906
Junction Loss	V Offset: 26.000 Y: 3088.645
Discharge Options Computations	Mirror Node Offset from Gutter to Inlet: 0.000

**NOTE:** The **Spread Criteria** defaults back automatically when the node is changed back to **ON GRADE**, therefore no changes are necessary.

c) Elevations > Elevation Data must be changed to match a CB#12 4X3. From the <u>TDOT</u> <u>GEOPAK Drainage Nodes</u> Document set the following:

Node ID 4 CB-9	• •	Window Center	🏂 🍺 🍓 🚺 🗛
Details			
Options	Reference Surface:	TIN File	Q
Properties Location Spread Criteria	Elevation Source: Node Elevation Option:	and the second	5 0/0./00
Elevations	Vertical Alignment:	Min, Fixed Drop	0.170
Junction Loss Discharge Options Computations	Minimum Depth: Maximum Depth:	2.210	
	Add Sump Depth:	0.000	

d) Click the Apply button to include this node in the Drainage Project.

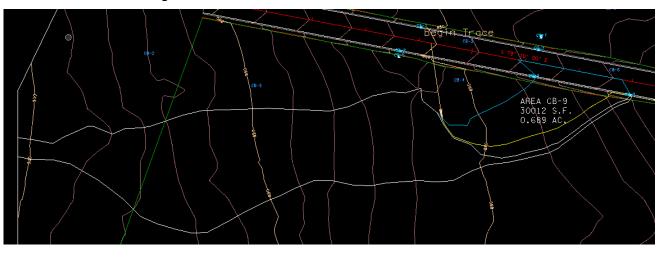
#### Catch Basins – Inlet and Outlet:

Min. Depth of Basin – Pipe Size – Drop Across Bottom of Structure = Minimum Depth

**CB#12 4x3:** 3.88' - 18"/12 - 0.17' = 2.21'

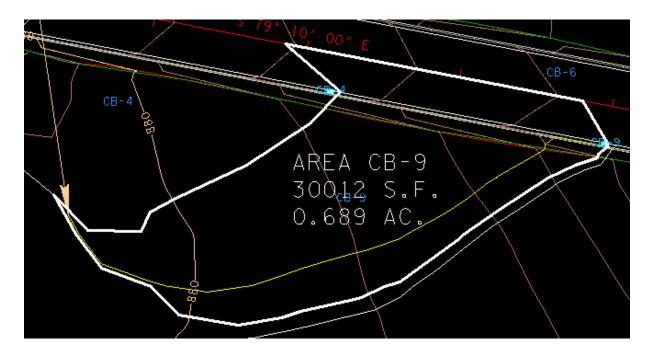
## 5.18 Delineate Drainage Area CB – 9

- a) From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-9** should automatically appear, click **OK**.
- b) Follow the steps in Exercise 3.2 to delineate and define the drainage area for Catch Basin 9. (You may use the following images as reference points. It is ok if your numbers do not match exactly.) Attach reference file DA\_CB-9 and turn off DA\_CB-8.



Delineate Drainage Area:

**NOTE:** Many iterations and much investigation went into developing the placement of the next few catch basins. The whole of the drainage area if one were to set CB-9 at the same station as CB-6 & CB-8 is delineated by CB-9 Area <u>and</u> the white drainage area. These were divided to keep the roadway spread within the required limits. The large portion of the drainage area and the odd shape will be discussed in Exercise 5.19.



#### c) Define Drainage Area:

ዞ Drainage Area D	efinition		
Area ID:	<b>T</b>	Window Center 🔬 🥻	) 🆄 🐴 🛛 Apply
Details			
Options	Description:	To Node	ID: CB-9 🦓
Definition Subareas Computation	Drainage Area: 0.689 Base C Value: 0.350 Time of Conc.: 5.000	Area Selection / Crea Select Shape	Create DTM Shape
Hydro. Method Rational SCS	Compute TC	Pick Boundary Elements	DP Create Shape

d) Calculate Time of Concentration:

()	Details				
Drainage Area ID: CB-9	Distance	Slope	Avg. Slope	Flow	
TIN File  final.tin Q	13.91	0.73	0.73	Sheet	
	23.59	0.59	0.64	Sheet	=
Define Path	29.77	1.37	0.96	Sheet	
Trace (I) ID - Segments	4.32	1.39	0.99	Sheet	
	10.42	1.64	1.07	Sheet	
Sheet Flow	22.27	1.59	1.18	Sheet	
Method: FHA  Length: 300.000	3.77	1.18	1.18	Sheet	
	26.97	1.65	1.28	Sheet	
n Value: 0.400 Slope: 1.779	1.61	1.64	1.28	Sheet	
Shallow Flow	0.06	2.20	1.28	Sheet	
	25.49	1.69	1.34	Sheet	
	8.43	1.81	1.37	Sheet	
Inter. K: 0.491 Slope: 5.593	17.26	2.17	1.44	Sheet	
	16.16	2.11	1.49	Sheet	*
Concentrated How Method: Continuity Length: 0.000	Distance:	Slope	e: _		_
	13,910	0.73	30	Adjust Flo	w
Velocity: 5.000 Accum. Distance: 390.708 Accum. Avg. Slope: 2.664		llow Flow	Distance:	300.000	]

The calculated Time of Concentration is **GREATER** than the minimum of 5 minutes; therefore the Time of Concentration will automatically be filled in after hitting Apply with NO further steps required.

NOTE: The maximum length for sheet flow has changed and will vary depending upon the drainage area. Keep Max Sheet Flow at 300 and Max Shallow Flow at 100.

e) Delineate Subareas utilizing the Land Use DGN:

🕌 Drainage Area Su	ıbareas							
Area ID: 4 CB-9		• •	] Window Center ] Highlight	<b>1</b>	6	8	8	Apply
Details								
Options				To No	de I[	D: C	B-9	l <sub>pd</sub>
Definition	Subarea	C Value	Description					
Subareas	0.1123	0.900	Conc/Asphalt	Pvmt				Itomatic
Computation	0.5396	0.300	Forested Areas			*	De	lineation
								)isplay Only
Hydro. Method						×		
Rational								
SCS								
0	0.540	0.300	Forested Areas					
		-						

f) Compute Discharge and Apply:

📕 Drainage Area Co	omputations			
Area ID: 4 CB-9	•	Window Center	10 IN I	🖌 🐴 🗛 Apply
Details				
Options		Area	C Value	Compute
Definition Subareas	Total Subareas:	0.652	0.403	Discharge
Computation	Remainder:	0.037	0.350	
Hydro. Method -	Composite:	0.689	0.400	
Rational	Computed Intensity:	3.210		
SCS	Computed Discharge:	0.886		

**g)** Back in the **Node Configuration** dialog box click on **Properties**, then click again on **Computations**. This allows the program to update and run calculations. Review the Computations.

Node ID 4 CB-9	Window Center	v ja 🎢 🕷 Apply
Details		
Options	Discharge = 0.8856	
Properties Location Spread Criteria Elevations Junction Loss Discharge Options Computations	Spread Width from Gutter = 4.0723 Total Ponded Width = 4.0723 Ponded Depth = 0.2114 Spread Left Intercept = 0.0000 Spread Right Intercept = 4.0723 Grate Length = 3.0210 Grate Width = 1.8130 Grate Capacity = 0.8022 ByPass Flow = 0.0834 Efficiency = 0.9058	<

Don't be alarmed if your results are off by a few 100<sup>th</sup>'s. It could just be a tolerance issue.

**NOTE:** Upon review of the computations the **Spread Width from Gutter** is within our limit of 8.0 feet, therefore the inlet is in good position.

## 5.19 Design Inlet CB - 10

It has been determined that a **CB#43 8' DIA.** will be used.

See Standard Drawing D-CB-43R for details.

 a) Select from the Main Menu Bar: Component > Node > Add; or from the Main Toolbar: Add Drainage Node; or click the Add Node button within the Node Configuration Dialog. Click OK to set the name CB-10

Properties > Change the Node Properties to Sag and to a CB#43 8' DIA:

Node ID 4 CB-10	• •	Window Cent	ter 🝺 🖉 🏅	ø 1 <mark>ø</mark> 18	Apply
Details					
Options	Description:				
Properties	Node Type:	Grate	<b>-</b>	-	
Location Spread Criteria	Profile:	Sag		0	
Elevations Junction Loss	Library Item:	CB#43 8' DIA	•	-	
Discharge Options					
Computations	Node Bottom:	None Available	Ŧ		
	Override Librar	v Pavitem:			Align

**NOTE:** 8' Diameter is a round catch basin. The reasoning behind this selection is the need for the grates to be at such an angle that a pipe cannot be attached at a skew within the required limits. See <u>TDOT Drainage Manual Chapter 7</u> Section 7.03.5.5 *Pipe Connections to Structures.* 

b) Location > All Reference information is defaulted from the previous Node (CB-9) such that only the + Angle, Station and the Offset needs to be changed. The reasoning for the location of CB-10 will be given in the drainage area discussion. Especially note the Angle and Offset:

Node ID	<ul> <li>Window Center</li> <li>Window Center</li> <li>Window Center</li> <li>Window Center</li> <li>Window Yat Yat</li> <li>Apply</li> </ul>
Details	
Options	Chain: CL   Profile: DESIGNCL
Properties	Coordinates / Stationing
Location	Align: Tangent to Chain V + Angle 120.000
Spread Criteria	
Elevations	Station: 8+00.00 X: 3361.650
Junction Loss	- V Offset: 38.000 Y: 3076.859
Discharge Options Computations	- Mirror Node Offset from Gutter to Inlet: 0.000

c) Spread Criteria > Enter the Spread Criteria as shown below.

% Slope Left: <u>5.00 % (From DTM Tools>Analysis>Height/Slope)</u>

% Slope Right: <u>5.00 % (From DTM Tools>Analysis>Height/Slope)</u>

% Discharge Left: 50.00% (Estimated based on placement within drainage area)

%	Discharge	<b>Right:</b>	50.00%	(Leftover area)

**NOTE:** Left and Right are set equal since the flow will come to each equally.

Node Configuration	- Optional Spread Criteria for Sags
Node ID: CB-10	▼ ▶ Window Center ★ ★ ★ Apply Highlight
Details	
Options	% Slope Left: 5.000 Right: 5.000
Properties Location	% Discharge Left: 50.000 Right: 50.000 Spread Cross Section:
Spread Criteria	Spread Source: Reference Surface
Elevations	Width % Slope Roughne: A Maximum
Junction Loss Discharge Options	4.095         -1.925         0.016         Ξ         Pond Depth:         0.500           1.906         -50.003         0.016         Ξ
Computations	1.000 -2.000 0.016 T Pond Width: 8.000
	0.000 0.000 0.000

**d)** Elevations > Elevation Data must be changed to match a CB#43 8' DIA. From the <u>TDOT GEOPAK Drainage Nodes</u> Document set the following:

Node Configuration	- Elevations		
Node ID: CB-10	• • <b>•</b>	Window Center 🙀 🝺 💃 Highlight	🖹 🍂 Apply
Details			
Options	Reference Surface:	TIN File	٩
Properties Location	Elevation Source:	Reference TIN	872.383
Spread Criteria	Node Elevation Option:	Same as Source 🔹	872.383
Elevations	Vertical Alignment:	Min. Fixed Drop 🔹	0.330
Junction Loss Discharge Options	Minimum Depth:	2.790	
Computations	Maximum Depth:	40.000	
	Add Sump Depth:	0.000	

e) Click the Apply button to include this node in the Drainage Project.

#### Catch Basins – Outlet Only:

Drop Across Bottom of Structure + Min. Depth of Cover = Minimum Depth

**CB#43 8'DIA:** 0.33' + 2.46' = 2.79

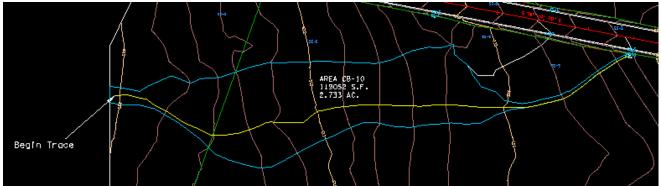
**NOTE:** See Appendix A, pg. A-4

GEOPAK Drainage V8*i* (SELECT Series 2)

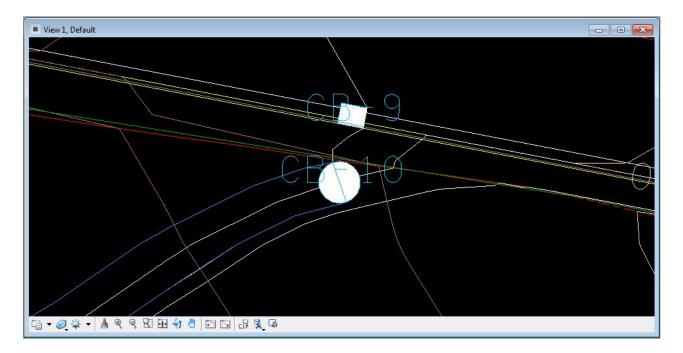
## 5.20 Delineate Drainage Area CB – 10

- a) From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-10** should automatically appear, click **OK**.
- b) Follow the steps in Exercise 3.2 to delineate and define the drainage area for Catch Basin 10. (You may use the following images as reference points. It is ok if your numbers do not match exactly.) Attach reference file DA\_CB-10 and turn off DA\_CB-9.

Delineate Drainage Area:



**NOTE:** Drainage area CB-10 was created by first using downstream trace and discovering that it converges into a relatively small area. Therefore when CB-10 was placed, upstream trace was used from either side of the catch basin to determine the drainage area. CB-10 was rotated to match the contours in order to catch as much flow as possible.



c) Define Drainage Area:

ዞ Drainage Area D	efinition		- • •
Area ID:	· · · · · · · · · · · · · · · · · · ·	Nindow Center 🐴 🦄	🔏 🐁 🗛 Apply
Details			
Options	Description:	To Node	ID: CB-10 🦓
Definition Subareas Computation	Drainage Area: 2.733 Base C Value: 0.350 Time of Conc.: 35.051	Area Selection / Creati Select Shape	Create DTM Shape
Hydro. Method	Compute TC	Pick Boundary Elements	DP Create Shape

d) Calculate Time of Concentration:

Distance 20.56 6.19 26.63 15.07 21.45 10.78 25.36 37.73 0.84 0.84	Slope 2.80 1.89 1.49 1.94 1.60 2.02 2.00 1.64 1.63	Avg. Slope 2.80 2.59 2.04 2.02 1.92 1.93 1.94 1.87 1.87	Flow Sheet Sheet Sheet Sheet Sheet Sheet Sheet Sheet	۲ ۲ ۲
20.56 6.19 26.63 15.07 21.45 10.78 25.36 37.73 0.84	2.80 1.89 1.49 1.94 1.60 2.02 2.00 1.64	2.80 2.59 2.04 2.02 1.92 1.93 1.94 1.87	Sheet Sheet Sheet Sheet Sheet Sheet Sheet	۲ ۲ ۲
6.19 26.63 15.07 21.45 10.78 25.36 37.73 0.84	1.89 1.49 1.94 1.60 2.02 2.00 1.64	2.59 2.04 2.02 1.92 1.93 1.94 1.87	Sheet Sheet Sheet Sheet Sheet Sheet	۲ ۲ ۲
26.63 15.07 21.45 10.78 25.36 37.73 0.84	1.49 1.94 1.60 2.02 2.00 1.64	2.04 2.02 1.92 1.93 1.94 1.87	Sheet Sheet Sheet Sheet Sheet Sheet	<b>–</b> (
15.07 21.45 10.78 25.36 37.73 0.84	1.94 1.60 2.02 2.00 1.64	2.02 1.92 1.93 1.94 1.87	Sheet Sheet Sheet Sheet	)
21.45 10.78 25.36 37.73 0.84	1.60 2.02 2.00 1.64	1.92 1.93 1.94 1.87	Sheet Sheet Sheet	)
10.78 25.36 37.73 0.84	2.02 2.00 1.64	1.93 1.94 1.87	Sheet Sheet Sheet	
25.36 37.73 0.84	2.00 1.64	1.94 1.87	Sheet Sheet	
37.73 0.84	1.64	1.87	Sheet	6
0.84				
	1.63	1.87	Sheet	
0.00				
0.39	1.88	1.87	Sheet	
34.54	1.75	1.85	Sheet	
27.49	1.58	1.82	Sheet	
7.34	2.10	1.83	Sheet	_
25.31	1.99	1.84	Sheet	-
Distance:	Slope	e:		
20.560	2.80	00	Adjust Flov	W
	llow Flow	Distance:		]
	27.49 7.34 25.31 Distance: 20.560 Max Sh	27.49 1.58 7.34 2.10 25.31 1.99 Distance: Slope 20.560 2.80 Max Sheet Flow Max Shallow Flow	27.49         1.58         1.82           7.34         2.10         1.83           25.31         1.99         1.84           Distance:         Slope:           20.560         2.800           Max Sheet Flow Distance:         3	27.49         1.58         1.82         Sheet           7.34         2.10         1.83         Sheet           25.31         1.99         1.84         Sheet           Distance:         Slope:         Adjust Flor           20.560         2.800         Adjust Flor           Max Sheet Flow Distance:         300.000           Max Shallow Flow Distance:         100.000

The calculated Time of Concentration is **GREATER** than the minimum of 5 minutes; therefore the Time of Concentration will automatically be filled in after hitting Apply with NO further steps required.

NOTE: The maximum length for sheet flow has changed and will vary depending upon the drainage area. Keep Max Sheet Flow at 300 and Max Shallow Flow at 100.

e) Delineate Subareas utilizing the Land Use DGN:

Area ID: 4 CB-10		• •	] Window Center ] Highlight	6	8	Apply Apply
Details						
Options			To N	lode ID	): C	B-10 🔏
Definition	Subarea	C Value	Description			
Subareas Computation	2.2860	0.300	Forested Areas		2	Automatic Delineation
						Display Only
Hydro. Method					×	
SCS				_		
	2.286	0.300	Forested Areas			

f) Compute Discharge and Apply:

📕 Drainage Area C	omputations					
Area ID:	•	Window Center	卷 🙆	8	۵	Apply
Details						
Options		Area	C Value	ſ	Cor	npute
Definition Subareas	Total Subareas:	2.286	0.300			charge
Computation	Remainder:	0.447	0.350			
Hydro. Method	Composite:	2.733	0.308			
Rational	Computed Intensity:	3.124				
SCS	Computed Discharge:	2.632				

**g)** Back in the **Node Configuration** dialog box click on **Properties**, then click again on **Computations**. This allows the program to update and run calculations. Review the Computations.

Node ID 4 CB-10	🔹 🕨 🕅 Window Center 搅 🍺 🏂 👘 Apply
Details	
Options	Total Ponded Width = 1.7253
Properties Location Spread Criteria Elevations Junction Loss Discharge Options Computations	Ponded Width Left = 3.5957 Ponded Width Right = 3.5957 Ponded Depth Left = 0.2019 Ponded Depth Right = 0.2019 Grate Area = 7.2000 Area Reduction = 0.5000 Grate Perimeter = 15.2000 Perimeter Reduction = 0.0000 Grate Capacity = 13.6814

Don't be alarmed if your results are off by a few 100<sup>th</sup>'s. It could just be a tolerance issue.

NOTE: Review the Computed Data. Items to review specifically are:

Total Ponded Width, Grate Capacity compared with Computed Discharge and Computed Head

### 5.21 Design Inlet CB - 11

It has been determined that another standard CB#12 4X3 will be used.

See Standard Drawing D-CB-12S for details.

a) Select from the Main Menu Bar: Component > Node > Add; or from the Main Toolbar: Add Drainage Node; or click the Add Node button within the Node Configuration Dialog. Click OK to set the name CB-11

Properties > Change the Node Properties to On Grade and to a CB#12 4x3:

Node ID 4 CB-11	• •	Window Ce	nter 🔊	ø 🏹 'ø 🍕	Apply
Details					
Options	Description:				
Properties	Node Type:	Grate	•		-
Location		On Grade	Ţ		
Spread Criteria Elevations	Library Item:		•		
Junction Loss	By Pass to Node:		10	2	
Discharge Options	Max By Pass:	0.000			
Computations	Node Bottom:	None Available	*		

b) Location > All Reference information is defaulted from the previous Node (CB-10) such that only the + Angle, Station and the Offset needs to be changed:

Node ID 4 CB-11	🗾 🕨 🦳 Window Center 📁 🖉 🏂 🍃 🆓 Apply
Details	
Options	Chain: CL
Properties	Coordinates / Stationing
Location	Align: Tangent to Chain 💌 💉 + Angle: 180.000
Spread Criteria Elevations	Station: 9+30.00 X: 3491.589
Junction Loss	V Offset: 26.000 Y: 3064.212
Discharge Options Computations	Mirror Node Offset from Gutter to Inlet: 0.000

**NOTE:** The **Spread Criteria** defaults back automatically when the node is changed back to **ON GRADE**, therefore no changes are necessary.

c) Elevations > Elevation Data must be changed to match a CB#12 4X3. From the <u>TDOT</u> <u>GEOPAK Drainage Nodes</u> Document set the following:

Node ID 4 CB-11	▼ ▶ □	Window Center Highlight	1 <b>10 7</b> 0	' 😼 🚳 [	Apply
Details					
Options	Reference Surface:	TIN File 🔻 fir	nal.tin		Q
Properties Location	Elevation Source:	Reference TIN	•	868.518	
Spread Criteria	Node Elevation Option:	Same as Source	•	868.518	
Elevations	Vertical Alignment:	Min, Fixed Drop	•	0.170	
Junction Loss Discharge Options	Minimum Depth:				
Computations	Maximum Depth:	20.000			
	Add Sump Depth:	0.000			

d) Click the Apply button to include this node in the Drainage Project.

#### Catch Basins – Inlet and Outlet:

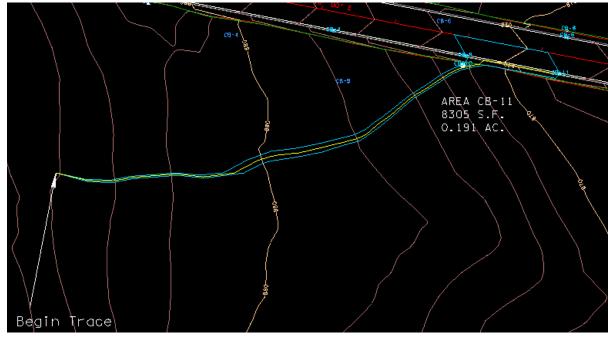
Min. Depth of Basin – Pipe Size – Drop Across Bottom of Structure = Minimum Depth

**CB#12 4x3:** 3.88' - 18"/12 - 0.17' = 2.21'

## 5.22 Delineate Drainage Area CB – 11

- a) From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-11** should automatically appear, click **OK**.
- b) Follow the steps in Exercise 3.2 to delineate and define the drainage area for Catch Basin 11. (You may use the following images as reference points. It is ok if your numbers do not match exactly.) Attach reference file DA\_CB-11 and turn off DA\_CB-10.

Delineate Drainage Area:



**NOTE:** There is a small sliver of CB-11 Drainage Area that lies alongside CB-10. This is included to make sure all drainage area is captured. In reality, this sliver would likely be captured by CB-10

c) Define Drainage Area:

🖊 Drainage Area D	efinition		- • •
Area ID:		Vindow Center 🐴 🦄	🔏 🐁 🗛 Apply
Details	_		
Options Definition Subareas	Description: Drainage Area: 0.191	Area Selection / Creat	
Computation	Base C Value: 0.350 Time of Conc.: 37.201	Select Shape	Create DTM Shape
Hydro. Method Rational SCS	Compute TC	Pick Boundary Elements	DP Create Shape

d) Calculate Time of Concentration:

	Details				
Drainage Area ID: CB-11	Distance	Slope	Avg. Slope	Flow	*
TIN File  final.tin Q	32.96	2.54	2.54	Sheet	E
	10.08	2.34	2.50	Sheet	
Define Path	22.33	2.79	2.60	Sheet	
Trace () ID - Segments	10.63	2.71	2.61	Sheet	
	21.79	3.47	2.80	Sheet	
Sheet Flow	5.83	2.82	2.81	Sheet	
Method: FHA  Length: 300.000	26.45	2.29	2.70	Sheet	
	3.64	2.32	2.69	Sheet	
n Value: 0.400 Slope: 2.104	28.53	2.35	2.63	Sheet	
Shallow Row	1.33	2.03	2.63	Sheet	
hadren and a second sec	30.93	1.66	2.47	Sheet	
Length: 100.000	5.05	1.57	2.45	Sheet	
Inter. K: 0.491 Slope: 1.593	27.22	1.98	2.39	Sheet	
	1.85	1.19	2.38	Sheet	*
Concentrated How	Distance:	Slope	e: _		
Method: Continuity  Length: 320.915	32,960	2.54	0	Adjust Flo	w
Velocity: 5.000 Accum. Distance: 720.915 Accum. Avg. Slope: 2.444		llow Flow	Distance:		

The calculated Time of Concentration is **GREATER** than the minimum of 5 minutes; therefore the Time of Concentration will automatically be filled in after hitting Apply with NO further steps required. **Keep Max Sheet Flow at 300 and Max Shallow Flow at 100.** 

e) Delineate Subareas utilizing the Land Use DGN:

🕌 Drainage Area Su	ıbareas				
Area ID: 4 CB-11		• •	] Window Center ] Highlight	) 🗞	Apply
Details					
Options			To Node	ID: C	:B-11 🦓
Definition	Subarea	C Value	Description	1	
Subareas	0.0788	0.900	Conc/Asphalt Pvmt		Automatic
Computation	0.0961	0.300	Forested Areas	2	Delineation
					Display Only
Hydro. Method -				X	in proprior critic
Rational				$  \frown  $	
SCS	0.096	0.300	Forested Areas		

f) Compute Discharge and Apply:

	<ul> <li>Window Center</li> <li>Highlight</li> </ul>	ත් වී	🖄 🖄 🗛 Apply
	Area	C Value	Compute
Total Subareas:	0.175	0.570	Discharge
Remainder:	0.016	0.350	
Composite:	0.191	0.552	
Computed Intensity:	3.200		
Computed Discharge:	0.337		
	Total Subareas: Remainder: Composite: Computed Intensity:	Highlight	AreaC ValueTotal Subareas:0.1750.570Remainder:0.0160.350Composite:0.1910.552Computed Intensity:3.200

**g)** Back in the **Node Configuration** dialog box click on **Properties**, then click again on **Computations**. This allows the program to update and run calculations. Review the Computations.

K Node Configuration	- Computations	- • •
Node ID 4 CB-11	Window Center	ta ta 🎢 🗋 🚷 🗛
Details		
Options Properties Location Spread Criteria Elevations Junction Loss Discharge Options Computations	Discharge = 0.3369 Spread Width from Gutter = 1.7590 Total Ponded Width = 1.7590 Ponded Depth = 0.1495 Spread Left Intercept = 0.0000 Spread Right Intercept = 1.7590 Grate Length = 3.0210 Grate Width = 1.8130 Grate Capacity = 0.3369 ByPass Flow = 0.0000 Efficiency = 1.0000	

Don't be alarmed if your results are off by a few  $100^{\text{th}}$ 's. It could just be a tolerance issue.

**NOTE:** Upon review of the computations the **Spread Width from Gutter** is within our limit of 8.0 feet, therefore the inlet is in good position.

## 5.23 Design Inlet CB – 12

It has been determined that another standard CB#12 4X3 will be used.

See Standard Drawing D-CB-12S for details.

 a) Select from the Main Menu Bar: Component > Node > Add; or from the Main Toolbar: Add Drainage Node; or click the Add Node button within the Node Configuration Dialog. Click OK to set the name CB-12

**Properties >** Verify the Node Properties are defaulted from the previous Node (CB-11) such that no user-input is required for this similar curb inlet.

Node ID	• •	Window Ce	nter 😠	a 🎽	ø 🚯	Apply
Details						
Options	Description:					
Properties	Node Type:	Grate	•			
Location		On Grade	•		8 8	
Spread Criteria Elevations	Library Item:	CB#12 4X3	•		<:	
Junction Loss	By Pass to Node:		10			
Discharge Options	Max By Pass:	0.000				
Computations	Node Bottom:	None Available	•			
	Override Librar	v Pavitem:				Align

**b)** Location > All Reference information is defaulted from the previous Node (CB-11) such that only the **+** Angle, Station and the Offset needs to be changed:

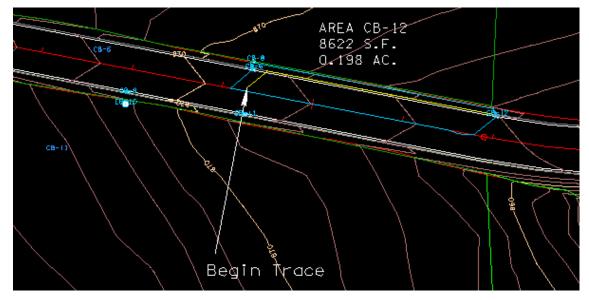
Node ID 4 CB-12	🗾 🕨 📄 Window Center 👘 🖉 🎢 Apply
Details	
Options	Chain: CL
Properties	Coordinates / Stationing
Location	Align: Tangent to Chain  Align: 4 Angle: 0.000
Spread Criteria	
Elevations	Station: 12+00.00 X: 3766.316
Junction Loss	V Offset: -26.000 Y: 3064.627
Discharge Options Computations	Mirror Node Offset from Gutter to Inlet: 0.000

c) Click the Apply button to include this node in the Drainage Project.

## 5.24 Delineate Drainage Area CB – 12

- a) From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-12** should automatically appear, click **OK**.
- b) Follow the steps in Exercise 3.2 to delineate and define the drainage area for Catch Basin 12. (You may use the following images as reference points. It is ok if your numbers do not match exactly.) Attach reference file DA\_CB-12 and turn off DA\_CB-11.

Delineate Drainage Area:



c) Define Drainage Area:

Area ID: 4 CB-	12 🗸	) 🕨 📙	Window Center Highlight	<u>1</u> 1	🔏 💩 🖪	pply
Details						
Options	Description:			To Node ID	: CB-12	Opt
Definition	Drainage Area:	0.199	Area Selectio	on / Creation	n	
Subareas Base C Value:	0.350	Select		Create		
	Time of Conc.:	5.000	Shape		DTM Shape	
Hydro. Method	Compute	e TC	Pick Bound	lary	DP	
Rational			Elements		Create Shape	
─ SCS						

#### d) Calculate Time of Concentration:

	Details				
Drainage Area ID: CB-12	Distance	Slope	Avg. Slope	Flow	*
TIN File  final.tin Q	4.62	2.63	2.63	Sheet	
	1.82	2.63	2.63	Sheet	
Define Path	3.74	2.63	2.63	Sheet	
Trace (1) ID - Segments	1.43	2.63	2.63	Sheet	
	0.70	2.63	2.63	Sheet	
Sheet How	4.48	2.63	2.63	Sheet	
Method: FHA  Length: 31.000	3.22	2.63	2.63	Sheet	
	1.95	2.63	2.63	Sheet	
Nalue: 0.012 Slope: 2.940	4.01	2.63	2.63	Sheet	
	0.42	8.67	2.73	Sheet	
Shallow Flow	1.62	8.67	3.07	Sheet	
Length: 0.000	0.72	1.71	3.04	Sheet	
Inter. K: 0.491 Slope: 0.000	2.27	1.71	2.94	Sheet	
	2.73	1.71	2.84	Conc	•
Concentrated How	Distance:	Slope	e: _		
Method: Continuity V Length: 252.483	4,620	2.63	30	Adjust Flo	w
Velocity: 5.000				$\sim$	_
	Max Sh	neet Flow	Distance:	31.000	
Accum, Distance: 283,483	Max Sha	low Flow	Distance:	0.000	1
Accum, Avg. Slope: 1.846				~	- A.
Coulli. Avg. Slope. 1.040		_	Apply		

The calculated Time of Concentration is less than the minimum of 5 minutes, therefore <u>5 must be manually typed</u> in the Drainage Area Definition dialog <u>after</u> hitting apply in the Time of Concentration Window.

The maximum length for sheet flow has changed and will vary depending upon the drainage area. Max. Sheet Flow is 31 and Shallow Flow should be toggled off. The n value should be set to .012.

e) Delineate Subareas utilizing the Land Use DGN:

Area ID:	2	• •	] Window Center ] Highlight	9 <b>X</b> 9	Apply Apply
Details					
Options			To Node	D: C	:B-12 💋
Definition	Subarea	C Value	Description	1	<u> </u>
Subareas	0.1617	0.900	Conc/Asphalt Pvmt		Automatic
Computation					Delineation
Hydro. Method Rational	1			×	Display Only
SCS	0.162	0.900	Conc/Asphalt Pvmt	1	

f) Compute Discharge and Apply:

Area ID: 4 CB-1	2 • •	Window Highlight	Center 🖄 🔞 🞗	🖌 👌 🚺
Details	23			
Options		Area	C Value	Compute
Definition Subareas	Total Subareas:	0.162	0.900	Discharge
Computation	Remainder:	0.037	0.350	
Hydro. Method	Composite:	0.199	0.797	
Rational	Computed Intensity:	6.980		
⊘ SCS	Computed Discharge:	1.106		

g) Back in the Node Configuration dialog box click on Properties, then click again on Computations. This allows the program to update and run calculations. Review the Computations.

Node ID 4 CB-12	🔹 🕨 Window Center 搅 🥳 🏂 🖨 Apply
Details	
Options	Discharge = 1.1065
Properties Location Spread Criteria Elevations Junction Loss Discharge Options Computations	Spread Width from Gutter = 4.8368 Total Ponded Width = 4.8368 Ponded Depth = 0.2267 Spread Left Intercept = 0.0000 Spread Right Intercept = 4.8368 Grate Length = 3.0210 Grate Width = 1.8130 Grate Capacity = 0.9578 ByPass Flow = 0.1487 Efficiency = 0.8656

Don't be alarmed if your results are off by a few 100<sup>th</sup>'s. It could just be a tolerance issue.

**NOTE:** Upon review of the computations the **Spread Width from Gutter** is within our limit of 8.0 feet, therefore the inlet is in good position.

## 5.25 Design Inlet CB – 13

It has been determined that another standard CB#12 4X3 will be used.

See Standard Drawing D-CB-12S for details.

 a) Select from the Main Menu Bar: Component > Node > Add; or from the Main Toolbar: Add Drainage Node; or click the Add Node button within the Node Configuration Dialog. Click OK to set the name CB-13

**Properties >** Verify the Node Properties are defaulted from the previous Node (CB-12) such that no user-input is required for this similar curb inlet.

Node ID 4 CB-13	• •	Window Ce	enter 늀	ø <b>*</b> ø 'ø	🏠 🗛 Apply
Details					
Options	Description:				
Properties	Node Type:	Grate	•		
Location	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	On Grade	•		
Spread Criteria Elevations	Library Item:	CB#12 4X3	•		
Junction Loss	By Pass to Node:		10		
Discharge Options	Max By Pass:	0.000			
Computations	Node Bottom:	None Available	•		Align

b) Location > All Reference information is defaulted from the previous Node (CB-12) such that only the + Angle, Station and the Offset needs to be changed. This station is not set equal to CB-12 due to changing super elevation shapes. After a few iterations this station was chosen in order to keep the spread within the limits. :

Node ID 4 CB-13	🔹 🕨 📄 Window Center 📁 🖉 🥳 🏂 🗛 🗛 Apply
Details	
Options	Chain: CL   Profile: DESIGNCL
Properties	Coordinates / Stationing
Location	Align: Tangent to Chain V / + Angle: 180.000
Spread Criteria	
Elevations	Station: 11+45.00 X: 3702.757
Junction Loss	V Offset: 26.000 Y: 3023.802
Discharge Options Computations	Mirror Node Offset from Gutter to Inlet: 0.000

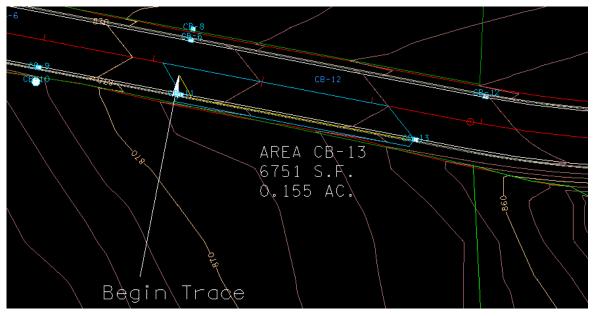
c) Click the Apply button to include this node in the Drainage Project.

## 5.26 Delineate Drainage Area CB – 13

- a) From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-13** should automatically appear, click **OK**.
- b) Follow the steps in Exercise 3.2 to delineate and define the drainage area for Catch Basin 13. (You may use the following images as reference points. It is ok if your numbers do not match exactly.) Attach reference file DA\_CB-13 and turn off

### DA\_CB-12.

Delineate Drainage Area:



c) Define Drainage Area:

Area ID: 4 CB-	13 🔹	) 🕨 📙	Window Center Highlight	<u>&amp;</u> &	<b>Б</b> 👌 🗛	oply
Details						
Options	Description:		1	To Node ID:	CB-13	Opt .
Definition		0.150	Area Selectio	n / Creation		
Subareas	Drainage Area:	0.156				_
Computation	Base C Value:	0.350	Select		Create	
	Time of Conc.:	5.000	Shape		DTM Shape	
Hydro. Method	Compute	e TC	Pick Bound	arv	DP	٦
Rational			Elements		Create Shape	
SCS			C			_

d) Calculate Time of Concentration:

	Details				
Drainage Area ID: CB-13	Distance	Slope	Avg. Slope	Flow	•
TIN File 🔹 final.tin 🔍	1.37	2.63	2.63	Sheet	
	4.03	2.63	2.63	Sheet	E
Define Path	1.15	2.63	2.63	Sheet	
Trace (I) ID - Segments	0.56	2.63	2.63	Sheet	_
	1.62	2.63	2.63	Sheet	
Sheet Flow	6.07	2.63	2.63	Sheet	
Method: FHA  Length: 20.000	5.21	2.63	2.63	Sheet	
	1.18	2.63	2.63	Conc	
Value: 0.012 Slope: 2.631	1.84	8.67	3.11	Conc	
Shallow Row	0.20	8.67	3.16	Conc	
	0.45	1.71	3.13	Conc	
Length: 0.000	5.00	1.71	2.89	Conc	
nter. K: 0.491 Slope: 0.000	5.00	1.71	2.71	Conc	
	5.00	1.71	2.58	Conc	*
Concentrated How	Distance:	Slope	e:		
Method: Continuity V Length: 208.668	1.370	2.63	30	Adjust Flo	w
Velocity: 5.000	1.070	2.00			
	Max Sh	heet Flow	Distance:	20.000	
Accum, Distance: 228.668	Max Sha	low Flow	Distance:	0.000	ī
<	Midx Jild		Distance.	0.000	-
Accum. Avg. Slope: 1.719					

The calculated Time of Concentration is less than the minimum of 5 minutes, therefore <u>5 must be manually typed</u> in the Drainage Area Definition dialog <u>after</u> hitting apply in the Time of Concentration Window.

NOTE: Since the majority of flow is in the gutter (Concentrated Flow), we toggle off Shallow Flow and change Max Sheet Flow to 20. The n Value for Sheet flow changes to 0.012.

e) Delineate Subareas utilizing the Land Use DGN:

	To Node	D: CE	3-13 💋
C Value	Description	7	
0.900		-	Automatic
0.000	Control op note i fine		Delineation
		×	Display Only
	C Value 0.900		0.900 Conc/Asphalt Pvmt 고

f) Compute Discharge and Apply:

🗸 Drainage Area C	omputations					
Area ID:	₃ • ►	Window Center	ත ක	8	٩	Apply
Details						
Options		Area	C Value	Γ	Con	npute
Definition Subareas	Total Subareas:	0.130	0.900			harge
Computation	Remainder:	0.025	0.350			
Hydro. Method -	Composite:	0.155	0.810			
Rational	Computed Intensity:	6.980				
SCS	Computed Discharge:	0.877				

g) Back in the Node Configuration dialog box click on Properties, then click again on Computations. This allows the program to update and run calculations. Review the Computations.

Node ID	Window Center for for for for the Apply     Highlight for the Apply
Details	
Options Properties Location Spread Criteria Elevations Junction Loss Discharge Options	Discharge = 0.8765 Spread Width from Gutter = 7.2730 Total Ponded Width = 7.2730 Ponded Depth = 0.2058 Spread Left Intercept = 0.0000 Spread Right Intercept = 7.2730 Grate Length = 3.0210 Grate Width = 1.8130 Grate Capacity = 0.7312
Computations	ByPass Flow = 0.1453 Efficiency = 0.8342

Don't be alarmed if your results are off by a few 100<sup>th</sup>'s. It could just be a tolerance issue.

**NOTE:** Upon review of the computations the **Spread Width from Gutter** is within our limit of 8.0 feet, therefore the inlet is in good position.

## 5.27 Design Inlet CB – 14

It has been determined that another standard CB#12 4X3 will be used.

See Standard Drawing D-CB-12S for details.

 a) Select from the Main Menu Bar: Component > Node > Add; or from the Main Toolbar: Add Drainage Node; or click the Add Node button within the Node Configuration Dialog. Click OK to set the name CB-14

**Properties >** Verify the Node Properties are defaulted from the previous Node (CB-13) such that no user-input is required for this similar curb inlet.

Node ID	• •	Window Ce	nter 📩	a <b>y</b> a "a	Apply Apply
Details					
Options	Description:				
Properties	Node Type:	Grate	•		
Location		On Grade	•		
Spread Criteria Elevations	Library Item:		•		
Junction Loss	By Pass to Node:		10		
Discharge Options	Max By Pass:	0.000			
Computations	Node Bottom:	None Available	-		
	Override Librar	v Pavitem:			Align

b) Location > All Reference information is defaulted from the previous Node (CB-13) such that only the + Angle, Station and the Offset needs to be changed. This station is chosen since it is on an even station and near where we want our outlet:

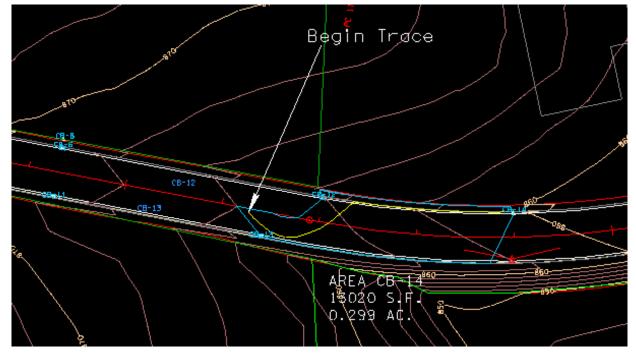
Node ID	🗾 🔹 🕨 Window Center 👘 🖉 🎢 Apply
Details	
Options	Chain: CL   Profile: DESIGNCL
Properties	Coordinates / Stationing
Location	Align: Tangent to Chain  Align: Tangent to Chain  Align: A
Spread Criteria Elevations	Station: 14+00.00 + X: 3960.176
Junction Loss	★⊕>
Discharge Options	☑ Offset: -26.000 ¥ Y: 3049.171
Computations	Mirror Node Offset from Gutter to Inlet: 0.000

c) Click the Apply button to include this node in the Drainage Project.

### 5.28 Delineate Drainage Area CB – 14

- a) From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-14** should automatically appear, click **OK**.
- b) Follow the steps in Exercise 3.2 to delineate and define the drainage area for Catch Basin 14. (You may use the following images as reference points. It is ok if your numbers do not match exactly.) Attach reference file DA\_CB-14 and turn off DA\_CB-13.

Delineate Drainage Area:



c) Define Drainage Area:

Area ID: 4 CB-	14 🔻	Window Cent	er 🖄 🙆 🥻	🀔 🖄 🗛	ply
Details					
Options	Description:		To Node ID:	CB-14	Pps
Definition	Designed Array	286 Area Sele			-
Subareas			·	Create DTM Share	
Computation	Base C Value: 0.	350 Sele			
	Time of Conc.: 5.	000 Sha	pe	DTM Shape	
Hydro. Method	Compute TO	Pick Box	indary	DP	٦
Rational		Eleme	Concentration Committee Commi	Create Shape	
SCS		<u></u>			9

d) Calculate Time of Concentration:

Drainage Area ID: CB-14	Details			-	1001
Sector and a sector of the	Distance	Slope	Avg. Slope	Flow	^
TIN File  final.tin Q	2.42	2.06	2.06	Sheet	H
	4.43	1.76	1.87	Sheet	
Define Path	1.91	1.98	1.89	Sheet	
Trace (I) ID - Segments	1.17	1.98	1.90	Sheet	
	4.55	1.57	1.80	Sheet	
Sheet Flow	0.13	1.66	1.80	Sheet	
Method: FHA  Length: 120.000	0.04	1.27	1.80	Sheet	
	0.09	1.27	1.79	Sheet	
n Value: 0.012 Slope: 1.730	5.54	1.50	1.71	Sheet	
Challen Dam	1.95	1.17	1.66	Sheet	
Shallow Row	3.66	1.43	1.63	Sheet	
Length: 0.000	3.16	1.09	1.57	Sheet	
Inter. K: 0.491 Slope: 0.000	2.30	1.38	1.56	Sheet	
	1.83	1.38	1.55	Sheet	*
Concentrated How	Distance:	Slope	e:		
Method: Continuity V Length: 170.667	2.420	2.00		Adjust Flor	N
Velocity: 5.000	2.420	2.00			
	Max St	heet Flow	Distance:	20.000	1
Accum Distance: 290.667					1
<	Max Sha	now riow	Distance:	.000	1
Accum, Avg. Slope: 1.933					

The calculated Time of Concentration is less than the minimum of 5 minutes, therefore <u>5 must be manually typed</u> in the Drainage Area Definition dialog <u>after</u> hitting apply in the Time of Concentration Window

**NOTE:** The maximum length for sheet flow has changed and will vary depending upon the drainage area. Change **Max. Sheet Flow to 120** and leave **Shallow Flow toggled off**.

e) Delineate Subareas utilizing the Land Use DGN:

ዞ Drainage Area Su	bareas					- • •
Area ID:		• •	] Window Center ] Highlight	න න	8	Apply Apply
Details						
Options			т	To Node I	D: C	B-14 🛛 💋
Definition	Subarea	C Value	Description			
Subareas	0.2709	0.900	Conc/Asphalt P	vmt		Automatic Delineation
Computation					2	Delineation
						Display Only
Hydro. Method					X	
Rational					$\sim$	
SCS						
0 000	0.271	0.900	Conc/Asphalt P	vmt		

f) Compute Discharge and Apply:

Drainage Area Computations						• <b>×</b>
Area ID:		Window Center	න බො	8	8	Apply
Details						
Options		Area	C Value	Γ	Compute Discharge	
Definition Subareas	Total Subareas:	0.271	0.900			
Computation	Remainder:	0.027	0.350			
Hydro. Method —	Composite:	0.298	0.851			
Rational	Computed Intensity:	6.980				
SCS	Computed Discharge:	1.767				

g) Back in the Node Configuration dialog box click on Properties, then click again on Computations. This allows the program to update and run calculations. Review the Computations.

Node Configuration		
Node ID	Window Center     Window Center     Window Center     Window Center	r 🧋 🐴 🛛 Apply
Details		
Options Properties Location Spread Criteria Elevations Junction Loss Discharge Options Computations	Discharge = 1.7672 Spread Width from Gutter = 4.8154 Total Ponded Width = 4.8154 Ponded Depth = 0.2685 Spread Left Intercept = 0.0000 Spread Right Intercept = 4.8154 Grate Length = 3.0210 Grate Width = 1.8130 Grate Capacity = 1.4849 ByPass Flow = 0.2822 Efficiency = 0.8403	

Don't be alarmed if your results are off by a few 100<sup>th</sup>'s. It could just be a tolerance issue.

**NOTE:** Upon review of the computations the **Spread Width from Gutter** is within our limit of 8.0 feet, therefore the inlet is in good position.

This is the last catch basin in this network. The curb and gutter section continues and any ByPass will be caught by the next network. If this were not the case, we would need to take steps to capture or mitigate the ByPass Flow.

## 5.29 Design Junction MH-1

 a) Select from the Main Menu Bar: Component > Node > Add; or from the Main Toolbar: Add Drainage Node; or click the Add Node button within the Node Configuration Dialog. Click OK to set the name MH-1

**Properties >** Make the following changes:

Node Type: Junction

Library Item: MH#3 5' DIA

(See Standard Drawing D-MH-3 for details.)

Node ID 4 MH-1	• •	Window Cer	nter 🙍 🙍 🥇	6 10 B	Apply
Details					
Options	Description:				
Properties	Node Type:	Junction	•		i
Location Spread Criteria	and the second	On Grade	-		
Elevations	Library Item:	MH#3 5' DIA	•		
Junction Loss					
Discharge Options					
Computations	Node Bottom:	None Available	•		
	Override Librar	v Pavitem:			Align

**NOTE:** A manhole is used at this location since; a junction is required, the superelevation of the roadway is such that there is little to no flow, and Junction Boxes are not allowed to be used under roadways.

b) Location > All Reference information is defaulted from the previous Node (CB-14) such that only the + Angle, Station and the Offset needs to be changed. Be sure manholes are located <u>out of wheel paths</u>:

Node ID 4 MH-1	🗾 🕨 📄 Window Center 📁 🖉 🏂 🍃 🐴 🗛 Apply
Details	
Options	Chain: CL
Properties	Coordinates / Stationing
Location	Align: Tangent to Chain  Align: Align
Spread Criteria	
Elevations	Station: 14+00.00 X: 3961.075
Junction Loss	-V Offset: 18.000 Y: 3005.180
Discharge Options	Mirror Node Offset from Gutter to Inlet: 0.000
Computations	

c) Elevations > Elevation Data must be changed to match a MH#3 5' DIA. From the <u>TDOT</u> <u>GEOPAK Drainage Nodes</u> Document set the following:

Node ID 4 MH-1	- →	Window Center	🎢 😼 🍓 🗛 Apply
Details			
Options	Reference Surface:	TIN File  Final.tin	٩
Properties Location Spread Criteria	Elevation Source: Node Elevation Option:		<ul><li>861.762</li><li>861.762</li></ul>
Elevations Junction Loss	Vertical Alignment:	Min. Fixed Drop	0.210
Discharge Options	Minimum Depth:	1.830	
Computations	Maximum Depth:	40.000	
	Add Sump Depth:	0.000	

d) Click the Apply button to include this node in the Drainage Project.

### Manhole:

Min. Depth of Basin – Pipe Size – Drop Across Bottom of Structure = Minimum Depth

**MH#3 5'DIA:** 3.54' - 18"/12 - 0.21' = 1.83'

NOTE: See Appendix A, pg. A-5

### 5.30 Design Outlet EW-1

 a) Select from the Main Menu Bar: Component > Node > Add; or from the Main Toolbar: Add Drainage Node; or click the Add Node button within the Node Configuration Dialog. Click OK to set the name EW-1

**Properties >** Make the following changes:

Node Type: Outlet

Library Item: Endwall

Fix Tailwater at: Critical Depth

Other Tailwater options are: Uniform Depth, Soffit (Top of pipe), or Elevation: User input (known elevation)

Node ID 4 EW-1	• •	Window Cen Highlight	iter 😿 ø	🎢 🖗 🖬	pply
Details					
Options	Description:				
Properties	Node Type:	Outlet	•		
Location	100 C 100	On Grade	<b>T</b>		
Spread Criteria Elevations	Library Item:		-		
Junction Loss	<ul> <li>Fix Tailwater a</li> </ul>		-	<u> </u>	
Discharge Options	<ul> <li>Tailwater Elev</li> </ul>				
Computations		None Available	-		

b) Location > All Reference information is defaulted from the previous Node (CB-14) such that only the + Angle, Station and the Offset needs to be changed. Angle is critical as to direction node will be displayed.

Node ID 4 EW-1	🔹 🕨 🦳 Window Center 📁 🖉 🏂 🎁 🦓 Apply
Details	
Options	Chain: CL    Profile: DESIGNCL
Properties	Coordinates / Stationing
Location	Align: Tangent to Chain  Align: Tangent to Chain  Align: Tangent to Chain
Spread Criteria Elevations	Station: 14+00.00 X: 3961.852
Junction Loss	Offset: 56.000 Y: 2967.188
Discharge Options Computations	- Mirror Node Offset from Gutter to Inlet: 0.000

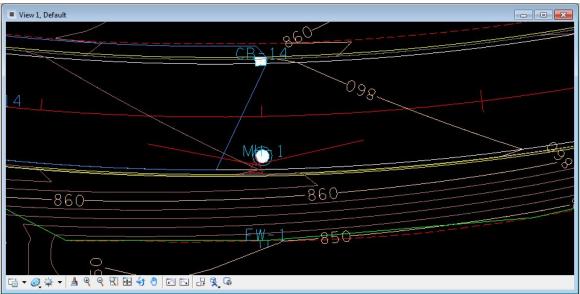
c) Elevations > Change the Elevation data to the following:

Vertical Alignment: <u>Match Invert</u> Minimum Depth: <u>0.000</u> Maximum Depth: <u>4.000</u>

Node ID 4 EW-1	• •	Window Center , Highlight	d d d	r 🍃 🚯 [	Apply
Details					
Options	Reference Surface:	TIN File 🔻	final.tin		Q
Properties Location Spread Criteria	Elevation Source: Node Elevation Option:		•	850.412 850.412	
Elevations	Vertical Alignment:			0.210	
Junction Loss Discharge Options	Minimum Depth:			0.210	
Computations	Maximum Depth:	4.000			
	Add Sump Depth:	0.000			

**NOTE:** This is a preliminary location used to determine outlet elevation, etc. This node will need to be adjusted to account for the side slope, endwall, velocity, and the final pipe size which is designed.

# **Exercise 5**

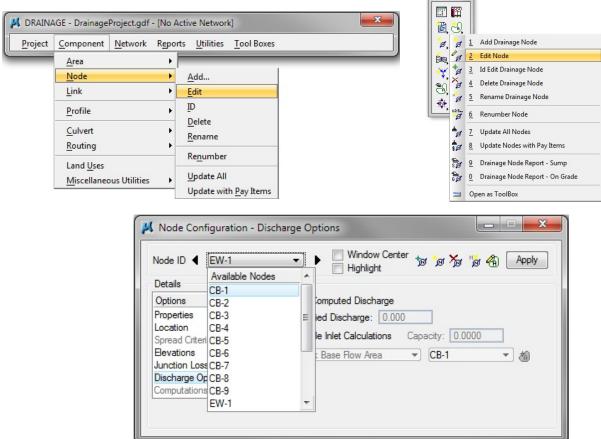


d) Click the Apply button to include this node in the Drainage Project.

### 5.31 Inlet Bypass

Set the Inlet bypass as required to bypass flow to the downstream inlets.

a) Select Component > Node > Edit or choose from the Tool Box and use the drop-down menu to select CB-1.



**b) Properties >** Keyin the **By Pass to Node** as CB-3 or click the **ID** button and data point on the node in the plan view.

The Bypass flow from this inlet will then contribute its resulting bypass flow to CB-3. Click the **Apply** button to accept the changes.

Node ID 4 CB-1	▼ ►	📃 Window Center 🍗 🍺 🤇	🗴 😼 🍓 🗛 Apply
Details			
Options	Description:		
Properties	Node Type:	Grate 🔹	
Location	and the second	On Grade 🔹	
Spread Criteria Elevations	Library Item:		
Junction Loss	By Pass to Node:		
Discharge Options	Max By Pass:	0.000	
Computations	Node Bottom:	None Available 🔻	

c) Select CB-3, Computations > Review the computations to make sure the spread is still within the design limits.

Node ID	Window Center	🝺 🕫 🌾 🐞 🗛 Apply
Details		
Options	Discharge = 1.0902	
Properties Location Spread Criteria Elevations Junction Loss Discharge Options Computations	Spread Width from Gutter = 4.1236 Total Ponded Width = 4.1236 Ponded Depth = 0.2125 Spread Left Intercept = 0.0000 Spread Right Intercept = 4.1236 Grate Length = 3.0210 Grate Width = 1.8130 - Grate Capacity = 0.9645 ByPass Flow = 0.1258 Efficiency = 0.8846	

**d)** Follow the same procedures to bypass the remaining flow to the inlets as described in the table below:

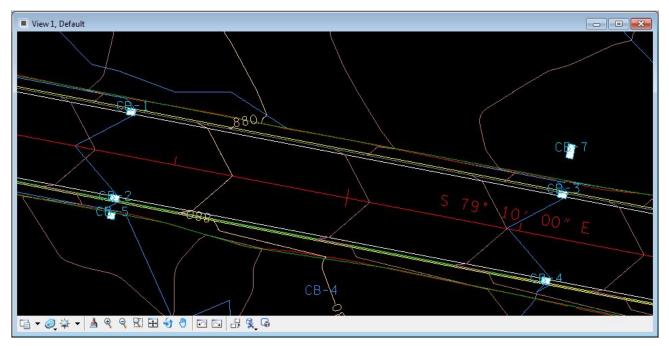
Node ID	By Pass to Node	Spread	Width
		Before Bypass	After Bypass
CB-2	CB-4	6.0289	7.1331
CB-3	CB-6	5.5181	5.8409
CB-4	CB-9	4.0723	6.1784
CB-6	CB-12	4.8368	5.6188
CB-9	CB-11	1.7590	3.1144
CB-11	CB-13	7.2730	7.5241
CB-12	CB-14	4.8154	5.1393
CB-13	CB-14	5.1393	5.3333

# 6. Storm Drainage Links

This exercise shows the user how to utilize the tools necessary for connecting the surface drainage (inlets) to the collection system (pipes). The user will design the storm drainage pipes for this project.

### 6.1 Link Design

a) Visually determine the tentative location of the first storm drainage pipe. This link will connect Nodes CB-1 and CB-3.



b) Select from the Drainage Menu Bar: Component > Link > Add or from the main toolbar: Add Drainage Link:

Project	Component Network	Report	ts <u>U</u> tilities <u>T</u> ool Boxes	
_	<u>A</u> rea	- +		Image: Comparison of the second sec
	<u>N</u> ode	+		😝 🎸 💁 Edit Link
	Link	•	<u>A</u> dd	Id Edit Drainage Link
	<u>P</u> rofile	•	<u>E</u> dit	A Delete Drainage Link
	<u>C</u> ulvert <u>R</u> outing	*	ID Delete Rename	↓     ↓     Anther Draining Link       ↓     6     Update All Links       ↓     7     Update Links with Pay Items
	Land <u>U</u> ses <u>M</u> iscellaneous Utilities	•	Update All Update with Pay Items	8         Drainage Link Report - Configuration           9         9         Drainage Link Report - Computation

c) In the New Link window that appears, click OK to set the name SS-1

	-14 
Link ID: SS-1	
ОК	Cancel

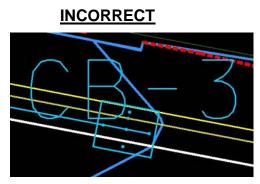
**d) Definition >** This dialog sets the pipe configuration including: From Node, To Node, Shape, Material, Library Item, etc.

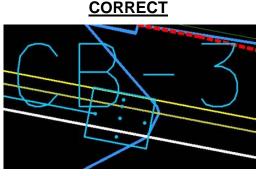
There are two ways to set the Nodes: from the dropdown list or graphically selecting the Nodes. Graphically is recommended to ensure the correct pipe connection points are utilized. See note concerning these below.

To select graphically **click the ID button** for each and identify the correct Node. SS-1 traverses **From Node** <u>CB-1</u> to **Node** <u>CB-3</u>:

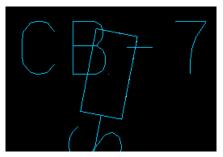
📕 Link Configura	ion Definition	• 🔀
Link ID: 4 SS-	▼ ► 🖾 Window Center 💅 🏏 🦋 🥢 🚺	Apply
Details		
Options	Description:	_
Definition	From Node: CB-1 🔹 🎲 To Node: CB-3	- 👩
Conditions Constraints Computation	Length: 216.0000 Use MS Element ID Configuration Shape: Circular  Material: Concrete	
Type Pipe Ditch	Design Size Size: None Select     Design Barrels Number of Barrels: 1      Roughness: 0.     Override Library Payitem:	) 012

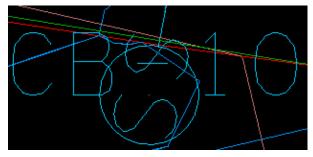
**NOTE:** All drainage nodes include pipe connection points on the structures (for circular structures there are <u>NOT</u> single points but an entire circle for connection). When a drainage node is identified for connection it will use the nearest face to the identification Data Point. **Therefore it is important to Zoom in close enough to drainage nodes and identify them at the correct connection point of the structure.** Correct and Incorrect examples are shown below.





The symbolization for drop inlets display the full extent of the sub-structure as opposed to the normal smaller symbol used for curb and gutter inlets. This is done so that the designer can ensure adequate R.O.W. or easement is provided. For this reason you will **not** see the pipe connection points for these structures since they coincide with the structure wall as shown below.





e) Set the remaining Link Configurations as follows:

Shape: <u>Circular</u> Material: <u>Concrete</u> Design Size: <u>Toggle ON</u> Design Barrels: <u>Toggle OFF</u> Number of Barrels: <u>1</u> Roughness: <u>Automatically set based on the selected Material</u>

### NOTES:

Multiple barrels could be designed, if required, by toggling **Design Barrels** <u>ON</u> or setting **Number of Barrels** to the determined number.

If the link size is known, it may be input by toggling **Design Size** <u>OFF</u> and clicking on the **Select...** button.

🕌 Link Configurat	ion Definition 📃 🗉 💌
Link ID: 4 SS-1	<ul> <li>Window Center</li> <li>Window Center</li> <li>Y</li> <li>Window Center</li> <li>Y</li> <li>X</li> <li>Apply</li> </ul>
Details	
Options	Description:
Definition	From Node: CB-1 🔹 🏂 To Node: CB-3 💌 💆
Conditions	Length: 216.0000 🔲 Use MS Element 🔟
Constraints	Configuration
Computation	Shape: Circular 💌 Material: Concrete 💌
Туре	☑ Design Size Size: None Select
Pipe	Design Barrels Number of Barrels: 1  Roughness: 0.012
Ditch	Override Library Payitem:

f) Conditions > The elevations shown are based on the Node Elevation minus the min/max depth. These depths were specified in the Node Definition (See Exercise 5) Dialog Box for Nodes CB-1 (From Node) and CB-3 (To Node) respectively. In this case, no entries are necessary and GEOPAK Drainage will design all the profiles for this project.

Link ID: 4 SS-1	•	) 🕨 📃 Window 📄 Highlight	Center 🧚 🏏	🏏 🥢 🗡
Details	Profile Conditi	ons		
Options Definition Conditions Constraints Computation	Min Cover: Soffit:	From Node 878.590 0.000	Slope 2.447 0.000	To Node 872.471 0.000
Type	Max Depth:	860.970	2.515	854.681
From No	ode: CB-1		To	Node: CB-3

**NOTE:** When **manually** defining Invert elevations for links, make sure the drop across a structure is accounted for. In other words, if you were to define the Invert elevations for Links SS-1 and SS-3 at CB-3, then make sure the **From Node Invert e**levation for Link SS-3 is at <u>least</u> the minimum drop <u>lower</u> than the **To Node Invert** elevation for Link SS-1.

g) Constraints > Establish the min/max design criteria for Links as follows:

Rise Min/Max: <u>1.5 / 4.0 (feet)</u>

Slope Min/Max: 0.50 / 11.00 (%)

Velocity Min/Max: 3.00 / 12.00 (fps)

Link ID: 🖣 SS-1	-	) • 🗖	Vindow Center 🎷	1 7	🧳 Apply
Details					
Options	Design Cor	nstraints Minimum	Maximum		
Definition Conditions	Rise:	1.500	4.000		
Constraints	Slope:	0.500	11.000		
Computation	Velocity:	3.000	12.000		
Type Pipe Ditch					

h) Computations > Displays the computed hydraulic properties of the Link.

Link ID: 4 SS-1	<ul> <li>Window Center</li> <li>Window Center</li> <li>Y</li> <li>Y</li> <li>Apply</li> </ul>
Details	
Options Definition Conditions Constraints Computation	Link is not currently part of a network Computations Unavailable - Perform Network Computations
Type Pipe Ditch	

**NOTE:** Link hydraulics are not available for review until a Network has been established and designed or analyzed successfully (See Exercise 8). Check back here for computations after the Network has been added and designed or analyzed.

i) Click the Apply button to include this Link in the drainage project.

j) Add the remainder of the link conveyance system using **Component > Link > Add** from the Drainage Menu Bar or by clicking the **Add Link** button as shown below.

Link ID: 4 SS-1	<ul> <li>Window Center</li> <li>Window C</li></ul>
Details	Add Link
Options Definition Conditions Constraints Computation	Link is not currently part of a network Computations Unavailable - Perform Network Computations
Type Pipe	

As Links are added, most dialog values default from the previous Link with the exception of **From Node** and **To Node**. Add Links between all of the following Nodes:

Link SS-2 Traverses From Node <u>CB-2</u> To Node <u>CB-4</u>
Link SS-3 Traverses From Node <u>CB-3</u> To Node <u>CB-6</u>
Link SS-4 Traverses From Node <u>CB-4</u> To Node <u>CB-9</u>
Link SS-5 Traverses From Node <u>CB-5</u> To Node <u>CB-2</u>
Link SS-6 Traverses From Node <u>CB-6</u> To Node <u>CB-12</u>
Link SS-7 Traverses From Node <u>CB-7</u> To Node <u>CB-3</u>
Link SS-8 Traverses From Node <u>CB-8</u> To Node <u>CB-6</u>
Link SS-9 Traverses From Node <u>CB-9</u> To Node <u>CB-11</u>
Link SS-10 Traverses From Node <u>CB-10</u> To Node <u>CB-9</u>
Link SS-11 Traverses From Node CB-11 To Node CB-13
**Link SS-12 Traverses From Node <u>CB-12</u> To Node <u>CB-14**</u>
**Link SS-13 Traverses From Node <u>CB-13</u> To Node <u>MH-1**</u>
Link SS-14 Traverses From Node <u>CB-14</u> To Node <u>MH-1</u>
Link SS-MH1 Traverses From Node MH-1 To Node EW-1
** Coo notoo on nové none **

\*\* See notes on next page \*\*

### 6.2 Curved Links

 a) Use MicroStation's Place Arc Tool and use the settings 'Method: Start, Mid, End' to draw a curved element (must be a continuous line string) between the nodes and following the middle of the gutter to the extent possible.

NOTE: Make sure the ends of the MicroStation Element terminate at the correct attachment point on the catch basin.

- b) In the Link Configuration Definition dialog toggle ON Use MS Element.
- c) Click the Select Element button then Data Point on the element created in Step 1. Then click Apply.

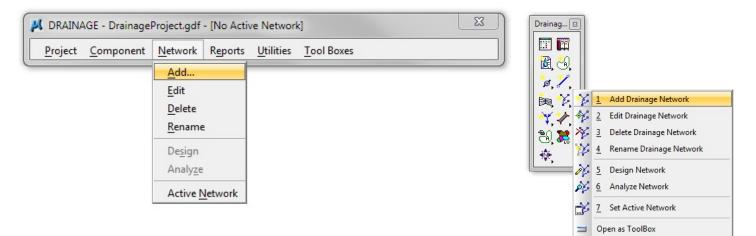
Details Description	
Options	
Definition From Nod	le: CB-12 🔹 🏂 To Node: CB-14 💌 🏂
Constraints Configu	
Computation Shape:	Circular   Material: Concrete   Select Element
- <b>D</b> :	sign Size Size: None Select
Pipe De	sign Barrels Number of Barrels: 1 💌 Roughness: 0.012



**NOTE:** Be sure to toggle **Use MS Element** <u>OFF</u> for subsequent Links that are not curved. When used, the Link position and length are defined by the MS Element. **Caution must be used** in order to properly define the Link.

### 6.3 Storm Drainage Network Design

a) Select the Add Drainage Network tool or select Network > Add from the main drainage menu bar.



b) In the Add a New Network dialog, enter the following information:

	t ID: <u>WEST</u> lode: <u>EW-1</u>
ſ	📕 Add a New Net
	Network ID: WEST Description: Outlet Node: EW-1
	OK Cancel ID Outlet

**NOTE:** The **Outlet Node** may be selected via the dropdown or by clicking **ID Outlet** and selecting the Node in the plan view.

c) Click OK in the Add a New Network dialog box.

Network ID: 4 WEST	• •	🌾 🌾 🎲 🎲 Apply
Details		
Description:		Outlet Node: EW-1 💌 🍫
Validation	Computations	Lock Sizes Unlock Sizes
<b>r</b> ě 🔸	it it	Lock Elevations Unlock Elevations

# **Exercise 6**

d) Click the **Build Network** button. This feature verifies the nodes and link connectivity.

Network Configuration - [No Active Netwo	ork]
Network ID: 4 WEST	🔉 🌾 🐝 👍 🛛 Apply
Details Description:	Outlet Node: EW-1 💌 🏂
Validation Computations	Lock Sizes Unlock Sizes Lock Elevations Unlock Elevations
Build Network	

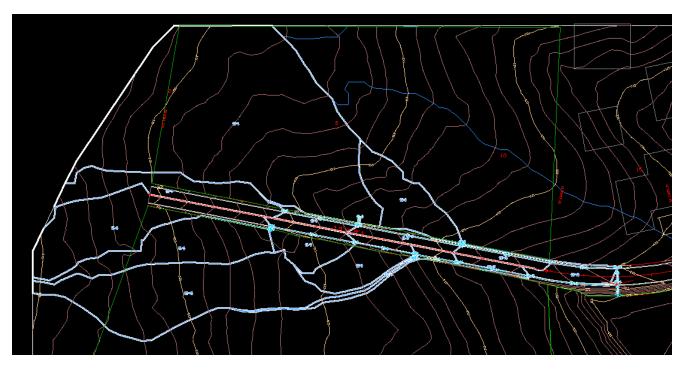
Click OK.

Network WEST Successfully Built Total Node in Network = 16 Total Links in Network = 15	
<u>O</u> K	

e) Click the **Highlight Network** feature. This Feature highlights all components (areas, inlets, pipes, etc.) connected to the active Network.

Network Configuration -	[No Active Netwo	ork]
Network ID: 4 WEST	• •	😽 🧏 🎲 🕁 🗛 Apply
Details Description:		Outlet Node: EW-1 🔹
Validation	Computations	Lock Sizes Unlock Sizes
Highlight	Network	Lock Elevations Unlock Elevations

f) Verify that all network components are highlighted.



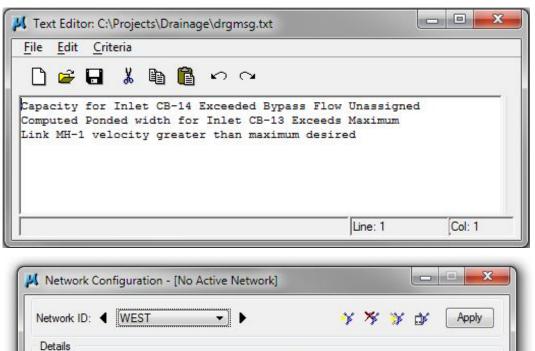
- g) Click the Apply button. Network "WEST" has been added to the project.
- h) Click the **Design** button. This command initiates the hydraulic design of the components contained in the Network.

letwork ID: 4 WEST	• •	🌾 🌾 🐩 🗛 Apply
Details		
Description:		Outlet Node: EW-1 👻 🏝
Validation	Computations	Lock Sizes Unlock Sizes
<b>T</b> 2 2	Of Pro	Lock Elevations Unlock Elevations

#### Click OK.

<b>(j)</b>	Network WEST Hydraulics Computed With Warnings Total Node in Network = 16 Total Links in Network = 15
-	<u>O</u> K

i) Review errors to determine steps needed to correct and close the text editor. (See **Appendix C** for common errors and fixes)



#### NOTES:

Pressing Design or Analyze should be the last step in Designing or Analyzing the Network.

Analyze

Computations

00

**Design** performs hydraulic design of the network and designs components of the network as indicated by the 'design toggles'. **Analyze** performs hydraulic analysis of the network as is and ignores all 'design toggles'.

Outlet Node: EW-1

Lock Sizes

Lock Elevations

Description:

Validation

T

X

**\***-

**Unlock Sizes** 

Unlock Elevations

Lock and Unlock buttons allow the user to lock or unlock all components in a network at the given Size or Elevation. Caution must be used when selecting Unlock as this action will unlock <u>ALL</u> Sizes or Elevations, including ones that should not have been unlocked.

After **Design** or **Analyze** has been utilized, computation values are shown in each link configuration of the network which can be reviewed in the Link Configuration edit dialog. Other methods of reviewing this data will be discussed in Exercise 10, Drainage Navigator.

Link Configuratior	n Computations	
Link ID: SS-1	▼ ▶ □ Window Center ▶ ▶ ▶ ≥  Highlight	Apply
Details		
Options Definition Conditions Constraints Computation Type Pipe Ditch	Flow is supercritical Discharge = 1.457 Capacity = 17.820 Rise = 1.500 Roughness = 0.013 Slope = 2.487 Friction Slope = 2.492 Critical Slope = 0.485	

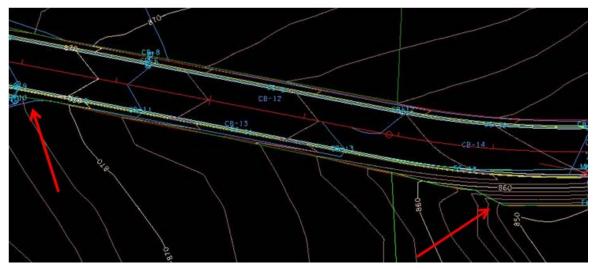
# 7. Ditch Nodes and Links

This exercise shows the user how to utilize the tools for nodes and links for ditch analysis. We will investigate the drainage flow along a fill slope with these settings and in a later chapter define a special ditch to manage it.

# 7.1 Ditch Node Design DIT-1

### **Begin Ditch**

a) Visually determine the tentative location of the beginning of the ditch. In this case a ditch is created along the south side of the roadway by the new fill slopes.



- b) Select from the Drainage Menu Bar: Component > Node > Add or from the main toolbar: Add Drainage Node.
- c) In the New Node window that appears, set the name DIT-1 and click OK.

	Node ID:	DIT-1
vescription:	Description:	

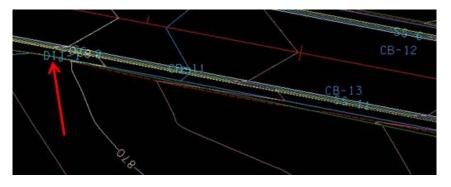
d) Properties > Set Node Type to Other and Library Item to Ditch Begin.

Node Configuratio	on - Properties	
Node ID:	▼ ► Window Cent	ter 🏂 🙍 🔭 🧏 Apply
Details		
Options	Description:	
Properties	Node Type: Other	
Location Spread Criteria	Profile: On Grade	
Elevations	Library Item: Ditch Begin	
Junction Loss		
Discharge Options		
Computations	Node Bottom: None Available	▼ ▲!*
	Override Library Payitem:	Align

e) Location > All settings should have carried over from the last Node input. Review and make the following changes:

Node Configuration - Location	X
Window Center	
Node ID: DIT-1 Mighlight	Apply
Details	
Options V Chain: CL V Profile: DESIGNCL	•
Properties Coordinates / Stationing	
Location Align: Tangent to Chain ▼ # + Angle: 0.000	
Spread Criteria	
Elevations Station: 8+50.00 X: 3411.793	
Junction Loss	
Discharge Options	

This will approximate the beginning of the ditch as shown below:



**NOTE:** The **Spread Criteria** configuration is not required for **Other** node types such as are used by ditches.

**f) Elevations >** All settings should have carried over from the last Node input. Review and make the following changes:

Vertical Alignment: <u>Match Invert</u> Minimum Depth: <u>0.00</u> Maximum Depth: <u>0.00</u>

Node ID:  DIT-1	• • •	Window Center 🏤 🏂 🖊	k 🖹 👫	Apply
Details	_			
Options	Reference Surface:	TIN File   final.tin		<u> </u>
Properties Location	Elevation Source:	Reference TIN	870.257	
Spread Criteria	Node Elevation Option:	Same as Source 🔹	870.257	
Elevations	Vertical Alignment:	Match Invert -	0.210	
Junction Loss Discharge Options	Minimum Depth:	0.000		
Computations	Maximum Depth:	0.000		
	Add Sump Depth:	0.000		

g) Discharge Options > Leave Use Computed Discharge selected and click Apply to save all settings.

Node Configuration	on - Discharge Options
Node ID:	Window Center
Details	
Options	Use Computed Discharge
Properties Location Spread Criteria Elevations Junction Loss Discharge Options Computations	Supplied Discharge: 0.000 Disable Inlet Calculations Capacity: 0.0000 Link Base Flow Area CB-1

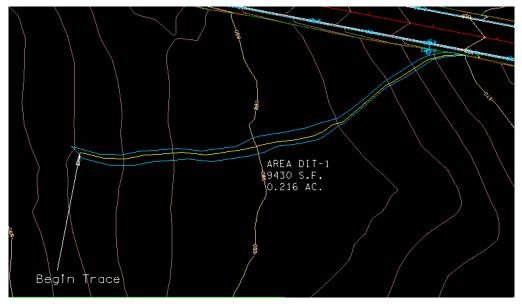
**NOTE:** For short ditches where only a single drainage area is utilized, the **Link Base Flow Area** option should be toggled ON and set to add the discharge for that area. It is then toggled off at the ditch outlet. If this is not toggled OFF at other nodes beyond the beginning, the discharge will accumulate at each node and not accurately represent the area's discharge.

### 7.2 Delineate Drainage Area DIT-1

### Begin Ditch Drainage Area

- a) From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **DIT-1** should automatically appear, click **OK**.
- b) Follow the steps in Exercise 4.1 to delineate and define the drainage area for the begin ditch location. (You may use the following images as reference points. It is ok if your numbers do not match exactly.) Attach reference file DA\_DIT-1. You may want to turn off the level SURVEY DRAINAGE Area Shapes to see the ditch easier.

Delineate Drainage Area:



**NOTE:** The drainage area should be broken into sections for long ditches, however, for short ditches; determine the area from the most downstream point (i.e. the stream outlet).

c) Define Drainage Area:

ዞ Drainage Area D	efinition		
Area ID: 4 DIT-1		Window Center 🔬 🦉	a 🔏 🐴 🛛 Apply
Details			
Options	Description:	To Node	eID: DIT-1 🦓
Definition Subareas Computation	Drainage Area: 0.216 Base C Value: 0.350 Time of Conc.: 5.000	Area Selection / Crea Select Shape	Create DTM Shape
<ul> <li>Hydro. Method</li> <li>Rational</li> <li>SCS</li> </ul>	Compute TC	Pick Boundary Elements	DP Create Shape

# **Exercise 7**

			Details				
Drainage Area ID: D	IT-1		Distance	Slope	Avg. Slope	Flow	-
TIN File  Final.tin	Ú.	Q	19.05	2.54	2.54	Sheet	
			18.09	2.34	2.44	Sheet	н
Define Path			14.57	2.79	2.54	Sheet	
Trace	() ID-	Segments	18.40	2.71	2.59	Sheet	
	-		13.90	3.47	2.73	Sheet	
Sheet How			13.51	2.82	2.74	Sheet	
Method: FHA	Length:	300.000	18.93	2.29	2.67	Sheet	
			11.16	2.32	2.64	Sheet	
Value: 0.400	Slope:	2.034	21.01	2.35	2.60	Sheet	
Challen Dem			8.78	2.03	2.57	Sheet	
Shallow Row	I and the	100.000	23.47	1.66	2.45	Sheet	
	Length:	100.000	12.56	1.57	2.39	Sheet	
Inter. K: 0.491	Slope:	1.593	19.71	1.98	2.35	Sheet	
			8.97	1.19	2.31	Sheet	Ŧ
Concentrated F	and the second se		Distance:	Slope	ь.		
Method: Continuity	Length:	225.554	19.050	2.54		Adjust Flo	w
	Velocity:	5.000	15.050	2.34	+0		
			Max S	heet Flow	Distance:	300.000	1
Arrent Distances	COF FEA						1
	625.554	<	Max Sha	NOW FIOW	Distance:	100.000	1
Accum. Avg. Slope:	2.477						

d) Calculate Time of Concentration:

Make settings as shown for Max Sheet Flow and Max Shallow Flow. We will use these settings for all the ditch areas.

The calculated Time of Concentration is **GREATER** than the minimum of 5 minutes; therefore the Time of Concentration will automatically be filled in after hitting Apply with NO further steps required

e) Delineate Subareas utilizing the Land Use DGN:

📕 Drainage Area Su	ıbareas						
Area ID: 4 DIT-1		• •	] Window Center ] Highlight	1 🖄	8	8	Apply
Details							
Options			To	Node I	D: D	)IT-1	<i>6</i> <sub>10</sub>
Definition	Subarea	C Value	Description				
Subareas	0.2164	0.300	Forested Areas				tomatic lineation
Computation					*	De	ameauon
						V D	)isplay Only
Hydro. Method					×		incpicely entity
Rational							
SCS							
0 000	0.216	0.300	Forested Areas				

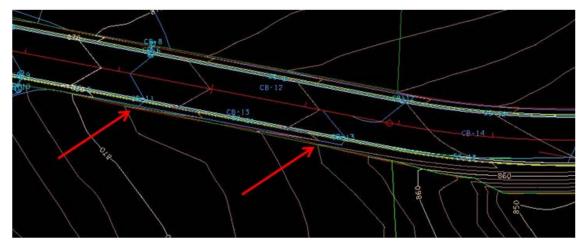
f) Compute Discharge and Apply:

Area ID:	•	Window Center	<u>*</u> n *n	🔏 👸 🗛 Apply
Details				
Options		Area	C Value	Compute
Definition Subareas	Total Subareas:	0.216	0.300	Discharge
Computation	Remainder:	0.000	0.350	
Hydro. Method	Composite:	0.216	0.300	
Rational	Computed Intensity:	3.219		
SCS	Computed Discharge:	0.209		

## 7.3 Ditch Node Design DIT-2

a) Visually determine the location of any major ditch change; such as a change in horizontal or vertical alignment or a change in cross section.

In this initial set up we are analyzing the flow along the fill slope and will set them as shown.



- b) Select from the Drainage Menu Bar: Component > Node > Add or from the main toolbar: Add Drainage Node.
- c) In the New Node window that appears, set the name DIT-2 and click OK.

d) Properties > Set Node Type to Other and Library Item to Ditch Change.

Node Configuration	on - Properties	
Node ID: DIT-2	Window Cente	er 🐀 😹 🧏 🦓 Apply
Details		
Options	Description:	
Properties Location Spread Criteria Elevations Junction Loss Discharge Options	Node Type: Other Profile: On Grade Library Item: Ditch Change	
Computations	Node Bottom:         None Available           Override Library Payitem:	Align

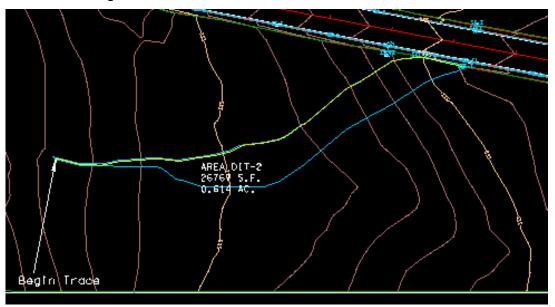
e) Location > All settings should have carried over from DIT-1. Review and make the following changes (estimated change locations):

Node Configuration - Location         Node ID:       DIT-2         Window Center       Image: Ima	Station: <u>9+25.00</u> Offset: <u>36.00</u>	<u>)</u>
Node ID:       DII-2       Image: Highlight       Image: Highlight       Image: Highlight       Apply         Details       Options       Image: Chain:	Node Configuratio	n - Location
Options       Image: Chain:       CL       Image: Properties         Properties       Coordinates / Stationing         Location       Align:       Tangent to Chain       Image: Align:       + Angle:       0.000         Spread Criteria       Elevations       Station:       9+25.00       Image: X:       3484.798         Junction Loss       Discharge Options       Offset:       36.000       Y:       3055.330	Node ID:	
Properties       Coordinates / Stationing         Location       Align: Tangent to Chain         Spread Criteria       Station: 9+25.00         Levations       X: 3484.798         Junction Loss       Offset: 36.000         Discharge Options       Min. Market and		Chain: CL
	Properties Location Spread Criteria Elevations Junction Loss	Coordinates / Stationing Align: Tangent to Chain  + Angle: 0.000 Station: 9+25.00 X: 3484.798

f) Click Apply.

### 7.4 Delineate Drainage Area DIT-2

- a) From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **DIT-2** should automatically appear, click **OK**.
- b) Follow the steps in Exercise 4.1 to delineate and define the drainage area for this ditch change location. Attach reference file DA\_DIT-2 and turn off DA\_DIT-1.



Delineate Drainage Area:

c) Define Drainage Area:

📕 Drainage Area D	efinition		
Area ID: 4 DIT-2	• •	] Window Center ] Highlight 🕺 🚷	🔏 🖓 🗛 Apply
Details			
Options	Description:	To Node II	D: DIT-2 🦓
Definition Subareas Computation	Drainage Area: 0.614 Base C Value: 0.350 Time of Conc.: 5.000	Area Selection / Creation Select Shape	Create DTM Shape
Hydro. Method Rational SCS	Compute TC	Pick Boundary Elements	DP Create Shape

d) Calculate Time of Concentration:

H Time of Concentration	
Drainage Area ID: DIT-2	
TIN File  Final.tin	۹
Define Path	
Trace (I) ID - :	Segments
Sheet How	
Method: FHA Length:	300.000
n Value: 0.400 Slope:	1.963
V Shallow Row	
Length:	100.000
Inter. K: 0.491 Slope:	1.573
Concentrated How	
Method: Continuity Length:	296.435
Velocity:	5.000
Accum. Distance: 696.435	
Accum. Avg. Slope: 2.566	>
Tc= 35.542 Compute	Apply

The calculated Time of Concentration is **GREATER** than the minimum of 5 minutes; therefore the Time of Concentration will automatically be filled in after hitting Apply with NO further steps required

e) Delineate Subareas utilizing the Land Use DGN:

📕 Drainage Area Su	ibareas				
Area ID:    DIT-2		• •	] Window Center ] Highlight	<u>8</u> 8	Apply
Details					
Options			To N	lode ID: [	DIT-2 🦓
Definition	Subarea	C Value	Description		
Subareas	0.6132	0.300	Forested Areas		Automatic
Computation				1	Delineation
				<b>P</b>	Display Only
Hydro. Method				_	V Dispidy Only
-				$ \times $	
Rational					
SCS	0.010	0.200	E 1 1 A		
	0.613	0.300	Forested Areas		

f) Compute Discharge and Apply:

📕 Drainage Area Co	📕 Drainage Area Computations					
Area ID:	•	Window Center	ත ති	8	۹	Apply
Details						
Options		Area	C Value	ſ	Com	pute
Definition Subareas	Total Subareas:	0.613	0.300			harge
Computation	Remainder:	0.001	0.350			
- Hydro. Method	Composite:	0.614	0.300			
Rational	Computed Intensity:	3.190				
	Computed Discharge:	0.588				

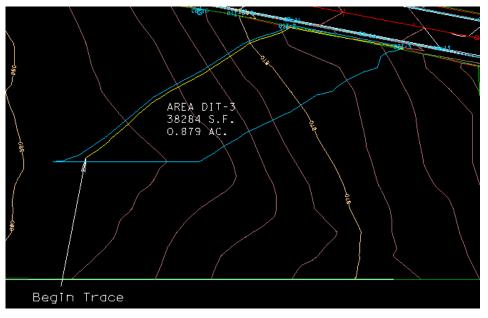
### 7.5 Ditch Node Design DIT-3

**Repeat previous steps** on pages 7-7 & 7-8 creating ditch change Node **DIT-3** at **Station: 10+90.00** and **Offset: 34.00**. All other information should remain unchanged.

## 7.6 Delineate Drainage Area DIT-3

- a) From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **DIT-3** should automatically appear, click **OK**.
- **b)** Follow the steps in Exercise 4.1 to delineate and define the drainage area for this ditch change location.

Delineate Drainage Area:



**c)** Define Drainage Area:

📕 Drainage Area D	efinition		- • ×
Area ID: 4 DIT	₃ ▼ ▶ □	Window Center Highlight	â 🔏 👸 🗛 Apply
Details			
Options	Description:	To No	de ID: DIT-3 🥠
Definition Subareas Computation	Drainage Area: 0.879 Base C Value: 0.350 Time of Conc.: 5.000	Area Selection / Cr Select Shape	Create DTM Shape
Hydro. Method Rational SCS	Compute TC	Pick Boundary Elements	DP Create Shape

d) Calculate Time of Concentration:

📕 Time of Concentration 🛛 📼 💌
Drainage Area ID: DIT-3
Define Path Trace (1) ID - Segments
✓ Sheet How         Method:       FHA         N Value:       0.400         Slope:       3.363
Shallow How
Length: 100.000
Inter. K: 0.491 Slope: 2.536
Concentrated Flow
Method: Continuity  Length: 107.199
Velocity: 5.000
Accum. Distance: 507.199 Accum. Avg. Slope: 2.779
Tc= 28.547 Compute Apply

The calculated Time of Concentration is **GREATER** than the minimum of 5 minutes; therefore the Time of Concentration will automatically be filled in after hitting Apply with NO further steps required e) Delineate Subareas utilizing the Land Use DGN:

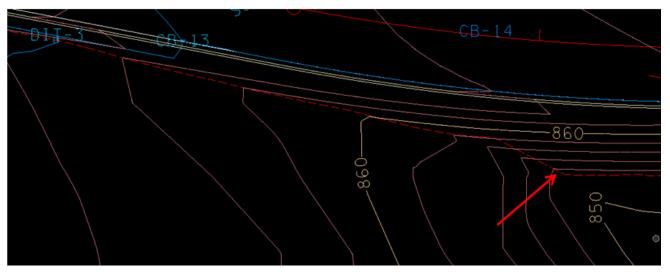
🦊 Drainage Area Su	bareas			
Area ID: 4 DIT-3	•	Window Center	ත හා 🕅	Apply Apply
Details				
Options		Т	Fo Node ID: D	)IT-3 💋
Definition Subareas	Subarea C Valu 0.8684 0.300			Automatic
Computation	0.0004 0.300	Forested Areas	1	Delineation
Hydro. Method Rational			×	🔽 Display Only
⊚ SCS	0.868 0.300	Forested Areas		

f) Compute Discharge and Apply:

📕 Drainage Area Co	omputations			- • •
Area ID: 4 DIT-3	•	Window Center	ත ති	🔏 🔏 🛛 Apply
Details				
Options		Area	C Value	Compute
Definition Subareas	Total Subareas:	0.868	0.300	Compute Discharge
Computation	Remainder:	0.010	0.350	
Hydro. Method	Composite:	0.879	0.301	
Rational	Computed Intensity:	3.536		
◎ SCS	Computed Discharge:	0.934		

### 7.7 Ditch Node Design DIT-4

a) Visually determine the location of the ditch outlet.



- b) Select from the Drainage Menu Bar: Component > Node > Add or from the main toolbar: Add Drainage Node.
- c) In the New Node window that appears, set the name DIT-4 and click OK.
- d) Properties > Set Node Type to <u>Outlet</u>, Library Item to <u>Ditch Outlet</u> and Fix Tailwater at <u>Critical Depth</u>

Node Configuration - Properties				
Node ID: <b>DIT-4 Window Center Node ID:</b> Highlight				
Details				
Options	Description:			
Properties	Node Type: Outlet			
Location	Profile: On Grade			
Spread Criteria Elevations	Library Item: Ditch Outlet	$\sim$		
Junction Loss	Fix Tailwater at: Critical Depth			
Discharge Options	Tailwater Elevation: 0.000			
Computations	Node Bottom: None Available			
	Override Library Payitem:	Align		

e) Location > All settings should have carried over from DIT-3. Review and make the following changes:

### Station: <u>13+15.00</u>

Offset:	58.00

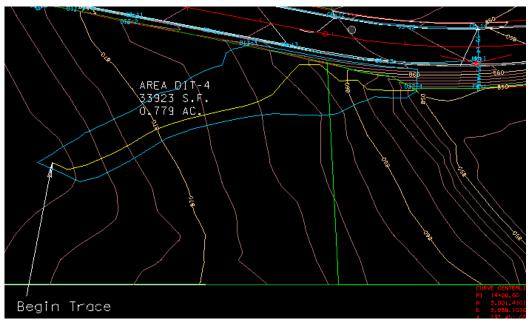
🛚 Node Configuratio	on - Location
Node ID: DIT-4	✓ Window Center Highlight
Details	
Options	Chain: CL   Profile: DESIGNCL
Properties	Coordinates / Stationing
Location	Align: Tangent to Chain 🔻 💉 + Angle: 0.000
Spread Criteria	
Elevations	Station: 13+15.00 X: 3872.012
Junction Loss	_♥ Offset: 58.000 ¥ Y: 2967.172
Discharge Options	Mirror Node Offset from Gutter to Inlet: 0.000
Computations	

f) All other options should be set from previous nodes, click Apply.

# 7.8 Delineate Drainage Area DIT-4

- a) From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes.** The name **DIT-4** should automatically appear, click **OK**.
- **b)** Follow the steps in Exercise 4.1 to delineate and define the drainage area for this ditch outlet location.

Delineate Drainage Area:



# **Exercise 7**

c) Define Drainage Area:

📕 Drainage Area D	efinition		
Area ID: 🖣 DIT-4	↓ ▼ ▶ …	Window Center Highlight 🐴 🦄	🕅 👸 🗛 Apply
Details	_		
Options	Description:	To Node	ID: DIT-4 🦓
Definition Subareas Computation	Drainage Area: 0.779 Base C Value: 0.350 Time of Conc.: 28.547	Area Selection / Creati Select Shape	Create DTM Shape
Hydro. Method	Compute TC	Pick Boundary Elements	DP Create Shape

d) Calculate Time of Concentration:

📕 Time of Concentration 🛛 🗖 🔳
Drainage Area ID: DIT-4 TIN File  final.tin
Define Path Trace () ID - Segments
Sheet Flow           Method:         FHA         Length: 300.000           n Value:         0.400         Slope: 3.628
Shallow Flow
Length: 100.000
Inter. K: 0.491 Slope: 4.372
Concentrated How
Method: Continuity Length: 146.165
Velocity: 5.000
Accum. Distance: 546.165 Accum. Avg. Slope: 4.840
Tc= 27.674 Compute Apply

The calculated Time of Concentration is **GREATER** than the minimum of 5 minutes; therefore the Time of Concentration will automatically be filled in after hitting Apply with NO further steps required e) Delineate Subareas utilizing the Land Use DGN:

ዞ Drainage Area Su	bareas						
Area ID:   DIT-4		• •	] Window Center ] Highlight	a 2a	8	٨	Apply
Details							
Options			To	Node I	D: D	IT-4	l <sub>øs</sub>
Definition Subareas	Subarea 0.1032	C Value 0 400	Description Turf Meadows				tomatic
Computation	0.6249	0.300	Forested Areas		*	De	lineation
<ul> <li>Hydro. Method</li> <li></li></ul>	0.625	0.300	Forested Areas				iisplay Only

f) Compute Discharge and Apply:

📕 Drainage Area Co	omputations					
Area ID: 4 DIT-4	•	Window Center	ත ක	8	٩	Apply
Details						
Options		Area	C Value	Γ	Cor	npute
Definition Subareas	Total Subareas:	0.728	0.314			charge
Computation	Remainder:	0.051	0.350			
Hydro. Method	Composite:	0.779	0.317			
Rational	Computed Intensity:	3.612				
© SCS	Computed Discharge:	0.890				

**g)** Since Node DIT-4 is an outlet type, it will **not** consider the drainage area developed for it. In order to ensure the final ditch link, will be adequate for the capacity at the end we will need to link the DIT-4 drainage area to Node DIT-3.

Go to **Component> Node> Edit** and **select node DIT-3**. Under Discharge Options click on the option to **Link Base Flow Area** and set to include the DIT-4 drainage area.

📕 Node Configuratio	on - Discharge Options
Node ID: DIT-3	▼ ▶ Window Center 🍿 🧏 🧏 🦓 Apply
Details	
Options	Ose Computed Discharge
Properties Location Spread Criteria Elevations Junction Loss	Supplied Discharge:       3.500         Disable Inlet Calculations       Capacity:       0.0000         Link Base Flow Area       DIT-4       X
Discharge Options	
Computations	

### 7.9 Ditch Link DIT-1

We are checking the drainage flow along a fill slope so all links are set up as cross section based. The surface is read for the ditch shape and capacity is calculated at each cross section that is cut along the links.

#### **Cross Section Based Link DIT-1**

- a) Select from the Drainage Menu Bar: Component > Link > Add or from the main toolbar: Add Drainage Link
- b) Set the Name to DIT-1 and click OK.
- c) Set the From Node as DIT-1 and the To Node as DIT-2 via the dropdown list or by clicking the Node ID button and selecting the appropriate node.
- d) In the Details portion of the dialog change Type to Ditch.
- e) In the Configuration portion of the dialog set the following:

Ditch Type: Cross Section Based

Roughness: 0.027 (See TDOT Drainage Manual Chapter 5 Table

5A-1 for typical values)

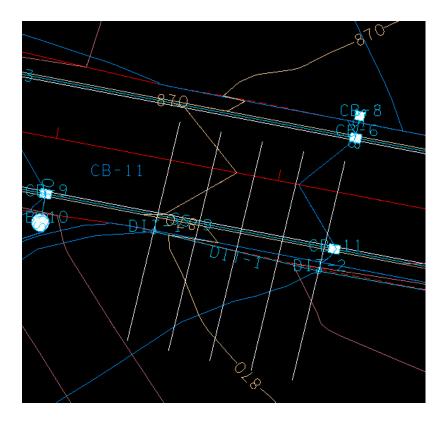
Number of Cross Sections: 5 (Typically one cross section every

5 feet to a maximum of every 50 feet for long ditches)

Width of Cross Sections: <u>100</u> (Ensure top of bank on both sides is captured)

Link ID: 🔳 DI	F-1 ▼ Window Center 2 2 2 Apply
Details	
Options	Description:
Definition	From Node: DIT-1 💌 🏂 To Node: DIT-2 💌 📩
Conditions Constraints Computation	Length: 75.0816 Use MS Element Configuration Ditch Type: Cross Section Based  Roughness: 0.027
Type Pipe ODitch	Number Of Cross Sections:     5       Width Of Cross Sections:     100.0000

f) Click **Apply** and review the cross section lines displayed in the plan view (shown on next page) to determine if adjustments should be made.



### NOTES:

Since we are using the Cross Section Based ditch type to analyze existing conditions, the **Conditions** and **Constraints** require no special settings. In the system modification chapter, we will use those to control the proposed ditch that is to be designed.

**Computation** will not show any information until a drainage network is built from the nodes and links in this ditch system.

This same set up using the **Cross Section Based** ditch type can be used to analyze long proposed roadway ditches for capacity and function.

### 7.10 Ditch Link DIT-2

### **Cross Section Based Link DIT-2**

- a) Select from the Drainage Menu Bar: Component > Link > Add or from the main toolbar: Add Drainage Link
- b) Set the Name to DIT-2 and click OK.
- c) Set the From Node as DIT-2 and the To Node as DIT-3 via the dropdown list or by clicking the Node ID button and selecting the appropriate node.
- d) In the *Details* portion of the dialog change Type to Ditch.
- e) In the *Configuration* portion of the dialog set the following:

Ditch Type: Cross Section Based

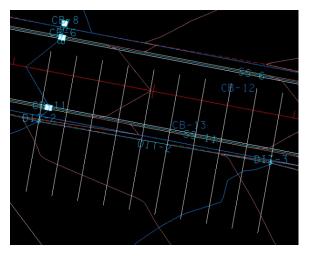
Roughness: 0.027 (See TDOT Drainage Manual Chapter 5 Table 5A-1 for typical values)

Number of Cross Sections: <u>10</u> (Typically one cross section every

5 feet to a maximum of every 50 feet for long ditches) Width of Cross Sections: 100 (Ensure top of bank on both sides is captured)

Link Configura	tion Definition
Link ID: 📕 DIT-:	2 Vindow Center 1 Nindow Center 1 Apply
Details	
Options	Description:
Definition	From Node: DIT-2 🔻 🙍 To Node: DIT-3 💌 🙍
Conditions Constraints Computation	Length: 165.0121 Use MS Element Configuration Ditch Type: Cross Section Based  Roughness: 0.027
Type Pipe Ottch	Number Of Cross Sections:     10       Width Of Cross Sections:     100.0000

f) Click Apply.



### 7.11 Ditch Link DIT-3

#### **Cross Section Based Link DIT-3**

- a) Select from the Drainage Menu Bar: Component > Link > Add or from the main toolbar: Add Drainage Link
- b) Set the Name to DIT-3 and click OK.
- c) Set the From Node as DIT-3 and the To Node as DIT-4 via the dropdown list or by clicking the Node ID button and selecting the appropriate node.
- d) In the *Details* portion of the dialog change Type to Ditch.
- e) In the *Configuration* portion of the dialog set the following:

Ditch Type: Cross Section Based

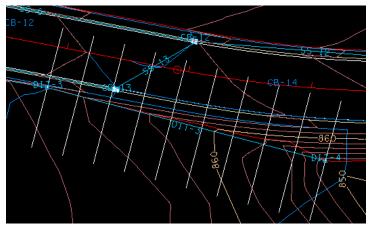
**Roughness:** <u>0.027</u> (See <u>TDOT Drainage Manual Chapter 5</u> Table 5A-1 for typical values)

Number of Cross Sections: <u>10</u> (Typically one cross section every 5 feet to a maximum of every 50 feet for long ditches)

Width of Cross Sections: 100 (Ensure top of bank on both sides is captured)

Link Configurat	tion Definition
Link ID: 📕 DIT-3	B Window Center 1 X X Apply
Details	
Options	Description:
Definition	From Node: DIT-3 💌 🙍 To Node: DIT-4 💌 🙍
Conditions Constraints Computation	Length: 232.4200 Use MS Element Configuration Ditch Type: Cross Section Based  Roughness: 0.027
Type Pipe Ditch	Number Of Cross Sections:     10       Width Of Cross Sections:     100.0000

f) Click Apply.



# 8. Ditch Networks

This exercise shows the user how to setup a network and perform network computations.

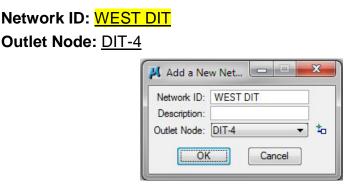
The Network computations serve as the final calculation process in the design or analysis of a storm drainage system. A GEOPAK drainage network is defined as a series of interconnected nodes, links and areas which drain to a single outlet. GEOPAK drainage accommodates multiple networks in a single drainage project.

## 8.1 Ditch Network Design

a) Select the Add Drainage Network tool, select Network > Add from the main drainage menu bar or click the Add Network button in the Network Configuration Dialog.

Network ID: 4 WEST	- ►	💕 ۶ 🧊 🏕 🛛 Apply
Details		Add Network
Description:		Outlet Node: EW-1 🔹 📩
Validation	Computations	Lock Sizes Unlock Sizes
<b>T</b> Ý Ý	16 A.	Lock Elevations Unlock Elevations

b) In the Add a New Network dialog, enter the following information:

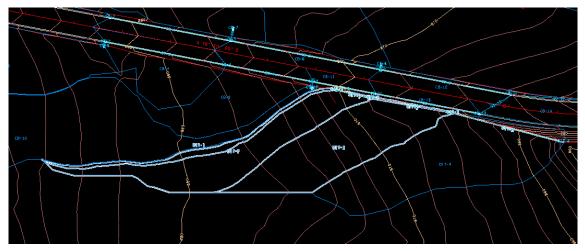


**NOTE:** The **Outlet Node** may be selected via the dropdown or by clicking **ID Outlet** and selecting the Node in the plan view.

c) Click OK in the Add a New Network dialog box.

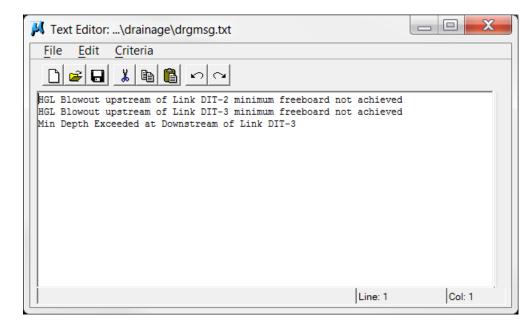
Network ID: 4 WEST	DIT 🔹 🕨	¥ ¥	🐝 🍰 🛛 Apply
Details			
Description:		Outlet Node: DIT-4	▼ <sup>t</sup> ₀
Validation Computations		Lock Sizes	Unlock Sizes
	it it		

- d) Click the Build Network button. Click OK.
- e) Click the Highlight Network feature.
- f) Verify that all network components are highlighted.



**NOTE:** The drainage area DIT-4 will not be highlighted since it is built for an outlet node type which does not consider drainage areas. In the previous chapter, we linked that area to node DIT-3 so that it is covered in this ditch drainage analysis.

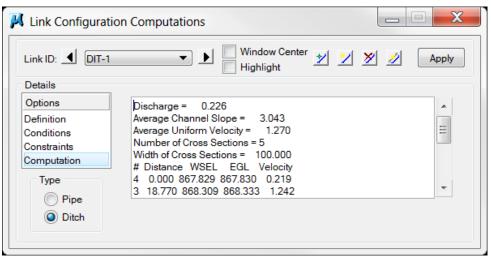
- g) Click the Apply button. Network "WEST DIT" has been added to the project.
- h) Click the Design button, then click OK.
- i) Review errors to determine steps needed to correct and close the text editor. (See **Appendix C** for common errors and fixes)



### 8.2 Ditch Link Review

Now that the ditch network has been built and designed, we can review the computation results for the existing ditch links in the network.

a) Select the Edit Link tool, select Component> Link> Edit from the main drainage menu bar or click the Edit Link button in the Network Configuration Dialog.



Set to link **DIT-1** and select **Computation**.

b) Scroll down through the computation results to the data following the Width of Cross Sections.

This data represents conditions at each cross section drop along the link. Note that these points start at the end of the link and come back up the link to the beginning.

The first data group provides the cross section number (0-4 in this case with 5 cross sections), distance from end, water surface elevation, energy grade line elevation and velocity.

Link Configurat	ion Computations	
Link ID:	▼ ▶ Window Center ½ ½ ½ ⊿/	Apply
Details		
Options	Number of Cross Sections = 5	
Definition Conditions Constraints Computation	Width of Cross Sections = 100.000 # Distance WSEL EGL Velocity 4 0.000 867.829 867.830 0.219 3 18.770 868.309 868.333 1.242 2 37.541 868.927 868.947 1.141	H
Type Pipe Ditch	1 56.311 869.616 869.634 1.078 0 75.082 870.036 870.075 1.586	•

c) Scroll down further to review the second data group.

The second data group provides the cross section number, number of slope break points in cross section, critical depth elevation, and top of water surface width.

📕 Link Configurati	on Computations	
Link ID:	▼ ▶ Window Center ½ ½ ⅔ ⅔	Apply
Details		
Options	1 56.311 869.616 869.634 1.078	
Definition Conditions Constraints Computation Type Pipe	0 75.082 870.036 870.075 1.586 # No Point Crit Depth Top Wid 4 29 867.694 8.847 3 27 868.309 3.830 2 25 868.927 4.755 1 33 869.616 13.044 0 32 870.036 1.842	THE T
<ul><li>Ditch</li></ul>		

d) Switch to our other ditch links, DIT-2 & DIT-3, and review the computed data.

Link ID: 📕 DIT-2	Window Center	💅 📝 🎢 Apply	
Details			
Options	# Distance WSEL EGL Velocity		
Definition Conditions Constraints Computation	9 0.000 865.481 865.485 0.514 8 18.335 865.865 865.908 1.671 7 36.669 866.197 866.248 1.824 6 55.004 866.275 866.321 1.736 5 73.339 866.431 866.497 2.057	Link ID: DIT-3 Window Center Highlight	Z X Apply
Type Pipe Ditch	4 91.673 866.717 866.789 2.161 3 110.008 866.941 867.018 2.217	Details         # Distance WSEL         EGL         Velocity           Definition         9         0.000         851.178         851.301         2.815           Conditions         8         25.824         855.274         855.426         3.128           Constraints         7         51.649         857.554         857.629         2.199           Computation         6         77.473         859.161         859.234         2.163           Type         Pipe         Pipe         3         154.947         862.518         862.606         2.375	

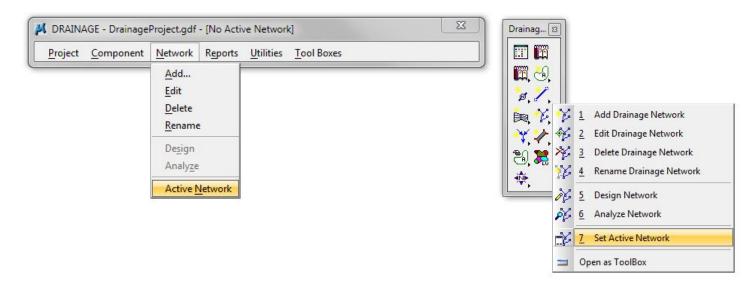
Using this information, we can determine if the existing conditions are adequate to convey the water along the fill line and critical points where more capacity may be required.

If using this methodology to analyze long proposed roadway ditches, you can determine locations where special ditches may be required as the depth/volume becomes too great for the regular ditch to handle.

### **8.3 Select Active Network**

With the possibility of multiple networks in a single drainage project it may be necessary to choose an Active Network to utilize certain GEOPAK Drainage Features.

a) Select the Set Active Network tool, select Network > Active Network from the main drainage menu bar or click the Add Network button in the Network Configuration Dialog.



Network ID:	•	¥ ¥	🌾 👔 Apply
Details			Set Active Netv
Description:	_	Outlet Node: EW-1	• *
Validation	Computations	Lock Sizes	Unlock Sizes
<b>16</b> - 6	de pe	Lock Elevations	Unlock Elevations

**b)** Select the network West and click OK.

ID WEST	Description
VEST DIT	
	Cancel

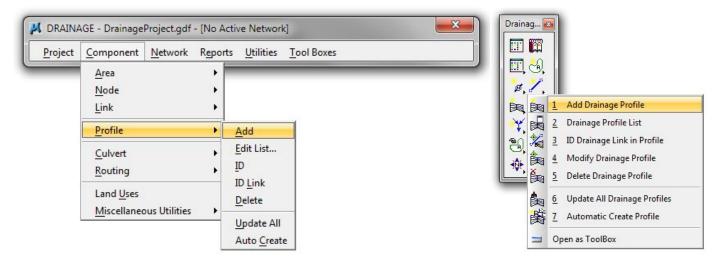
# 9. Profiles

This exercise shows the user how to perform profile computations and properly display the drainage profile.

Profiles can be constructed in a path running in either direction, upstream or downstream, in a drainage network. The Profiles dialog is used to display customized profiles including groundline, nodes, links, depth of cover, hydraulic grade line, etc.

# 9.1 Storm Drainage Profile Design

a) Select from the Menu Bar: Component > Profile > Add or from the main toolbar: Add Drainage Profile



b) Complete the **Profile Configuration** dialog box information as follows for the left side of the roadway in the WEST drainage network. Click **Apply** when finished.

📕 Add Prof	ile 🗖 🗖	×	
Profile ID: Description: From Node: To Node:	CB-1 •	র্জ অ	

**NOTE:** To select the appropriate node; use the dropdown menu or use the **ID** node button and select the node from the plan view. <u>From Node</u> and <u>To Node</u> *must* be in the same network.

c) Load the Profile Preferences file. Inside the Edit Drainage Profile dialog, click File > Open.

ዞ Edit Drainage Profile - WestLT	
<u>F</u> ile	
Open	View Number: 1 🔹 🖪 Apply
Save Display Drainage Informati	ion Grid & Labels Link Profile
Save <u>A</u> s Point	Projection
X: 0.000 DP	Project to Chain: Identify Profile Cell
Y: 0.000	Chain :
Scale	Grid Stationing and Elevations
Horizontal: 10.000	Begin Station: 0+00.00
Vertical: 1.000	End Station: 10+75.88
Node Information	Max. Elevation: 890.000
From: CB-1 To	Min Elevation: 830.000
To: EW-1 🔻 🏂	Reference Surface
Reset Profile	Site Model 🔹
Host Holic	Vertical Offset: 0.000

Navigate to C:Users\Public\Geopak Standards\ and select TDOTStormSewerProfiles-Design.ppf. Click Open.

Look in:	🍌 Geopak Standa	rds	- 🕝 🤌 📂 🛄 -	3 🖲
(Pa)	Name	*	Date modified	Туре
Recent Places	TDOTStormSe	werProfiles.ppf werProfiles-Design.ppf werProfiles-Plan.ppf	8/20/2013 10:24 AM 2/27/2013 8:52 PM 8/23/2013 7:25 AM 11/24/2003 10:35 9/14/2006 10:25 AM 7/25/2012 4:36 PM	File folde File folde PPF File
	•	,III		F
Network	File name:	TDOTStormSewerProfiles-Desig	gn.ppf 👻 [	Open
	Files of type:	*.ppf		Cancel

All settings have been set for the profile. To view the settings, click on the **Display**, **Drainage Information** and **Grid & Labels** tabs. They should look as shown below.

ile				
Description:		View Numb	er: 🚺 💌 🗖	Apply
Registration Display	Drainage Information	Grid & Labels	Link Profile	
Soffit	Water Line Cr	rossings	Label:	12:34
Pipe Center	Drainage Cros	ssings	Label:	12:34
Design Surface	Sewer Line C	rossings	Label:	12:34
Original Ground	Misc. Utility C		Label:	12
Ref Surface	ID:	None Available	<b>v</b>	

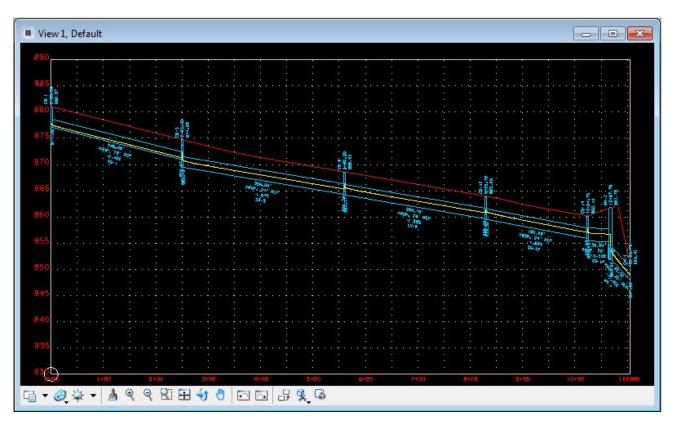
File	10		
Description:		View N	lumber: 🚺 🗾 🔤 App
Registration	Display Dra	inage Information Grid & Lab	oels Link Profile
Hydraulic Grade Line M		Maximum Soffit	Drainage Node
Critical Dep	th	Minimum Invert	
Uniform De	pth	Minimum Cover	
Energy Gra	de Line	Maximum Depth	

ile		
Description:		View Number: 1 - Appl
Registration	Display	Drainage Information Grid & Labels Link Profile
Labels & Grid	Lines	Node Labels
Node Link Label Elevations Grid Boundary Horizontal Grid		Position: Along Profile -
		Label Offset: 5.000
		Library Item Name
		Library Item Description
Vertical G	rid	Profile Name
		Station
		Elevation
		Place Label: Prefix:
		Suffix:

**NOTE:** During the design process these preferences can be modified to display needed information. However, when projecting to a profile (see Exercise 9.2) the settings should match those defined in profile preference file **TDOTStormSewerProfiles-Plan.ppf**.

d) Click the **Registration** tab and make the settings as below in the *Registration Point*, *Scale* and *Reference Surface* portions (ignore the *Projection* portion for now). The Registration Point will correspond to the lower left corner of the profile and can be wherever an open space is available. Click **Apply**.

escription:	View Number: 1 View Apply
egistration Display Drainage Inform	nation Grid & Labels Link Profile
Registration Point	Projection
X: 7500.000 DP	Project to Chain: Identify Profile Cell
Y: 2500.000	Chain :
Scale	Grid Stationing and Elevations
Horizontal: 50.000	Begin Station: 0+00.00
Vertical: 5.000	End Station: 10+75.88
Node Information	Max. Elevation: 890.000
From: CB-1 V	Min Elevation: 830.000
To: EW-1 🔻 💅	Reference Surface
	TIN File  Final.tin Q
Reset Profile	Vertical Offset: 0.000



e) Review the profile for anything that needs to be corrected.

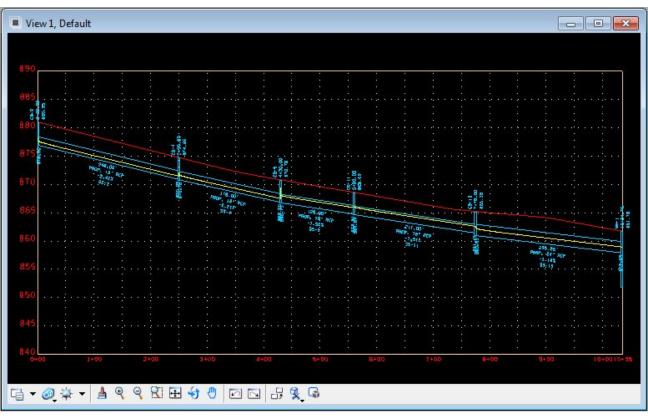
f)	Repeat steps a-d t	o create the	following	profiles:
----	--------------------	--------------	-----------	-----------

Profile ID	From Node - To Node	Registrat	ion Point
WestRT	CB-2 - EW-1	X = 7500	Y = 1000
CB5	CB-5 - CB-2	X = 9000	Y = 1000
CB7	CB-7 - CB-3	X = 9000	Y = 2500
CB8	CB-8 - CB-6	X = 9500	Y = 2500
CB10	CB-10 - CB-9	X = 9500	Y = 1000

**NOTE:** All Profiles should go forward with the alignment so they can be projected to the roadway alignment profile at a later time.

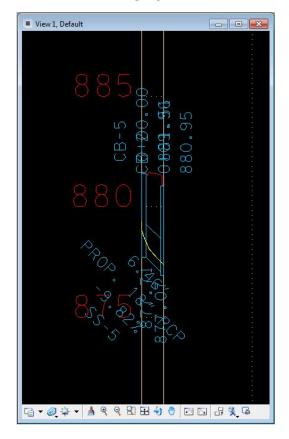
See the following pages for images of the profiles.

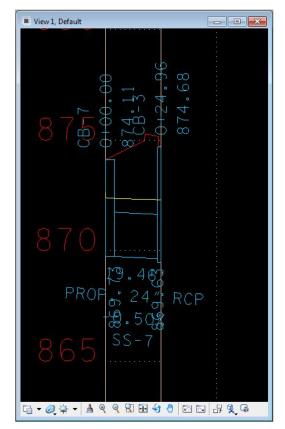




CB5

CB7





GEOPAK Drainage V8*i* (SELECT Series 2)

 Image: Wiew1, Default

 <t

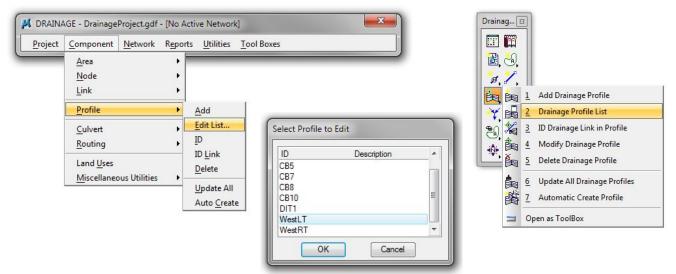
CB8



╔╺∅҉҂╸≜९९₨₶ॳॖॖऀॎ⊡₿₰₲

### 9.2 Projecting Profiles to a Chain

 a) Click Component > Profile > Edit List from the GEOPAK Drainage Menu or by Drainage Profile List from the Drainage Toolbar and select the Profile WestLT. Click OK.

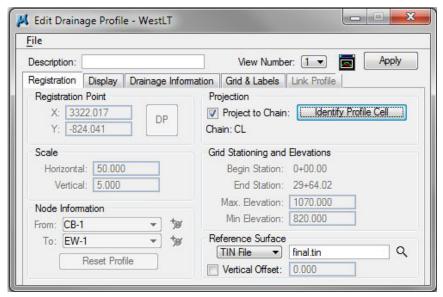


b) Load the Profile Preferences file. Inside the Edit Drainage Profile dialog, click File > Open.

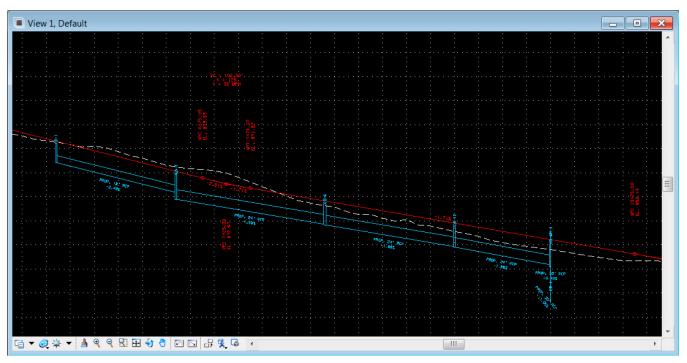
Navigate to C:Users\Public\Geopak Standards\ and select TDOTStormSewerProfiles-Plan.ppf. Click Open.

Look in:	👢 Geopak Standards	3	▼ ③  Ø  Ø	8 🖲
æ	Name	A	Date modified	Туре
	👗 3PC		8/20/2013 9:57 AM	File folder
Recent Places	🐌 ConstCriteria		2/27/2013 8:52 PM	File folder
	📕 Criteria		12/17/2013 5:10 PM	File folder
·	TDOTStormSewe	erProfiles.ppf	11/24/2003 10:35 AM	PPF File
Desktop	DOTStormSewe	erProfiles-Design.ppf	9/14/2006 10:25 AM	PPF File
Libraries	TDOTStormSewe	erProfiles-Plan.ppf	7/25/2012 4:36 PM	PPF File
Computer				
Network	•	III		
	File name: T	lan.ppf 🔹	Open	

c) Toggle <u>ON</u> Project to Chain in the *Projection* portion of the dialog. Click Identify Profile Cell and select the Profile Cell for the *Roadway* Profile and Data Point to accept. Click Apply.



d) View the Projected Drainage Profile along the Roadway Profile.



**NOTE:** Caution must be used when Projecting Drainage Profiles since the profile will be skewed to fit the station and elevation data of the roadway profile.

### 9.3 Ditch Profile

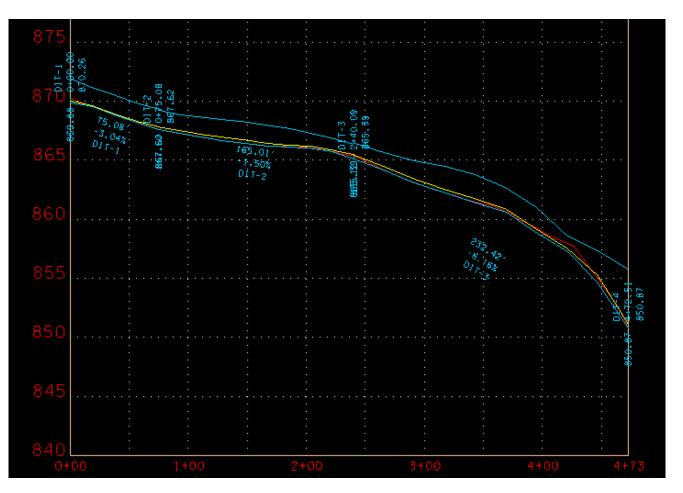
- a) Select from the Menu Bar: Component > Profile > Add or from the main toolbar: Add Drainage Profile
- **b)** Complete the **Profile Configuration** dialog box information as follows for the special ditch drainage network. Click **Apply** when finished.

Profile ID: <u>DIT1</u> From Node: <u>DIT-1</u> To Node: <u>DIT-4</u>

- c) Load the Profile Preferences file. Inside the Edit Drainage Profile dialog, click File > Open. Navigate to C:Users\Public\Geopak Standards\ and select TDOTStormSewerProfiles-Design.ppf. Click Open.
- d) Click the Registration tab and make the settings as below in the Registration Point, Scale and Reference Surface portions (make sure Project to Chain is toggled <u>OFF</u>). Click Apply.

Letter Profile - DIT-1\TDC	)TStormSewerProfiles-Design 👝 😐 💌
<u>F</u> ile	
Description:	View Number: 1 🔹 🔤 Apply
Registration Display Drainage Informat	ion Grid & Labels Link Profile
Registration Point	Projection
X: 10000.000 DP	Project to Chain: Identify Profile Cell
Y: -1000.000	Chain :
Scale	Grid Stationing and Elevations
Horizontal: 50.000	Begin Station: 0+00.00
Vertical: 5.000	End Station: 4+72.51
Node Information	Max. Elevation 920.000
From: DIT-1	Min Elevation: 840.000
	Reference Surface
To: DIT-4 🔹 🏂	TIN File
Reset Profile	Vertical Offset: 0.000
	Volica onact. 0.000

**NOTE:** For ditch profiles defined with Fixed Geometry, this dialog can be used to help identify and correct errors produced in the drainage calculations and ensure the drainage flows as it should. Our current ditch network set up is Cross Section Based on the existing terrain so that functionality is not applicable.



#### NOTES:

For Cross Section Based links the invert generally follows the existing surface terrain.

The yellow hydraulic grade line indicates locations where the existing ditch cross section geometry and water volume cause a rise or fall in the water surface elevation. Rises indicate points where greater capacity may be required. This information along with computation information provided with the links can be used to determine any possible special ditch needs.

In Exercise 11, the system modification chapter, we will relocate these nodes and set the links as fixed geometry to define a special ditch set up to handle the drainage in this area.

### 9.4 Editing Links via Profiles

The Edit Profiles dialog allows you to edit a Link's design. This being the case the **Link Configuration** dialog must be closed in order to open the **Edit Drainage Profile** dialog.

- a) Open profile WestRT by selecting Component > Profile > Edit List or by selecting Drainage Profile List from the GEOPAK Drainage Main Toolbar.
- b) Click the Link Profile tab. Highlight the SS-2 Link ID.

- )escriptio	n:		Vie	ew Number: 1 🔻		Ap	ply
Registratio	on Display [	Drainage Inform	ation Grid	& Labels Link P	rofile		
	e Profile Points	1	1		_		1
Link ID Node		Elevation	Node	Elevation	Slope	_ ^	-
SS-2	CB-2	876.903	CB-4	870.954	2.418	Ξ	모
SS-4	CB-4	870.784	CB-9	867.070	2.110		n
SS-9	CB-9	866.570	CB-11	864.308	1.795	Ψ.	
E He	lin. Cover: 878			a. Cover: 872.454 Id Invert: 870.95		.418	

The SS-2 link's control data is populated in the **Details** section at the bottom.

Link ID	Node	Elevation	Node	Elevation	Slope	-	
SS-2	CB-2	876.903	CB-4	870.954	2.418	Ξ	모
SS-4	CB-4	870.784	CB-9	867.070	2.110		
SS-9	CB-9	866.570	CB-11	864.308	1.795	-	<ul> <li>Modify Segment</li> </ul>
Draina	lin. Cover: 878. Id Invert: 876. age Library Item Inch Dia. Circul	903			54 👲	418	

From here you can set and hold the invert elevations, set the slope to hold or change the pipe size.

Once any desired changes are made, click the **Modify Segment** icon on the right. An alert will appear. Click **Yes**, review and dismiss the warnings.

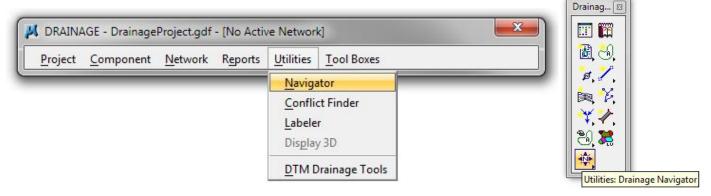
c) Do not make any changes at this time. Click the red X to dismiss the dialog.

# **10. Drainage Navigator**

This exercise shows the user how to navigate a network and perform queries.

# 10.1 Navigating/Query

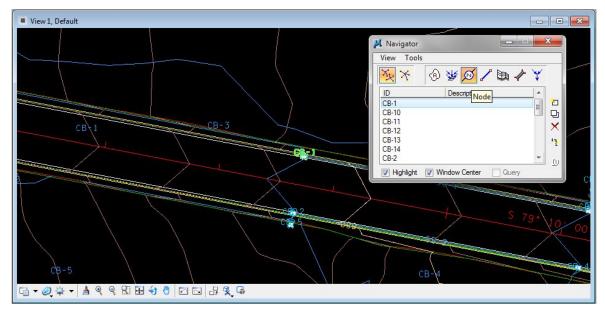
a) Select from the Drainage Menu Bar Utilities > Navigator or from the drainage main toolbar Drainage Navigator.



b) Select the Drainage Nodes button on the Navigator.

📕 Navigator			x
View Tools	;		
$\mathbf{X}$	📀 ¥ 🙍 🖍	🖽 🖊 🎽	
ID	Descrip Node	*	
CB-1			1
CB-10		-	
CB-11			$\overline{\mathbf{v}}$
CB-12			$\sim$
CB-13			H <sub>2</sub> :
CB-14			-
CB-2		*	τu
🔽 Highlight	Window Center	Query	2

c) Toggle ON the Highlight and Window Center tools and click once on various nodes in the network.



As you can see the **Drainage Navigator** makes it easy to go to specific components in the network. A **double click** automatically opens the component's configuration dialog for easy editing of any Drainage component.

- d) Set the Active Component Type to Link and toggle the Query option:
- e) Use the Query tool to determine which Links have exceeded the Min Rise. Make the settings as shown and then click on **Apply Query**.

/iew Tools		
<u>x</u> x 6	) ¥ Ø 🖊 🛤	14
ID	Description	
MH-1		
SS-3		
SS-6		E
SS-7		
DIT-3		
SS-12		
SS-13		-
Highlight      Guery Options     Query Type: Const     Condition: >		lery

Note the results of your query here:

f) Follow the same procedures to determine the following:

Using Query type **Values**; Which pipes have a velocity less than 3 fps?

(This will show you which links need to be modified to increase the velocity.)

Using Query type **Values;** Which pipes have a velocity greater than 12 fps?

(This will show you which links need to be modified to decrease the velocity.)

Using Query type **Constraints**; Which links have slopes less than Min Slope?

(This will show you which links need to have their slopes increased.)

#### Set the active component type to Inlet.

Using Query type **Constraints**; Which inlets have exceeded their max ponded width?

(This will show you which inlets need to be relocated to decrease the ponded width.)

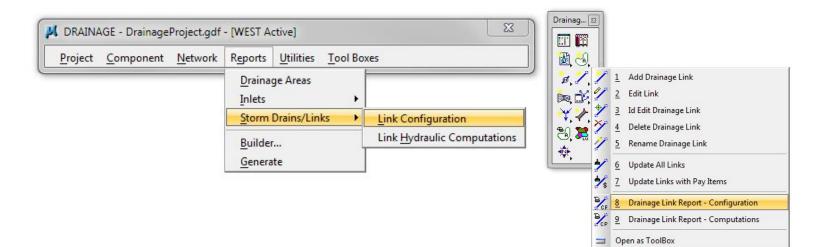
# **10.2 Navigating/Global Editor**

From the query in **Step 5** of Exercise 10.1 you should have found that 2 pipes were designed at a value greater than the minimum rise 1.5' (18"). These should have been SS-14 and SS-MH1.

Since for the initial design we set our minimum depth of cover based on the minimum pipe size it will be necessary to check our catch basin depths to be sure they have not violated minimum depth requirements and to make sure that the larger pipe size is valid for the node which was used. To do this take the following steps:

#### Checking Minimum Depth Requirements vs. Designed Node Depths & Pipe Sizes:

a) Identify which drainage nodes are involved by going to Reports > Storm Drains/Links > Link Configuration in the GEOPAK Drainage menu bar. This report describes each link including From Node (Upstream), To Node (Downstream) and Size/Diameter (Rise).



	Upstream	Downstream									Upstream	Downstream	
ID	ID	ID	Discharge	Length	Shape	#	Rise	Span	n	Slope	Invert	Invert	-
SS-MH1	MH-1	EW-1	19.713	35.500	Circul	1	2.000	n/a	0.013	11.000	852.317	848.412	10
SS-13	CB-13	MH-1	8.451	258	Circul	1	1.500	n/a	0.013	1.103	861.279	858.432	
SS-14	CB-14	MH-1	11.453	39.040	Circul	1	2.000	n/a	0.013	0.500	855.929	855.733	=
SS-11	CB-11	CB-13	8.110	211	Circul	1	1.500	n/a	0.013	1.512	864.638	861.449	
SS-12	CB-12	CB-14	10.717	191	Circul	1	1.500	n/a	0.013	1.880	860.022	856.429	
SS-9	CB-9	CB-11	7.810	126	Circul	1	1.500	n/a	0.013	1.660	866.900	864.808	
SS-6	CB-6	CB-12	10.292	265	Circul	1	1.500	n/a	0.013	1.684	864.668	860.192	
SS-4	CB-4	CB-9	4.453	176	Circul	1	1.500	n/a	0.013	2.110	870.784	867.070	
SS-10	CB-10	CB-9	2.632	7.460	Circul	1	1.500	n/a	0.013	11.000	867.890	867.070	
SS-3	CB-3	CB-6	8.915	306	Circul	1	1.500	n/a	0.013	1.675	869.963	864.838	-
			þ				Window C	enter					

b) Open the Navigator tool under Utilities and expand it to the Global Editor by choosing from the pull-down menu View > Global Editor. Once the Global Editor is open, click on the Node button.

iew Tools				
Navigator	) ¥ 🖸 🖊 🛤	14		
Global Editor	Description	-	Variable to Edit	
CB-1			Node - ID	
CB-10			Node - Description	
CB-11			Node - Reference Chain	
CB-12			Node - Reference PGL	
CB-13			Node - Reference TIN	
CB-14			Node - Elevation	
B-2		*	Node - Reference Elevation	

c) SS-MH1 is the first link shown in the Storm Drain Configuration Summary (Step 1). This link was designed by GEOPAK drainage to have a rise of 2.0 feet (24 inches). Find and select the Upstream Node (From Node) MH-1 for this Link in the Global Editor Dialog, then find and select Node – Minimum Depth in the Variable to Edit portion of the editor. Set the New Value to the correct minimum depth for a 2.0' (24") diameter pipe found in the TDOT GEOPAK Drainage Nodes document (Appendix A, pg. A-5).

📕 Global Edit	tor					- • •
View Tools	s					
×, *	(†) 🕸 🚯	1 🖽 🥢	¥	Current Value: 1.870		
ID	Description			Variable to Edit		
CB-9			11	Node - Reference PGL		New Value: 1.870
DIT-1				Node - Reference TIN		
DIT-2				Node - Elevation		
DIT-3				Node - Reference Elevation		
DIT-4			=	Node - Supplied Discharge	=	
EW-1				Node - Minimum Depth		
MH-1			Ŧ	Node - Maximum Depth	Ŧ	
V Highlight	Vindow Center	Query	Арр	ly Edit With Confirm Apply Edit No Co	onfirm	

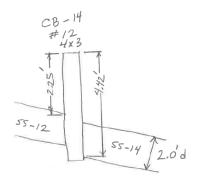
**NOTE:** If the type of structure for a given node is unknown or needs to be changed (would happen if pipe size is too large for a given catch basin), simply double click the **Node ID** in the Global Editor and the Node Configuration Dialog will be invoked.

Min. Depth of Basin – Pipe Size – Drop Across Bottom of Structure = Minimum Depth **MH#3 5'DIA:** 4.08' - 24"/12 - 0.21' = 1.87'

d) Click Apply Edit With Confirm to apply the New Value and Click Yes in the Alert box.

**NOTE:** Global Editor may be used to edit multiple Nodes/Links at once.

e) Repeat the previous steps to correct the minimum depth settings for the other storm drainage nodes for pipe link SS-14.



Min Depth of Basin – Pipe Size – Drop Across Bottom of Structure = Minimum Depth

```
CB#12 4x3, 24'DIA Pipe: 4.42 - 24"/12 - 0.17' = 2.25'
```

f) Re-design the network WEST and review your profile. The Nodes should now meet minimum depth requirements.

Ketwork Configuratio	n - [WEST]		- • •
Network ID: 4 WEST	<b>•</b> •	¥ ¥	🐝 🏕 🗛 Apply
Details			
Description:		Outlet Node: EW-1	- *
Validation	Computations	Lock Sizes	Unlock Sizes
<b>TÝ Ý</b>	(iz) iz	Lock Elevations	Unlock Elevations

### 10.3 Re-Run the Network

It is recommended that once a drainage network is set up all component constraints should be reviewed to insure that all criteria for design has been met.

After re running the network **WEST** in Step 6 there are three errors:

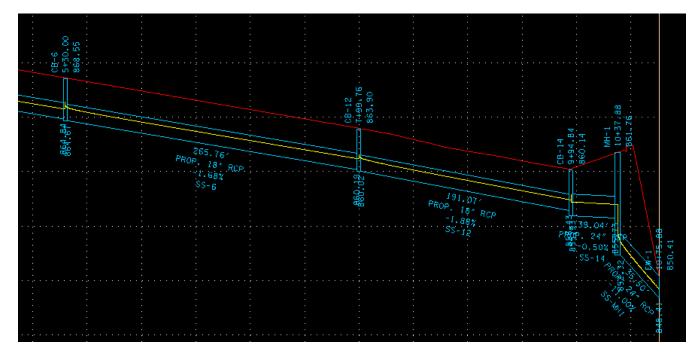
SS-8 Velocity less than minimum desired

SS-MH-1 Velocity greater than maximum desired

Capacity for Inlet CB-14 Exceeded Bypass Flow Unassigned

#### a) Navigate to Reports > Storm Drains/Links > Link Hydraulic Computations.

For link SS-8, the slope is 8.512 and the actual velocity is 0.538. To correct this error we can increase the slope of SS-8. The maximum slope is 11 percent. The upper end of SS-8 at CB-8 is at minimum depth, so we will have to lower the outlet end which is connected to CB-6. For link SS-MH-1, the slope is the maximum 11% and the actual velocity is 16.560. Looking at the profile, we definitely have some room to both lower the CB-6 outlet and to decrease the slope of SS-MH-1.



b) Go to Component – Link- Edit – SS-8 – Conditions. Fix the upper invert elevation at 865.388 and the slope at 11.000 by checking the boxes next to the elevations. Click Apply after making changes.

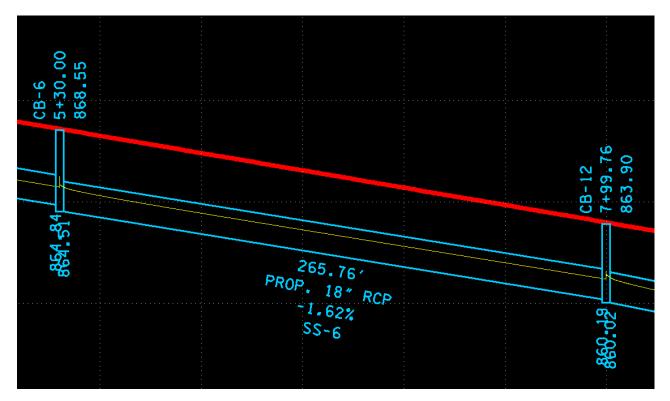
📕 Link Configuration	n Conditions			
Link ID: 4 SS-8	•	Window	· · · · · · ·	🐓 🥢 🛛 Apply
Details				
Options Definition Conditions Constraints Computation	<ul> <li>Profile Conditi</li> <li>Min Cover:</li> <li>Soffit:</li> <li>Invert:</li> </ul>	ons From Node 866.888 866.888	Slope 5.518 11.000	To Node 866.338 866.338 864.838
Type Pipe Ditch	Max Depth:	841.188	-73.899	848.548
Ditch				

#### c) Re- run Network WEST

Upon checking the hydraulic computations, the new velocity is 7.592, which is in our acceptable range:

	Upstream	Downstream	Upstream	Downstream					Unifo	m	Actua	L	
ID	ID	ID	HGL	HGL	Discharge	Capacity	Slope	Loss	Velocity	Depth	Velocity	Depth	
SS-9	CB-9	CB-11	868.701	865.627	7.810	14.557	1.665	0.652	7.940	0.817	7.914	0.819	
SS-6	CB-6	CB-12	866.122	861.178	10.292	14.399	1.632	0.315	8.370	0.985	8.350	0.987	
SS-4	CB-4	CB-9	871.704	867.625	4.453	16.415	2.103	0.026	7.482	0.556	7.478	0.556	
SS-10	CB-10	CB-9	869.156	867.388	2.632	37.476	10.996	0.045	11.608	0.279	9.602	0.318	
SS-3	CB-3	CB-6	872.479	865.725	8.915	14.624	1.677	1.293	8.211	0.886	8 200	0.887	
SS-8	CB-8	CB-6	866.151	864.861	0.941	37.476	11.003	0.018	8.546	0.170	7.592	.184	=
SS-2	CB-2	CB-4	878.051	871.433	3.612	17.571	2.419	0.325	7.425	0.479	7.420	0.479	
SS-1	CB-1	CB-3	876.988	871.285	1.580	17.774	2.470	0.102	5.898	0.314	5.898	0.314	
SS-7	CB-7	CB-3	872.835	872.479	7.006	7.990	0.494	0.244	4.754	1.166	3.965	1.500	
SS-5	CB-5	CB-2	878.506	877.298	1.282	35.412	9.825	0.031	9.012	0.202	7.718	0.225	-
ASCII File	s.			Edit	🔲 Wind	dow Center	Арр	ly ]					

Upon rerunning the network, you can see the profile automatically updated, the upper invert of SS-6 changing to 864.51 from 864.67 and the slope to 1.62% from 1.68%. :



**d)** Now to correct, the high velocity in SS-MH-1, we need to reduce the slope. In Link Configuration Conditions for SS-MH-1, the upper invert is 852.317 so let's lower it to 849.5 and fix the lower at its current value of 848.412 which is the outlet endwall.

📕 Link Configuration	Conditions					• 🗙
Link ID: 4 SS-MH-	1 •	Window	· · · ·	~ *	1	Apply
Details						
Options Definition Conditions Constraints Computation Type	Profile Conditi Min Cover: Soffit: Invert: Max Depth:	ons From Node 859.892 854.317 852.317 821.762	Slope 24.947 11.000 -64.869	2 2 2	To Node 350.412 350.412 348.412 346.412	
Ditch						

Change to:

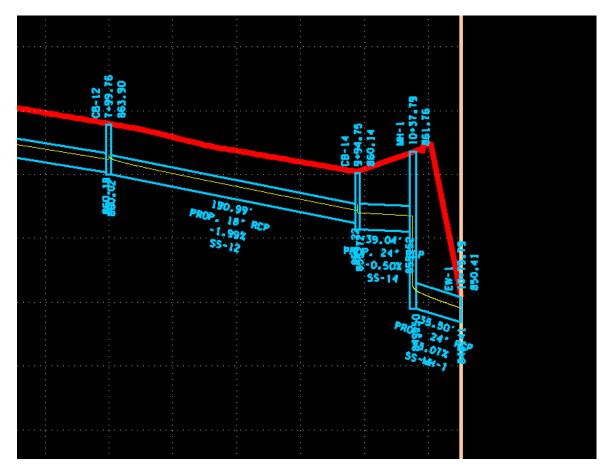
Link Configuratio	n Conditions			
Link ID: 4 SS-MH	I-1 <b>v</b>	<ul> <li>Window</li> <li>Highlight</li> </ul>	<u> </u>	🖌 🏏 🛛 Apply
Details				
Options Definition Conditions Constraints Computation	Profile Condition Min Cover: Soffit: Invert: Max Depth:	Sons           From Node           859.892           852.317           849.500           \$21.762	Slope 24.947 5.367 -64.869	To Node 850.412 850.412 848.412 846.412
<ul><li>Pipe</li><li>Ditch</li></ul>				

#### e) Re-run Network WEST.

Check Hydraulic Computations, 10.943 is within our acceptable range

	Upstream	Downstream	Upstream	Downstream					Unifo	m	Actua	l.	
ID	ID	ID	HGL	HGL	Discharge	Capacity	Slope	Loss	Velocity	Depth	Velocity	Depth	1
SS-MH-1	MH-1	EW-1	852.013	849.527	19.715	42.606	3.065	0.840	12.593	0.997	10.943	1116	Ī
SS-13	CB-13	MH-1	862.493	859.365	8.451	12.007	1.136	0.038	6.962	0.974	6.962	0.974	"
SS-14	CB-14	MH-1	857.617	856.738	11.453	17.207	0.506	0.631	5.562	1.247	5.735	1.215	=
SS-11	CB-11	CB-13	865.813	862.312	8.110	13.893	1.502	0.010	7.700	0.864	7.700	0.864	
SS-12	CB-12	CB-14	861.407	857.165	10.717	15.945	1.985	0.049	9.126	0.946	9.122	0.946	
SS-9	CB-9	CB-11	868.701	865.627	7.810	14.557	1.665	0.652	7.940	0.817	7.914	0.819	
SS-6	CB-6	CB-12	866.122	861.178	10.292	14.399	1.632	0.315	8.370	0.985	8.350	0.987	
SS-4	CB-4	CB-9	871.704	867.625	4.453	16.415	2.103	0.026	7.482	0.556	7.478	0.556	
SS-10	CB-10	CB-9	869.156	867.388	2.632	37.476	10.996	0.045	11.608	0.279	9.602	0.318	
SS-3	CB-3	CB-6	872.479	865.725	8.915	14.624	1.677	1.293	8.211	0.886	8.200	0.887	-
			Ð		🔲 Wind	dow Center							

Also note that the profile at SS-MH-1 is automatically updated:

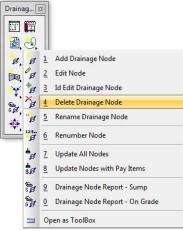


# **11. System Modification**

This exercise shows the user how to modify the storm drainage system design. Specifically we will combine links SS-14 & SS-MH1 by eliminating MH-1, change SS-13 to end at CB-12 instead of at MH-1, reengineering the network connectivity. We will also change our ditch network set up to define a special ditch to handle the drainage along the base of the fill slope in that area.

## **11.1 Storm Drainage Network Modification**

 a) Delete Node MH-1 by using Drainage Navigator, selecting Component > Node > Delete from the Drainage Menu Bar, or by selecting Delete Drainage Node from the Drainage Toolbar.



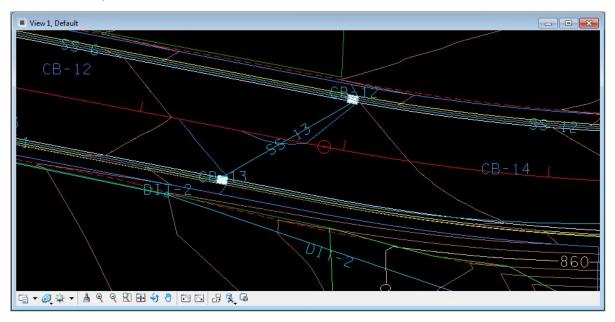
**NOTE:** Click **Yes** that you would like to delete the Node, **OK** to delete the Network WEST and <u>NO</u> to *Do you want to delete all the components of the network as well?* 

- b) Follow the same basic procedures to delete Link SS-MH1.
- c) Edit Link SS-13, to start at the front face of CB-13 towards centerline and end at the front face of Node CB-12 across the road.

Link ID: 🖣 <u>SS</u>	-13   Window Center   Window Center   Apply  Apply
Details	
Options	Description:
Definition	From Node: CB-13 🔹 🏂 To Node: CB-12 🔹 🏌
Conditions Constraints Computation	Length: 72.2571 Use MS Element D Configuration Shape: Circular  Material: Concrete
Type	Design Size Size: 24 Inch Dia. Circular Select
O Ditch	Design Barrels Number of Barrels: 1      Roughness: 0.013     Override Library Payitem:

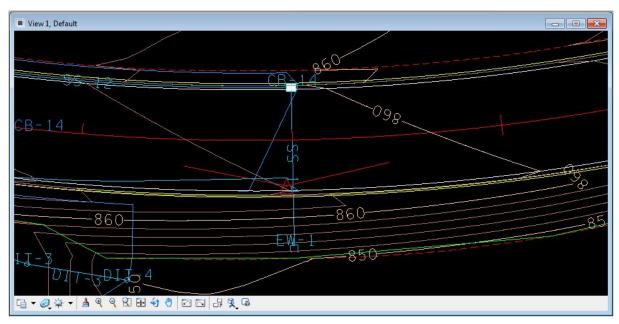
d) Go to edit CB-12 and CB-13 to change the Library Item to CB#12 4'DIA.

**REMINDER:** Use the **ID** button to the right of the node list to identify the front wall connection points at nodes CB-13 and CB-12.

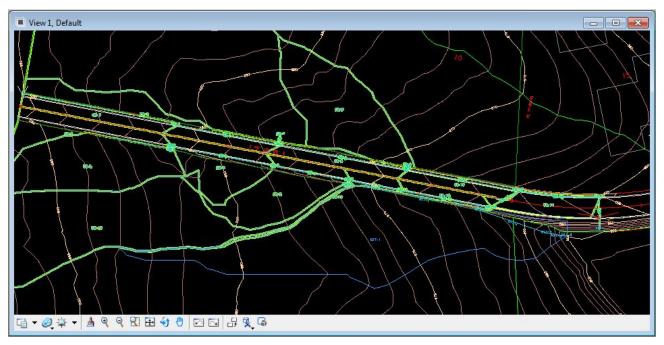


**NOTE:** In an actual design, the skew angles would now need to be checked to ensure the pipe would fit in the catch basin wall.

- e) Edit Link SS-14, to go to Node EW-1.
- f) Since pipe at EW-1(link SS-14) is now a 24" pipe (from previous exercise) and the side slope at that location is 2:1, move the location of the outlet from an offset of 56' to 52' to account for the length of the end wall and properly locate the outlet.
- g) Reset EW-1's Max Depth to 2.0 (designed pipe size at outlet).



h) Add a New Network named WEST with the Outlet Node set to EW-1 (this is necessary since the network WEST was deleted in Step 1). Highlight the Network to ensure all components are connected, and then Design the Network.



i) Update Profile **WestRT** to End at CB-12 and redraw other profiles as required based on these modifications.

#### **Optional:**

Depending on the drainage areas developed in the previous exercises you may still have errors in your network. If your hydraulic gradeline exceeds the minimum freeboard, try increasing pipe sizes to lower the water surface. If the velocity in Link SS-14 is over the maximum limit try hard coding SS-14's invert elevation at Node CB-14 to lower the slope of that Link.

# **11.2 Ditch Network Modification**

Initially, we set up a ditch network along a fill line using the Cross Section Based ditch type to analyze the drainage there. Now we will relocate our ditch nodes and set up our links as fixed geometry to design a special ditch along that slope to handle the drainage.

**Relocate Ditch Nodes and their Drainage Areas** 

- a) Delete previous drainage areas for ditch nodes.
- b) Go to Component > Node > Edit and select Node DIT-1.

Under Location, change the station to 9+25 and the offset to 35.23.

This is the beginning of the desired special ditch at the base of the fill slope. We will define the ditch link later as a "V" ditch with 2:1 side slopes although it will be at the existing ground elevation here at the beginning.

Node Configuration	on - Location
Node ID:	▼ ▶ Window Center א א א א Apply
Details	
Options	✓ Chain: CL ▼ ✓ Profile: DESIGNCL ▼
Properties	Coordinates / Stationing
Location	Align: Tangent to Chain  Align: Tangent to Chain  Align: Tangent to Chain
Spread Criteria	
Elevations	Station: 9+25.00 X: 3484.943
Junction Loss	V: 3056.086
Discharge Options	
Computations	Mirror Node Offset from Gutter to Inlet: 0.000

Click Apply.

c) Reference in the new DIT-1 file and use methods described previously to rebuild the DIT-1 drainage area for the new location, establish a time of concentration, apply land use areas and compute discharge.

Area ID: 4 DIT-	· · · ·	Window Center Highlight	a 2a Xa 2a (	Apply			
Details	a		🕌 Drainage Area C	omputations			
Options Definition Subareas	Description: Drainage Area: 0.845	Area Selection	Area ID: 4 DIT-1	• •	<ul> <li>Window Center</li> <li>Highlight</li> </ul>	18 in 18	Apply Apply
Computation Hydro, Method	Base C Value: 0.350 Time of Conc.: 35.178	Select Shape Pick Bounda Elements	Details Options Definition Subareas	Total Subareas:	Area 0.843	C Value (	Compute Discharge
SCS			Computation	Remainder: Composite:		0.350	
			Hydro. Method Rational	Computed Intensity:			
			SCS	Computed Discharge:	0.812		

Click **Apply** to save the changes.

d) Go to Component > Node > Edit and select Node DIT-2.

Under Location, change the station to **10+48** and the offset to **36.00**.

This is the point where we will achieve the 1 foot depth in our special ditch. By modifying the links at this location the ditch link will be a "V" ditch with 2:1 side slopes and is offset from the fill slope tie by 2 feet.

Node ID: DIT-2	Vindow Center 🐀 🙇 🏌 Apply
Details	
Options	Chain: CL   Profile: DESIGNCL
Properties	Coordinates / Stationing
Location	Align: Tangent to Chain  Align: (0.000
Spread Criteria	
Elevations	Station: 10+48.00 X: 3605.606
Junction Loss	V Offset: 36.000 Y: 3032.211
Discharge Options Computations	Mirror Node Offset from Gutter to Inlet: 0.000

Click Apply.

e) Use methods described previously to rebuild the **DIT-2** drainage area for the new location, establish a time of concentration, apply land use areas and compute discharge.

Remember ...ditch node drainage areas should include the area for the current node as well as any others previously defined that contribute to the ditch drainage network.

Area ID: 4 DIT- Details	2 • •	lighlight	න හි හි හි	Apply			
Options Definition Subareas	Description: Drainage Area: 0.847	Area Selectio	H Drainage Area C		Window Center		
Computation	Base C Value: 0.350 Time of Conc.: 27.233	Select Shape	Area ID:  DIT-2 Details	▶	Highlight	19 19 <del>1</del> 9	) 👌 🛛 Apply
Hydro. Method –	[Compute TC]	Pick Bound Element	Options Definition		Area	C Value	Compute
SCS			Subareas	Total Subareas:	0.840	0.300	Discharge
			Computation	Remainder:	0.008	0.350	
			Hydro. Method	Composite:	0.847	0.300	
			Rational	Computed Intensity:	3.650		
			SCS	Computed Discharge:	0.929		

Click **Apply** to save the changes.

f) Go to Component > Node > Edit and select Node DIT-3.

Under Location, change the station to **11+85** and the offset to **43.00**.

This is the beginning of the final ditch slope and to mitigate the steeper slope and resulting increase in velocity we will change the ditch link section to a 2 foot wide trapezoidal shape, 1 foot deep with 2:1 side slopes and is offset from the fill slope tie by 3 feet.

Node Configuration	on - Location	
Node ID:	▼ ► Window Center	te te 🔭 🕅 🦛 Apply
Details		
Options	🗸 Chain: CL 🔹 🗸	Profile: DESIGNCL
Properties Location Spread Criteria	Coordinates / Stationing Align: Tangent to Chain 🔻 🏄	+ Angle: 0.000
Elevations Junction Loss Discharge Options	Station: 11+85.00	X: 3738.849 Y: 2999.587
Computations	Mirror Node Offset from	Gutter to Inlet: 0.000

#### Click Apply.

g) Use methods described previously to rebuild the **DIT-3** drainage area for the new location, establish a time of concentration, apply land use areas and compute discharge.

Area ID: 4 DIT-	3 <b>T</b>	Vindow Center Highlight	8 8 8 8	Apply			
Details	_						
Options	Description:		To Node ID: DIT-3	la			
Definition Subareas Computation	Drainage Area: 0.333 Base C Value: 0.350 Time of Conc.: 26.579	Area Selecti Select Shape	Area ID:		Window Cente	" * 8 * E	🕞 🖷 📕
Hydro. Method Rational SCS	[Compute TC]	Pick Bound Element	Details Options Definition Subareas	Total Subareas:	Area 0.319	C Value 0.300	Compute Discharge
			Computation	Remainder:	0.014	0.350	
			Hydro. Method	Composite:	0.333	0.302	
			Rational	Computed Intensity:	3.706		
			SCS	Computed Discharge:	0.373		

Click **Apply** to save the changes.

h) Go to Component > Node > Edit and select Node DIT-4.

Under Location, change the station to 13+28 and the offset to 72.00.

This is the outlet for the special ditch and is shifted away from the fill slope tie to lead into the current existing drainage path.

Node ID: DIT-4	Window Center 🐀 🙇 🎠 🦓 🗛
Details	
Options	Chain: CL
Properties	Coordinates / Stationing
Location	Align: Tangent to Chain  Align: # + Angle: 0.000
Spread Criteria	
Elevations	Station: 13+28.00 X: 3885.021
Junction Loss	V: 2952.392
Discharge Options	
Computations	Mirror Node Offset from Gutter to Inlet: 0.000
o ornpatanono	

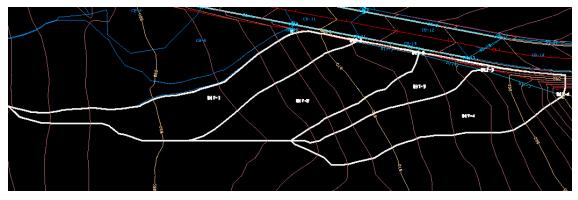
Click Apply.

i) Use methods described previously to rebuild the **DIT-4** drainage area for the new location, establish a time of concentration, apply land use areas and compute discharge.

Options       Description:       To Node ID: DIT-4       Image Area       0.997       Area Selective         Subareas       Computation       Drainage Area:       0.997       Area Selective       Image Area       Image Area <th>Area ID:    DIT- Details</th> <th>4 • • •</th> <th>Vindow Center Highlight</th> <th>ත හි හි හි</th> <th>Apply</th> <th></th> <th></th> <th></th>	Area ID:    DIT- Details	4 • • •	Vindow Center Highlight	ත හි හි හි	Apply			
Subareas       Drainage Area: 0.337         Computation       Base C Value: 0.350         Time of Conc.: 28.173       Select         Hydro. Method       ICompute TC         ICompute TC       Pick Bourn         Definition       Science         SCS       Area       C Value         Computation       Definition         Subareas       Computers       0.948         Options       Remainder: 0.048       0.350         Computation       Remainder: 0.048       0.326	Options							
Options     Area     C Value     Compute       Options     Definition     SCS     Total Subareas:     0.948     0.324       Definition     Subareas     Computation     Remainder:     0.048     0.350		Base C Value: 0.350	Select				ୀର <u>ଅ</u> କ୍ଷ	
Computation Remainder: 0.048 0.350	Rational	[Compute_TC]		Options Definition	Total Subareas:			
Hydro. Method Composite: 0.997 0.326		J			Remainder:	0.048	0.350	
				Hydro. Method	Composite:	0.997	0.326	

Click **Apply** to save the changes.

Final layout of revised ditch nodes and drainage areas.



GEOPAK Drainage V8*i* (SELECT Series 2)

j) Since Node DIT-4 is an outlet type, it will not consider the drainage area developed for it. In order to ensure the final ditch link, DIT-3, will be adequate for the capacity at the end we will need to link the DIT-4 drainage area to it.

Go to **Component> Node> Edit** and select node DIT-3. Under Discharge Options click on the option to **Link Base Flow Area** and set to include the DIT-4 drainage area.

Node ID:	Vindow Center 👷 🧏 🦓 Apply
Details	
Options	Output Discharge
Properties Location Spread Criteria Elevations Junction Loss Discharge Options Computations	Supplied Discharge:       3.500         Disable Inlet Calculations       Capacity:       0.0000         ✓       Link Base Flow Area       DIT-4       ★

## **11.3 Ditch Link Modification**

#### **Redefine Ditch Links with Fixed Geometry & Invert Elevations**

a) Go to Component > Link > Edit and select Link DIT-1.

Under **Definition**, make the following changes:

Ditch Type: Fixed Geometry

Ditch Width: 0 (Toggle OFF Design Width) - for V-ditch

Ditch Depth: 1 (Toggle OFF Design Depth)

Side Slope Ratio Left (H:1): 2.00

#### Side Slope Ratio Right (H:1): 2.00

These settings define a "V" ditch at a 1' depth with 2:1 side slopes.

Link Configura	tion Definition
Link ID: 📕 DIT-1	1
Details	
Options	Description:
Definition	From Node: DIT-1 🔻 🏂 To Node: DIT-2 💌 🏂
Conditions Constraints Computation	Length: 123.0024 Use MS Element Configuration Ditch Type: Fixed Geometry Roughness: 0.027
Type Pipe Ditch	Ditch Width:       0.0000       Design Width         Ditch Depth:       1.0000       Design Depth         Side Slope Ratio Left (H:1):       2.0000       Right (H:1):       2.0000

**NOTE:** You can use the **Design Width** or **Design Depth** options individually but it is **not** recommended to use both at the same time. The software will always use the Minimum Rise value under **Constraints** for the depth and only adjusts the width if needed from that point.

b) Under Conditions, make the following changes:

From Node Invert: 867.599 (existing ground elevation)

**To Node Invert**: <u>865.058</u> (1 foot below existing ground elevation)

Link ID: 📕 DIT-1	•	) 🕨 🔲 Window	<b>Y Y</b>	🖋 🏄 🛛 Apply
Details				
Options	Profile Condit		0	T N 1
Definition		From Node	Slope	To Node
Conditions	Min Cover:	867.599	1.253	866.058
Constraints	Soffit:	999999999.9	0.030	99999999.9
Computation	Invert:	867.599		865.058
Туре	Max Depth:	867.599	1.253	866.058
Pipe				

These settings provide the transition from existing ground to the 1' depth.

**NOTE:** The large numbers you may see specified for **Soffit** elevations can be ignored. These values are a result of the previous application of the Cross Section Based ditch type where these values are not applicable. When the ditch network is redesigned, the Soffit elevations will be recalculated.

c) Under Constraints, make the following change:

Minimum Rise: 1.000 (to allow for defined 1 foot depth)

Link ID:	•		/indow Center 💉	🏏 💥 🥖 Apply
Details				
Options	<ul> <li>Design Cor</li> </ul>			
Definition		Minimum	Maximum	
Conditions	Rise:	1.000	4.000	
Constraints	Slope:	0.400	11.000	
Computation	Velocity:	3.000	12.000	
Туре				
Pipe				
Ditch				

d) Click Apply to save the changes to link DIT-1.

e) In the Link Configuration Definition dialog go to Link DIT-2.

Under **Definition**, make the following changes:

Ditch Type: Fixed Geometry

Ditch Width: 0 (Toggle OFF Design Width) – for V-ditch

Ditch Depth: 1 (Toggle OFF Design Depth)

Side Slope Ratio Left (H:1): 2.00

#### Side Slope Ratio Right (H:1): 2.00

These settings define a "V" ditch at a 1' depth with 2:1 side slopes.

Link Configura	tion Definition
Link ID: 🔳 DIT-2	2 Vindow Center 1 Nindow Center 1 Apply
Details	
Options	Description:
Definition	From Node: DIT-2 💌 🏂 To Node: DIT-3 💌 🏂
Conditions Constraints Computation	Length: 137.1787 Use MS Element Configuration Ditch Type: Fixed Geometry  Roughness: 0.027
Type Pipe O Ditch	Ditch Width:       0.0000       Design Width         Ditch Depth:       1.0000       Design Depth         Side Slope Ratio Left (H:1):       2.0000       Right (H:1):       2.0000

f) Under Conditions, make the following changes:

**From Node Invert**: <u>865.058</u> (1 foot below existing ground elevation) **To Node Invert**: <u>860.678</u> (1 foot below existing ground elevation)

Link ID: 📕 DIT-2	•	) ▶ 📃 Window	<u> </u>	<b>×</b>	n Apply
Details					
Options	Profile Condit		01		T N 1
Definition		From Node	Slope		To Node
Conditions	Min Cover:	866.058	3.193		861.678
Constraints	Soffit:	99999999.9	0.015		999999999.9
Computation	Invert:	865.058 🗸		[	860.678 🗸
Туре	Max Depth:	866.058	3.193		861.678
Pipe					
O Ditch					

These settings maintain the 1' depth below the existing ground.

g) Under Constraints, make the following change:

Minimum Rise: <u>1.000</u> (to allow for defined 1 foot depth)

Link ID: 📕 DIT-2	•		indow Center 💅	1 🗾	<u>×</u>	2	Apply
Details							
Options	Design Co	nstraints Minimum	Maximum				
Definition							
Conditions	Rise:	1.000	4.000				
Constraints	Slope:	0.400	11.000				
Computation	Velocity:	3.000	12.000				
Туре		-					
Pipe							
O Ditch							

Click **Apply** to save the changes to link DIT-2.

h) In the Link Configuration Definition dialog go to Link DIT-3.

Under Definition, make the following changes: Ditch Type: <u>Fixed Geometry</u> Ditch Width: <u>2</u> (Toggle OFF Design Width) Ditch Depth: <u>1</u> (Toggle OFF Design Depth) Side Slope Ratio Left (H:1): <u>2.00</u> Side Slope Ratio Right (H:1): <u>2.00</u>

Link ID:	-3 Vindow Center 1 N N Apply
Details	
Options	Description:
Definition	From Node: DIT-3 💌 🏂 To Node: DIT-4 💌 📩
Conditions Constraints Computation	Length: 153.6017 Use MS Element Configuration Ditch Type: Fixed Geometry Roughness: 0.027
Type Pipe Ditch	Ditch Width:       2.0000       Design Width         Ditch Depth:       1.0000       Design Depth         Side Slope Ratio Left (H:1):       2.0000       Right (H:1):       2.0000

These settings define a 2' wide trapezoidal (flat bottom) ditch at a 1' depth with 2:1 side slopes.

**Note:** See Appendix E for Roughness Values for Open Channel Hydraulics.

i) Under Conditions, make the following changes:

**From Node Invert**: <u>860.678</u> (1 foot below existing ground elevation) **To Node Invert**: <u>850.037</u> (existing ground elevation)

Link ID: 📕 DIT-3	•	) 🕨 🔲 Window	<b>y</b>	2	🖋 🥖 Apply
Details					
Options	Profile Condit				<b>T</b> N 1
Definition		From Node	Slope		To Node
Conditions	Min Cover:	861.678	7.579		850.037
Constraints	Soffit:	99999999.9	0.062		99999999.9
Computation	Invert:	860.678 🗸			850.037 🗸
Туре	Max Depth:	861.678	7.579		850.037
Pipe					
Ditch					

These settings provide the transition from the 1' depth back to the existing ground elevation at the end of the ditch.

j) Under **Constraints**, make the following change:

Minimum Rise: 1.000 (to allow for defined 1 foot depth)

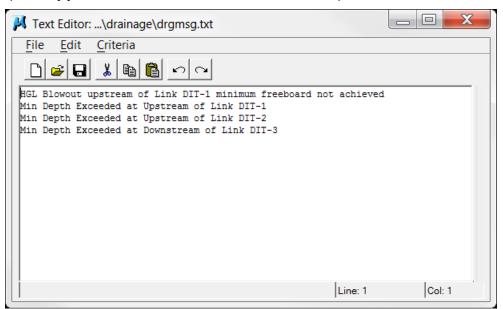
Link ID: 📕 DIT-3	•		/indow Center jghlight	2	۷ 🌶	Apply
Details						
Options	Design Cor	nstraints Minimum	Maximum			
Definition	Rise:		4.000			
Conditions Constraints	Slope:	0.400	11.000			
Computation	Velocity:	3.000	12.000			
Туре						
Pipe						
O Ditch						

**k)** Click **Apply** to save the changes to link DIT-3.

**NOTE:** You can select the entire ditch of one profile, copy beside itself, select all and Edit > Group so that you will still have the ditch profile from before modifications and you can compare.

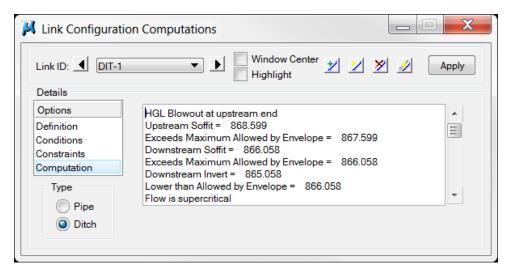
### **11.4 Redesign Ditch Network & Review**

- a) Go to Network > Active Network and select WEST DIT.
- b) Go to Network > Design to run the network.
- c) Review any errors that are generated by the redesign of the network and close the text editor. (See Appendix C for common errors and fixes)



d) Review computation results.

Go to **Component > Link > Edit** and review the link computations for links DIT-1, DIT-2 & DIT-3.

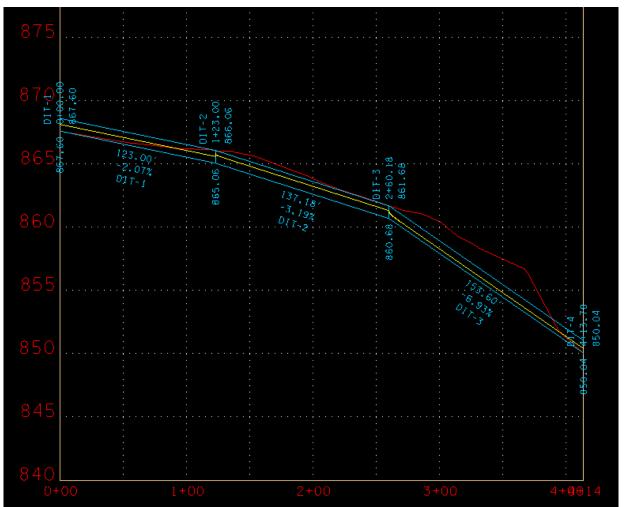


	Upstream	Downstream	Upstream	Downstream					Unifo	orm	Actual	l
ID	ID	ID	HGL	HGL	Discharge	Capacity	Slope	Loss	Velocity	Depth	Velocity	Depth
DIT-3	DIT-3	DIT-4	861.234	850.395	5.888	42.042	6.926	0.020	6.053	0.358	6.053	0.358
DIT-2	DIT-2	DIT-3	865.807	861.303	3.289	11.502	3.203	0.049	4.211	0.625	4.211	0.625
DIT-1	DIT-1	DIT-2	868.269	865.586	1.688	9.252	2.066	0.134	3.023	0.528	3.023	0.528
			모		Vinc	low Center						

#### Go to Reports> Storm Drains\Links> Link Hydraulic Computations.

e) Zoom in on the ditch profile graphics.

The profile has been automatically updated and reflects our new proposed ditch definitions.

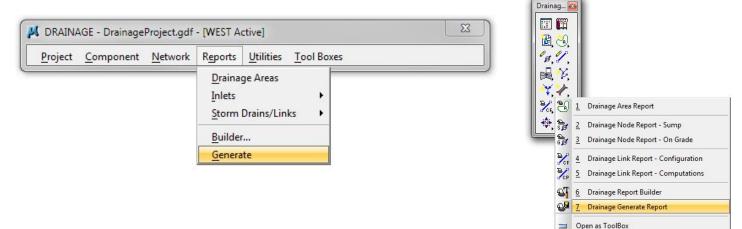


# 12. Reports

This exercise shows the user the report options by creating standard and customized reports.

## **12.1 Customized Reports**

a) Select **Reports > Generate** from the Drainage Menu Bar or **Drainage Generate Report** from the Drainage Toolbar:



 b) Use the browse button to select report format file TDOTnodesFULL.drf (from C:\Users\Public\Geopak Standards\). Click in the Output File Name area and type in nodes.csv as the file name. Click Generate to create the report file.

Generate Report		X
Drainage Report Format File:	tandards\TDOTnodesFULL.drf	Q
Outp <mark>ut File Name</mark> :	nodes.csv	Q
Generate	View	

- c) Use Excel to open and review nodes.csv report file.
- d) Access report format TDOTlinksFULL.drf and generate links.csv report file.
- e) Use Excel to open and review links.csv report file.

## 12.2 Excel Tab Builder

- a) Open Excel and click File > New
- b) Click My templates > TDOT English Tab Quantities > Storm Drainage Structure Tab Builder

If the "My templates" button does not provide you with the Storm Drainage Structure Tab Builder excel file, then navigate to C:\Users\Public\Office Standards\TDOT English Tab Quantities and open the file there. Do a "Save As" and save it into your Project folder before making any changes.

- c) Click Build Catch Basins and Manholes Block.
- d) Navigate to the project folder, select the file **nodes.csv** created in Exercise 12.1 and click open. The tab block is created.

						CATC	H BASI	NS						
SHEET NO.	LOCATION	STATION	OFFSET (FT.)	DRAINAGE CODE	GRATE/TOP ELEV.		INSIDE DIMENSION	DEPTH (FT.)	STANDARD DRAWINGS		TYPE 12 C.B. 611-12.02 4' - 8'	TYPE 42 C.B. 611-42.01 0' - 4'	TYPE 43 C.B. 611-43.02 4' - 8'	REMARKS
	CL	11+45.00	26	CB-13	865.16	#12	4X3	4.59			1			
	CL	12+00.00	-26	CB-12	863.9	#12	4X3	5.9			1			
	CL	14+00.00	-26	CB-14	860.14	#12	4X3	6.64			1			
	CL	3+70.00	-26	CB-1	880.97	#12	4X3	3.88		1				
	CL	3+70.00	26	CB-2	880.95	#12	4X3	4.05			1			
	CL	3+70.00	35	CB-5	881.51	#42	4X4	3.8				1		
	CL	6+20.00	-26	CB-3	874.68	#12	4X3	5.24			1			
	CL	6+20.00	26	CB-4	874.66	#12	4X3	3.88		1				
	CL	6+20.00	-50	CB-7	874.11	#43	8X4	4.42					1	
	CL	8+00.00	26	CB-9	870.78	#12	4X3	4.21			1			
	CL	8+00.00	38	CB-10	872.38	#43	8' DIA	4.49					1	
	CL	9+30.00	-26	CB-6	868.55	#12	4X3	4.42			1			
	CL	9+30.00	-35	CB-8	869.19	#42	4X4	3.8				1		
	CL	9+30.00	26	CB-11	868.52	#12	4X3	4.38			1			
TOTAL	S		I		I				1	2	8	2	2	

e) Repeat Step 1 through Step 4 using the links.csv file and the Storm Drainage Pipe Tab Builder

				STOP	RM DR	AINAGE F	PIPES		
		OM	-	o		4	RCP C	LASS III	
SHEET	FR			<u> </u>	%	607-03.02	607-05.02	607-06.02	607-07.02
NO.	CODE	OUTLET	CODE	INLET	GRADE	18"	24"	30"	36"
		ELEV.		ELEV.		(L.F.)	(L.F.)	(L.F.)	(L.F.)
	CB-1	877.09	CB-3	870.93	2.50	246			
	CB-2	876.90	CB-4	870.95	2.42	246			
	CB-3	869.44	CB-6	864.30	1.68		306		
	CB-4	870.78	CB-9	867.07	2.11	176			2
	CB-5	877.71	CB-2	877.07	9.82	6			
	CB-6	864.13	CB-12	859.65	1.68	6	266		5
	CB-7	869.69	CB-3	869.61	0.40		19		
	CB-8	865.39	CB-6	864.80	9.13	6			
	CB-9	866.57	CB-11	864.31	1.79		126		
	CB-10	867.89	CB-9	867.07	11.00	7			
	CB-11	864.14	CB-13	860.74	1.61		211		
	CB-12	858.00	CB-14	854.00	2.10	<pre></pre>		191	2
	CB-13	860.57	CB-12	859.65	1.27		72		
	CB-14	853.50	EW-1	850.42	4.18				74
TOTAL	S					688	1000	191	74

### **12.3 Standard Reports**

Geopak Drainage also provides several standard reports which are useful during storm drainage network design. The current Active Network will determine which drainage features are listed.

Identification	Runoff C	Drainage Area	Time of Conc.	Time Used	Intensity	Discharge	-
CB-1	0.794	0.263	5.00	5.000	6.980	1.457	
CB-2	0.590	0.452	5.00	5.000	6.980	1.864	
CB-3	0.470	0.539	5.62	5.624	6.805	1.725	Ξ
CB-4	0.470	0.547	5.00	5.000	6.980	1.793	
CB-5	0.300	1.023	5.00	5.000	6.980	2.146	
CB-6	0.750	0.257	5.00	5.000	6.980	1.343	
CB-7	0.300	5.778	6.43	6.428	6.580	11.409	
CB-8	0.300	1.103	5.00	5.000	6.980	2.311	
CB-9	0.398	0.708	5.79	5.795	6.757	1.904	
23+20	0.475	20.628	25.80	25.795	3.774	36.978	-

a) Select Reports > Drainage Areas from the Drainage Menu Bar.

#### b) Select Reports > Inlets> On Grade Inlets from the Drainage Menu Bar.

			Po	nded							
ID	Туре	Discharge	Width	Depth	Slope	Length	Width	Depr.	Capacity	By Pas	To Node
CB-1	Grate	1.457	5.123	0.232	2.515	3.021	1.813	n/a	1.200	0.257	CB-3
CB-2	Grate	1.864	6.004	0.250	2.515	3.021	1.813	n/a	1.441	0.423	CB-4
CB-3	Grate	1.981	6.227	0.255	2.515	3.021	1.813	n/a	1.507	0.474	CB-6
CB-4	Grate	2.216	6.644	0.263	2.515	3.021	1.813	n/a	1.634	0.581	CB-9
CB-6	Grate	1.818	6.624	0.262	1.710	3.021	1.813	n/a	1.408	0.409	CB-12
CB-9	Grate	2.486	7.842	0.287	1.710	3.021	1.813	n/a	1.779	0.706	CB-11
CB-11	Grate	1.303	5.411	0.238	1.710	3.021	1.813	n/a	1.089	0.214	CB-13
CB-12	Grate	1.517	5.956	0.249	1.710	3.021	1.813	n/a	1.226	0.291	CB-14
CB-13	Grate	1.096	8.974	0.217	1.710	3.021	1.813	n/a	0.871	0.225	CB-14
CB-14	Grate	2.207	5.385	0.288	1.710	3.021	1.813	n/a	1.771	0.436	Unassigned
Network:	All Netwo	rks 🔻		모				W	indow Cente	er	

#### Sag Inlets

			Discha	rge	Pond	ed Widt	h S	Slope							Ponded
D	Туре	Discharge	Left	Right	Left	Right	Left	Right	Length	Width	Depr.	Area	Perim.	Capacity	Depth
CB-5	Grate	2.146	2.103	0.043	4.466	2.117	1.000	1.000	n/a	n/a	n/a	3.600	7.600	6.841	0.203
CB-7	Grate	11.409	1.141	10.268	3.208	7.809	5.000	3.500	n/a	n/a	n/a	7.200	15.200	13.681	0.390
CB-8	Grate	2.311	0.046	2.265	2.069	6.770	1.000	1.000	n/a	n/a	n/a	3.600	7.600	6.841	0.213
CB-10	Grate	4.582	2.291	2.291	5.508	5.508	5.000	5.000	n/a	n/a	n/a	7.200	15.200	13.681	0.212

# c) Select Reports > Storm Drains/Links> Link Configuration from the Drainage Menu Bar.

	Upstream	Downstream									Upstream	Downstream	
ID	ID	ID	Discharge	Length	Shape	#	Rise	Span	n	Slope	Invert	Invert	1
SS-14	CB-14	EW-1	31.612	73.540	Circ	1	3.000	n/a	0.013	4.182	853.500	850.425	
SS-12	CB-12	CB-14	30.494	190	Circ	1	2.500	n/a	0.013	2.098	858.000	854.000	
SS-6	CB-6	CB-12	17.408	265	Circ	1	2.000	n/a	0.013	1.684	864.128	859.652	
SS-13	CB-13	CB-12	12.726	72.257	Circ	1	2.000	n/a	0.013	1.270	860.569	859.652	
SS-3	CB-3	CB-6	14.399	306	Circ	1	2.000	n/a	0.013	1.681	869.443	864.298	
SS-8	CB-8	CB-6	2.311	6.460	Circ	1	1.500	n/a	0.013	9.127	865.388	864.798	
SS-11	CB-11	CB-13	12.156	211	Circ	1	2.000	n/a	0.013	1.611	864.138	860.739	
SS-1	CB-1	CB-3	1.457	246	Circ	1	1.500	n/a	0.013	2.503	877.090	870.931	
SS-7	CB-7	CB-3	11.409	19.460	Circ	1	2.000	n/a	0.013	0.400	869.691	869.613	
SS-9	CB-9	CB-11	11.735	126	Circ	1	2.000	n/a	0.013	1.795	866.570	864.308	
			모			V	Vindow Ce	enter					

#### Link Hydraulic Calculations

ID 14 EW-1	HGL 856.237	HGL	Discharge	Capacity	0					
	856.237			Capacity	Slope	Loss	Velocity	Depth	Velocity	Depth
10 00.14		851.489	31.612	146.718	4.181	0.851	15.703	0.982	14.069	1.065
12 CB-14	861.997	855.280	30.494	63.904	2.097	2.031	12.181	1.270	12.052	1.280
6 CB-12	866.140	860.760	17.408	31.583	1.689	0.440	9.752	1.107	9.736	1.109
13 CB-12	862.211	861.997	12.726	27.419	1.277	0.141	8.129	0.997	4.051	2.000
3 CB-6	872.281	865.288	14.399	31.554	1.677	1.404	9.285	0.990	9.285	0.990
8 CB-6	866.351	865.120	2.311	34.138	9.125	0.069	10.461	0.274	8.311	0.322
11 CB-13	865.466	861.648	12.156	30.889	1.604	0.010	8.746	0.909	8.746	0.909
1 CB-3	877.737	871.232	1.457	17.878	2.504	0.094	5.787	0.300	5.787	0.300
7 CB-3	872.550	872.281	11.409	15.391	0.400	0.205	5.059	1.349	3.632	2.000
9 CB-11	869.185	865.178	11.735	32.600	1.797	1.313	9.036	0.864	8.959	0.869
	13         CB-12           -3         CB-6           -8         CB-6           -11         CB-13           -1         CB-3           -7         CB-3	-13         CB-12         862.211           -3         CB-6         872.281           -8         CB-6         866.351           -11         CB-13         865.466           -1         CB-3         877.737           -7         CB-3         872.550	13         CB-12         862.211         861.997           -3         CB-6         872.281         865.288           -8         CB-6         866.351         865.120           -11         CB-13         865.466         861.648           -1         CB-3         877.737         871.232           -7         CB-3         872.550         872.281           -9         CB-11         869.185         865.178	13         CB-12         862.211         861.997         12.726           -3         CB-6         872.281         865.288         14.399           -8         CB-6         866.351         865.120         2.311           -11         CB-13         865.466         861.648         12.156           -1         CB-3         877.737         871.232         1.457           -7         CB-3         872.550         872.281         11.409           -9         CB-11         869.185         865.178         11.735	13         CB-12         862.211         861.997         12.726         27.419           -3         CB-6         872.281         865.288         14.399         31.554           -8         CB-6         866.351         865.120         2.311         34.138           -11         CB-13         865.466         861.648         12.156         30.889           -1         CB-3         877.737         871.232         1.457         17.878           -7         CB-3         872.550         872.281         11.409         15.391           -9         CB-11         869.185         865.178         11.735         32.600	13         CB-12         862.211         861.997         12.726         27.419         1.277           3         CB-6         872.281         865.288         14.399         31.554         1.677           8         CB-6         866.351         865.120         2.311         34.138         9.125           11         CB-13         865.466         861.648         12.156         30.889         1.604           -1         CB-3         877.737         871.232         1.457         17.878         2.504           -7         CB-3         872.550         872.281         11.409         15.391         0.400           -9         CB-11         869.185         865.178         11.735         32.600         1.797	13         CB-12         862.211         861.997         12.726         27.419         1.277         0.141           -3         CB-6         872.281         865.288         14.399         31.554         1.677         1.404           -8         CB-6         866.351         865.120         2.311         34.138         9.125         0.069           -11         CB-13         865.466         861.648         12.156         30.889         1.604         0.010           -1         CB-3         877.737         871.232         1.457         17.878         2.504         0.094           -7         CB-3         872.550         872.281         11.409         15.391         0.400         0.205           -9         CB-11         869.185         865.178         11.735         32.600         1.797         1.313	13         CB-12         862.211         861.997         12.726         27.419         1.277         0.141         8.129           3         CB-6         872.281         865.288         14.399         31.554         1.677         1.404         9.285           8         CB-6         866.351         865.120         2.311         34.138         9.125         0.069         10.461           11         CB-13         865.466         861.648         12.156         30.889         1.604         0.010         8.746           1         CB-3         877.737         871.232         1.457         17.878         2.504         0.094         5.787           7         CB-3         872.550         872.281         11.409         15.391         0.400         0.205         5.059           9         CB-11         869.185         865.178         11.735         32.600         1.797         1.313         9.036	13         CB-12         862.211         861.997         12.726         27.419         1.277         0.141         8.129         0.997           3         CB-6         872.281         865.288         14.399         31.554         1.677         1.404         9.285         0.990           8         CB-6         866.351         865.120         2.311         34.138         9.125         0.069         10.461         0.274           11         CB-13         865.466         861.648         12.156         30.889         1.604         0.010         8.746         0.909           -1         CB-3         877.737         871.232         1.457         17.878         2.504         0.094         5.787         0.300           -7         CB-3         872.550         872.281         11.409         15.391         0.400         0.205         5.059         1.349           -9         CB-11         869.185         865.178         11.735         32.600         1.797         1.313         9.036         0.864	13         CB-12         862.211         861.997         12.726         27.419         1.277         0.141         8.129         0.997         4.051           3         CB-6         872.281         865.288         14.399         31.554         1.677         1.404         9.285         0.990         9.285           8         CB-6         866.351         865.120         2.311         34.138         9.125         0.069         10.461         0.274         8.311           11         CB-13         865.466         861.648         12.156         30.889         1.604         0.010         8.746         0.909         8.746           11         CB-3         877.737         871.232         1.457         17.878         2.504         0.094         5.787         0.300         5.787           7         CB-3         872.550         872.281         11.409         15.391         0.400         0.205         5.059         1.349         3.632           9         CB-11         869.185         865.178         11.735         32.600         1.797         1.313         9.036         0.864         8.959

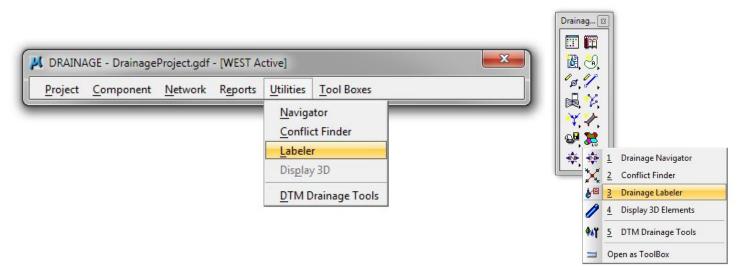
# **13. Storm Drainage Labeling**

This exercise shows the user how to use standard labels by labeling the plan and profile views.

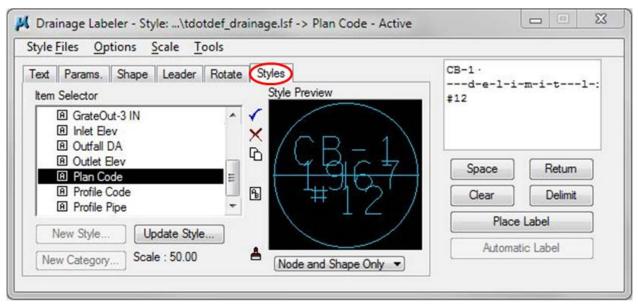
The Labeler automates the composition and placement of many types of labels into the dgn file. This interactive tool permits the creation of very simple to very complex labels.

## 13.1 Plan View Labeling

a) Open the Drainage Labeler by selecting **Utilities > Labeler** from the pull down menu or **Drainage Labeler** from the Drainage Toolbar.

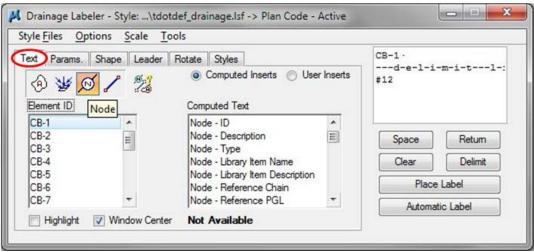


b) Click on the **Style** tab, double click **Plan Code** under the Storm Drainage category and double click it to make it the active style.

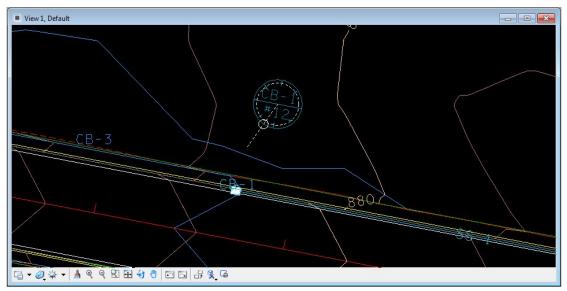


c) Zoom in to CB-1 in plan view.

- d) Click on the Text tab, then click the Nodes icon and toggle ON Window Center.
- e) Click on **CB-1** from the node list. Label data is automatically set for that node and view centers at node location.



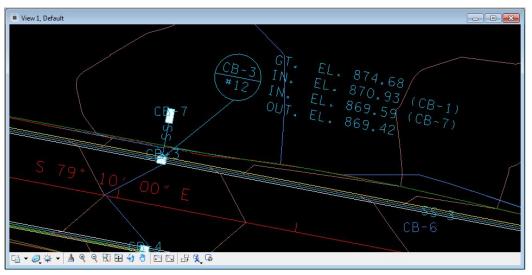
- f) Select from the pulldown menu: **Scale > Change Scale** and change to **50**.
- g) Click the Place Label button on the right of dialog to initiate placement of the label.
- h) Move the cursor to position the label and data point to place the label in the vicinity of CB-1. If the label text is not horizontal to the view or alignment, you may need to go to the Rotate tab to set the angle prior to placement.
- i) Move the cursor around and **data point** once again to locate the leader line point of beginning (i.e. where you want the leader to connect to the label).



- j) Click the Style tab and set the active style to GrateOut-OIN with a double click.
- k) Click the Text tab and select CB-1. Click Place Label and data point next to the Code Label to position the text.

**NOTE:** For catch basins with one or more inlets, elevation labels will require an extra step to insert the inlet elevation(s).

- I) Place labels for CB-3 which includes 2 inlet pipes.
  - 1. Click the **Style** tab and set the active style to **GrateOut-2IN** with a double click.
  - 2. Click the **Text** tab and select **CB-3**. Click **Place Label** and data point next to the Code Label to position the text.
  - 3. Click the Style tab and set the active style to Inlet Elev with a double click.
  - 4. Click the **Text** tab and select **SS-1**. Click **Place Label** and data point below the **GT**. **EL.** Text placed in step **b**.
  - 5. Select SS-7. Click Place Label and data point below the IN. EL. Text placed in step d.



m) Place the remaining plan view Node labels.

### 13.2 Profile View Labeling

Normally the plan view displays most of the data for a catch basin, however, in some circumstance labels on the profile may be required.

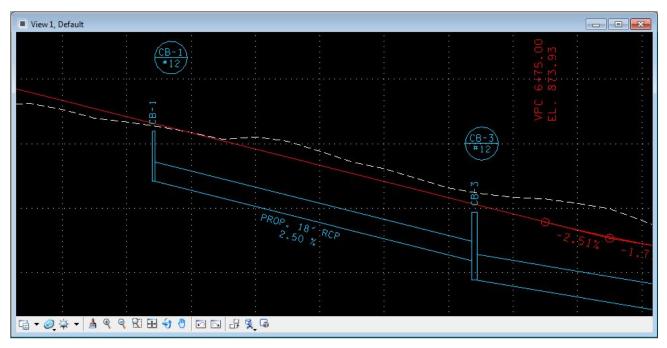
- a) Click on the Styles tab and double click on the style Profile Code to activate it.
- b) Click on the Rotate tab and click on Current Angle (If needed set to 0)

yle <u>Files</u> Options <u>S</u> cale <u>T</u> ools	
ext Params. Shape Leader Rotate Styles Text Angle Sample Output	CB-1. d-e-l-i-m-i-tl- #12
Alignment Angle: 0.0	Space Return
Set Angle By	Clear Delimit
DP Element AA	Place Label
	Automatic Label

- c) Click on the **Text** tab and toggle <u>OFF</u> the **Window Center Box**. This option works with plan view only.
- d) Zoom in on the alignment profile view in the vicinity of CB-1.
- e) Click on CB-1 in the node list and then click Place Label.
- f) Locate in profile view and place the label.
- g) Repeat until all codes are placed for all nodes in the profile view.

#### Leader Line Optional Steps:

- **Step 8.** Use MicroStation's **Match Element Attributes** and click on any code placement.
- **Step 9.** Use MicroStation's **Place Line** to place leader lines from code placement to node.



#### NOTE:

Pipes are automatically annotated correctly for the plans when the preference file **TDOTStormSewerProfiles-Plan.ppf** is used for profile display control. When using label style **Profile pipe** to label proposed pipes on the profile ...

- 1) Select the link under the Text tab
- 2) Go to the Rotate tab and set to Element Angle
- 3) Click **Element** button in the *Set Angle* By portion of the dialog and identify the bottom of pipe on the profile to set label angle.
- 4) Data point to place label.

# 14. Design & Computation Manager with Drainage Links

This exercise shows the user how to use the D&C Manager to control symbology, compute quantities, which can be used in preliminary estimates, and set pay items for drainage links by setting the symbology of all pipes and generating pipe quantities for this project.

## 14.1 Set Link Symbology

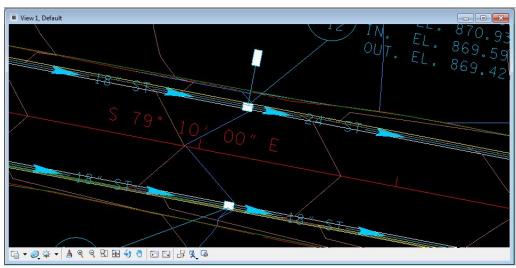
a) Select Components > Links > Update With Pay Items from the main menu bar or Update Links with Pay Items from the Drainage Toolbox.



b) Utilize the MicroStation command Fit View to view the entire Drainage Network.



c) Note that the Link symbology has changed to reflect that of the D&C Manager. All links use appropriate custom line styles and are labeled with ST's and pipe size.



## 14.2 Label Short Pipe Links

Often we have cases where the pipes are too short for their symbology to show as is the case with the pipes from various drop inlets just off the roadway in this project. We have a tool available to handle these with a separate label which is available through D&C Manager.

a) Open the Design and Computation Manager and select item **Drafting Standards**> **Prop. Drainage**> Label ST Pipe.

📕 Design and Computati	on Manager	X
<u>File Edit Settings</u>	F <u>a</u> vorites <u>H</u> elp	
🚞 Exist. Drainage		*
🗁 Prop. Drainage		
Structures in Pla	n	
Structures on Pr	ofiles	
Cross-drains & N	ledian-drains	
Storm Sewer Pip	es	
Special Ditches		
Plan Cells	drainage plan view cells	Ξ
Profile Cells	drainage profile/culv xsection cells	
🖹 Rip-Rap Area	pattern proposed Rip-Rap area	
Flow Direction	draw flow direction	
Label ST Pipe	place proposed storm drainage pipe la	bel
Trench Drain	proposed trench drain	
🖹 18" Pr BR drain	proposed 18" Pipe for bridge end drain	n
📄 Guardrail		-

b) The Place Prop. Storm Drainage Pipe Label dialog opens and you are prompted to identify the pipe. Data point on link SS-7, the pipe between CB-7 and CB-3, and the appropriate text is filled in on the dialog.

By default the label will come up as text only at the angle of the pipe. If there is room, you can place the label as such along the pipe.

For pipes too short for that, click on the option to **Place Label as Flag** and click the **Place Label** button.

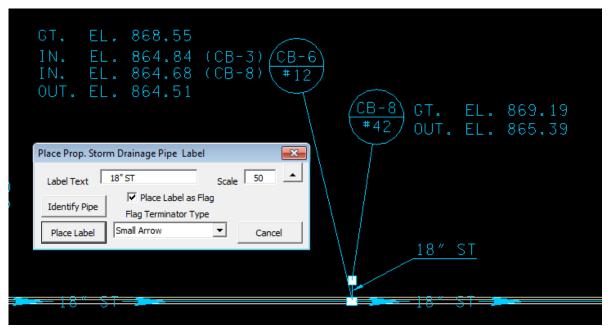
Place Prop. Stor	m Drainage Pipe Labe	ł	<b>x</b>
Label Text	18" ST	Scale	50
Identify Pipe	Place Label as F Flag Terminator Typ	-	
Place Label	None	•	Cancel

c) Data point on or near the pipe for the beginning of the leader and once again to position the label which is shown dynamically.

Place Prop. Storm Drainage Pipe Label       Label Text     18° ST       Scale     50       Identify Pipe     IV Place Label as Flag       Flag Terminator Type     Flag Terminator Type       Place Label     None	GT. EL. 868.55 IN. EL. 864.84 (CB-3) IN. EL. 864.68 (CB-8) OUT. EL. 864.51
GT. EL. 874.11 OUT. EL. 870.23 18" ST GT. EL. 874.68 IN. EL. 870.97 (CB-1) IN. EL. 870.13 (CB-7) OUT. EL. 869.96 IN. EL. 870.97 (CB-1) IN. EL. 870.13 (CB-7) OUT. EL. 869.96	
S 79° 10′ 00″ E	

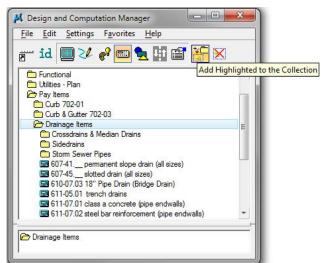
d) Use the Identify Pipe button to read and Iabel the other short pipe links on the project.

You may wish to use one of the terminator options for pipes in tight places with other text and line work.



## **14.3 Compute Link Quantities**

- a) Open the Design and Computation Manager and set the Mode to Compute by clicking the 'calculator' icon button.
- b) Under Pay Items, highlight the Prop. Drainage category, then click the Add to Collection button on the Design & Computation Manager toolbar.



c) Within the Plan Quantity Computation box ensure Extents: is set to Active Design File. Click the Compute Quantities button for initiation of the report. Your results may vary.

Job: 01	Q Extents:	Active Desi	gn File 🔻	Inside •	-) ¢
Baseline Ref	erence				
Chain 🔻	CL ·	🔹 🛵 🔽 Be	egin Station:	0+00.00	+0+
Range:	100.00	<b>V</b> 6	End Station:	29+64.02	<b>+</b> ••+

**NOTE:** To limit the extent of calculation set Extents: to Station Range, and set the limits desired in the *Baseline Reference* portion of the dialog.

d) Select your Export Format. Select **CSV By Item** for use with standard estimate files. Type in drainage.csv for the filename and click on **Export**.

ltem	Description	Quantity	Unit	Export
607-03.02	18" storm sewer pipe Class 3	690.00	LF	7
607-05.02	24" storm sewer pipe Class 3	1002.00	LF	1
607-06.02	30" storm sewer pipe Class 3	191.00	LF	~
607-07.02	36" storm sewer pipe Class 3	74.00	LF	~
	CSV By Item	Q Create V Export V		

In the Estimated Roadway Quantities Excel file use the **Import CSV File for Items** command button to import the data compiled with D&C Manager.

**NOTE:** This function reads only the item number and quantity from the csv file. Item description and unit are pulled from the official item number listing.

9	- C <sup>u</sup> -   <del>-</del>		Estimated Roadway Quanti	ties1 - Micr	osoft Excel			
File	Home Insert	Page Layout Formulas Data	Review View Developer	Acrobat				a 🕜 🗆 🖬
Ê 🖁	Arial	• 10 • A • = = *	♥ - ■ Wrap Text	Text	•		B*= Insert ≠ B* Delete ≠	Σ 27 🕅
ipboard			E 💷 Merge & Center 🔻	\$ - % :	.00 9.0	Conditional Format as Formatting * Table * Styles		✓ ∠ - Sort & Find Filter - Select Editing
	B6							
A	В	C		D	E	I J	К	L
		ESTIMATED ROAL		e		1		
		ES TIMATED ROAL		3	1	These p	programs can also be	accessed under Vie
	ITEM NO.	DESCRIPT	ON	UNIT	QUANTITY		This estimated roadw <b>Data</b> worksheet. Th	
							e detailed information	
	607-03.02	18" CONCRETE PIPE CULVERT (CI	/	L.F.	690	http://ww	w.tdot.state.tn.us/Chie	ef Engineer/assistan
	607-05.02	24" CONCRETE PIPE CULVERT (CI		L.F.	1002			1
	607-06.02	30" CONCRETE PIPE CULVERT (CI		L.F.	191	s	elect Items Numbers	s From List
-	607-07.02	36" CONCRETE PIPE CULVERT (CI	LASS III)	L.F.	74			
-							Fill In Description	and Unit
						De	wnload Items.dat fro	m Web Bare
							windad items.dat ito	in web Fage
							Import CSV File fo	or Items
						_		
							Sort Item Numb	arr
-							Soft item Num	Jers
							-	.
							Format Notes A	Area
							Format Item Nur	nbers
							1 Column Forr	nat
< > >		Col #1-Est. Rdwy. Quantities	Col #2-Est. Rdwy. Quantitie	s / Box	Bridge Quant	ities ⁄ 🕽 🕴	•	· · · · · · · · · · · · · · · · · · ·
ady  🛅							90% -	— <b>(</b>

## 14.4 Alternate Pay Items for Links

- a) Open Edit Link and select Link SS-14.
- b) In Definition, under the *Configuration* portion, toggle ON Override Library Payitem.

Link Configu	ration Definition
Link ID: 📕 😒	-14 Vindow Center 1 X X Apply
Details	
Options	Description:
Definition	From Node: CB-14 🔻 🏂 To Node: EW-1 💌 🏂
Conditions Constraints Computation	Length: 73.5400 Use MS Element Configuration Shape: Circular  Material: Concrete
Type Pipe Ditch	Design Size       Size: 36 Inch Dia. Circular       Select         Design Barrels       Number of Barrels:       Roughness:       0.013         V       Override Library Payitem:       Image: Select
	Select Payitem

c) Click on the calculator button to select an alternate pay item. Go to Pay Items > Storm Sewer Pipes > 607-07.03 36" storm sewer pipe Class 4.

Double click on the 36" Class 4 Concrete pipe item to switch it from the defaulted Class 3 item number.

**NOTE:** All circular concrete pipes are set up with Class 3 concrete pipe item numbers. When setting up a system of median drains for depressed grass medians then all pipes will need to be set to use alternate pipe item numbers as listed under D & C manager category **Pay Items > Drainage Items > Crossdrains & Median Drains**.

<u>File E</u> dit <u>S</u> ettings F <u>a</u> vorites <u>H</u> elp	Distin
搞 id 📃 🔤	K Close
🛅 Utilities - Plan	
Pay Items	
Curb 702-01	
Curb & Gutter 702-03	
🗁 Drainage Items	
Crossdrains & Median Drains	=
C Sidedrains	
Storm Sewer Pipes 607-02.02 15" storm sewer pipe C	200
607-02.02 15 storm sewer pipe C	
607-05.02 24" storm sewer pipe C	
607-06.02 30" storm sewer pipe C	
607-07.02 36" storm sewer pipe C	
507-08.02 42" storm sewer pipe C	
📾 607-09.02 48" storm sewer pipe C	lass 3
607-10.02 54" storm sewer pipe C	lass 3
607-11.03 60" storm sewer pipe C	
607-12.03 66" storm sewer pipe C	
607-13.03 72" storm sewer pipe C	
607-14.03 78" stom sewer pipe C	
607-02.03 15" storm sewer pipe C	
607-03.03 18" storm sewer pipe C 607-05.03 24" storm sewer pipe C	
607-05.03 24 storm sewer pipe C	
607-07.03 36" storm sewer pipe C	
607-08.03 42" storm sewer pipe C	

d) Click Apply in the Link Configuration Definition dialog to accept the change.

Follow Exercise 14.1 to update the link graphics.

Follow Exercise 14.3 to re-compute the quantities and see the difference.

ltem	Description	Quantity	Unit	Export
607-03.02	18" storm sewer pipe Class 3	690.00	LF	<b>V</b>
607-05.02	24" storm sewer pipe Class 3	1002.00	LF	2
607-06.02	30" storm sewer pipe Class 3	191.00	LF	1
607-07.03	36" storm sewer pipe Class 4	74.00	LF	
xport Format:	CSV By Item    CSV By Item    CSV By Item    CSV By Item    CSV By Item    CSV By Item    CSV By Item    CSV By Item    CSV By Item     CSV By Item     CSV By Item     CSV By Item     CSV By Item     CSV By Item      CSV By Item       CSV By Item       CSV By Item	Create		

NOTE: See Appendix G for Pipe Selection Criteria based on system and fill height.

D.O.T. Geopak Drainage	Nodes
0.0.T. Geopak Dra	Ë
O.T. Geor	
1.0.	ieop
	1.0.

1) Names for nodes indicate inside length & width dimensions of square structures or inside diameter of circular structures.

2) All values are from T.D.O.T. Standard Roadway Drawings based on concrete pipe.

3) For use with "Min Fixed Drop" option... Minimum Depth of Cover = Minimum Depth of Node - (Pipe Size + Drop Across Bottom of Structure) with both inlet & outlet pipes of the same size. When node has outlet pipe only or the outlet pipe is larger than the inlet pipe, increase the

minimum depth of cover by the drop across bottom of structure value.

If no values are entered under a pipe size this indicates that pipe size is not valid with that node.
 Any pipe size which includes a "W" with the minimum depth of cover value indicates the pipe size can only be used in the wide side of the structure.

42"
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Drainage	Node	Cell	Drop	Мах.						Pipe Sizes	izes					
Node	Description	Name	Across	Depth		15		18		24		30		36		42
Name			Bottom		Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.		Min.	Min.	Min.
			of		Depth	Depth of	Depth	Depth of	Depth	Depth of	Depth	Depth of	Depth	Õ	Depth	Depth of
ype: Grate			Structure			Cover		Cover		Cover		Cover		Cover		Cover
CB#10 32"X26"	Lowered 6-30 Curb & Grate Inlet	CB32X26S	0.12	5.08			3.74	2.12	4.28	W 2.16						
CB#10 4X3	6" NonMount. Curb & Grate Inlet	CB4X3S	0.17	20.00			3.88	2.21	4.42	2.25	4.96	W 2.29	9 5.50	) W 2.33		
CB#10 4' DIA	6" NonMount. Curb & Grate Inlet	CB4DIAS	0.17	20.00			3.88	2.21	4.42	2.25						
CB#10 4X4	6" NonMount. Curb & Grate Inlet	CB4X4S	0.17	28.00			3.88	2.21	4.42	2.25	4.96	2.29	9 5.50	0 2.33	~	
CB#12 32"X32"	6" NonMount. Curb & Grate Inlet	CB32X32	0.12	4.58			3.74	2.12	4.28	2.16						
CB#12 4X3	6" NonMount. Curb & Grate Inlet	CB4X3	0.17	20.00			3.88	2.21	4.42	2.25	4.96	W 2.29	9 5.50	0 W 2.33		
CB#12 4' DIA	6" NonMount. Curb & Grate Inlet	CB4DIA	0.17	20.00			3.88	2.21	4.42	2.25						
CB#12 4X4	6" NonMount. Curb & Grate Inlet	CB4X4	0.17	28.00			3.88	2.21	4.42	2.25	4.96	2.29	9 5.50	0 2.33	8	
CB#12 5' DIA	6" NonMount. Curb & Grate Inlet	CB5DIA	0.21	40.00			3.92	2.21	4.46	2.25	5.00	2.29	9 5.55	5 2.34	t 6.09	2.38
CB#12 5'2"X5'2"	6" NonMount. Curb & Grate Inlet	CB62X62	0.22	28.00			4.13	2.41	4.67	2.45	5.22	2.50	0 5.76	5 2.54	t 6.30	2.58
CB#12 6' DIA	6" NonMount. Curb & Grate Inlet	CB6DIA	0.25	40.00			3.97	2.22	4.51	2.26	5.05	2.30	0 5.59	) 2.34	t 6.13	2.38
CB#12 7' DIA	6" NonMount. Curb & Grate Inlet	CB7DIA	0.29	40.00			4.34	2.55	4.88	2.59	5.42	2.63	3 5.97	7 2.68	6.51	2.72
CB#12 7X7	6" NonMount. Curb & Grate Inlet	CB7X7	0.29	28.00			4.17	2.38	4.72	2.43	5.26	2.4	7 5.80	) 2.51	6.34	2.55
CB#12 8' DIA	6" NonMount. Curb & Grate Inlet	CB8DIA	0.33	40.00			4.38	2.55	4.92	2.59	5.46	2.63	3 6.00	0.2.67	6.54	2.7
CB#12 9' DIA	6" NonMount. Curb & Grate Inlet	CB9DIA	0.38	40.00			4.42	2.54	4.96	2.58	5.50	2.62	2 6.04	t 2.66	6.58	2.7(
CB#12 9X9	6" NonMount. Curb & Grate Inlet	CB9X9	0.38	28.00			4.25	2.37	4.79	2.41	5.33	2.45	5 5.88	3 2.50	0.42	2.54
CB#12 10' DIA	6" NonMount. Curb & Grate Inlet	<b>CB10DIA</b>	0.42	40.00			4.46	2.54	5.00	2.58	5.54	2.62	2 6.08	3 2.66	6.63	2.7
CB#13 4X3	6" NonMount. Curb & Grate Inlet	CB4X3	0.17	20.00			3.88	2.21	4.42	2.25	4.96	W 2.29	9 5.50	0 W 2.83		
CB#13 4' DIA	6" NonMount. Curb & Grate Inlet	CB4DIA	0.17	20.00			3.88	2.21	4.42	2.25						
CB#13 5' DIA	6" NonMount. Curb & Grate Inlet	CB5DIA	0.21	40.00			3.92	2.21	4.46	2.25	5.00	2.29	9 5.55	5 2.34	t 6.09	2.38

Drainage Node	Cell	Drop	мах.						Pipe Sizes	IZeS					
Description	Name	Across	Depth		15		18		24		30		36		42
		Bottom		Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	2
		of		Depth	Depth of	Depth	Depth of	Depth	Depth of	Depth	Depth of	f Depth	n Depth of	of Depth	h Depth of
		Structure			Cover		Cover		Cover		Cover		Cover	-	Cover
6" NonMount. Curb & Grate Inlet	CB6DIA	0.25	40.00			3.97	2.22	4.51	2.26	5.05	2.30	5.59		2.34 6.13	3
6" NonMount. Curb & Grate Inlet	CB7DIA	0.29	40.00			4.34	2.55	4.88	2.59	5.42	2.63			2.68 6.51	51
6" NonMount. Curb & Grate Inlet	CB8DIA	0.33	40.00			4.38	2.55	4.92	2.59	5.46	2.63	6.00		2.67 6.54	54
6" NonMount. Curb & Grate Inlet	CB9DIA	0.38	40.00			4.42	2.54	4.96	2.58	5.50	2.62	2 6.04	14 2	.66 6.58	86
CB#13 10' DIA 6" NonMount. Curb & Grate Inlet	CB10DIA	0.42	40.00			4.46	2.54	5.00	2.58	5.54	2.62	6.08		2.66 6.63	53
6" NonMount. Curb & Grate Inlet	CB8X3	0.33	20.00			4.05	2.22	4.59	2.26	5.13	<b>W</b> 2.30	0 5.67	M	2.34 6.21	M Li
6" NonMount. Curb & Grate Inlet	CB8DIA	0.33	40.00			4.38	2.55	4.92	2.59	5.46	2.63	6.00		2.67 6.54	54
6" NonMount. Curb & Grate Inlet	CB9X9	0.38	28.00			4.42	2.54	4.96	2.58	5.50	2.62	6.04		2.66 6.58	89
6" NonMount. Curb & Grate Inlet	CB8X4	0.33	20.00			4.05	2.22	4.59	2.26	5.13	2.30	5.67		2.34 6.21	M Li
6" NonMount. Curb & Grate Inlet	CB8X62	0.33	20.00			4.22	2.39	4.76	2.43	5.30	2.4	7 5.84	34 2.	.51 6.38	88
CB#25 32"X32" 6" Mountable Curb & Grate Inlet	CB32X32	0.12	4.58			3.74	2.12	4.28	2.16						
6" Mountable Curb & Grate Inlet	CB4X3	0.17	20.00			3.88	2.21	4.42	2.25	4.96	W 2.29	9 5.50	N	2.33	
6" Mountable Curb & Grate Inlet	CB4DIA	0.17	20.00			3.88	2.21	4.42	2.25						
6" Mountable Curb & Grate Inlet	CB4X4	0.17	28.00			3.88	2.21	4.42	2.25	4.96	2.29	9 5.50		2.33	
6" Mountable Curb & Grate Inlet	CB5DIA	0.21	40.00			3.92	2.21	4.46	2.25	5.00	2.29	9 5.55		2.34 6.09	60
CB#25 5'2"X5'2" 6" Mountable Curb & Grate Inlet	CB62X62	0.22	28.00			4.13	2.41	4.67	2.45	5.22	2.50	5.76		2.54 6.30	80
6" Mountable Curb & Grate Inlet	CB6DIA	0.25	40.00			3.97	2.22	4.51	2.26	5.05	2.30	5.59		2.34 6.13	3
6" Mountable Curb & Grate Inlet	CB7DIA	0.29	40.00			4.34	2.55	4.88	2.59	5.42	2.63	3 5.97		2.68 6.51	51
6" Mountable Curb & Grate Inlet	CB7X7	0.29	28.00			4.17	2.38	4.72	2.43	5.26	2.4	7 5.80		2.51 6.34	34
6" Mountable Curb & Grate Inlet	CB8DIA	0.33	40.00			4.38	2.55	4.92	2.59	5.46	2.63	6.00		2.67 6.54	54
6" Mountable Curb & Grate Inlet	CB9X9	0.38	28.00			4.25	2.37	4.79	2.41	5.33	2.45	5.88		2.50 6.42	12
6" Mountable Curb & Grate Inlet	CB8X3	0.33	20.00			4.05	2.22	4.59	2.26	5.13	<b>W</b> 2.30	0 5.67	Μ	2.34 6.21	M La
6" Mountable Curb & Grate Inlet	CB8X4	0.33	20.00			4.05	2.22	4.59	2.26	5.13	2.30	5.67		2.34 6.3	1 W
CB#28 32"X32" 4" Mountable Curb & Grate Inlet	CB32X32	0.12	4.58			3.74	2.12	4.28	2.16						
4" Mountable Curb & Grate Inlet	CB4X3	0.17	20.00			3.88	2.21	4.42	2.25	4.96	W 2.29	9 5.50	M	2.33	
4" Mountable Curb & Grate Inlet	CB4DIA	0.17	20.00			3 88	166	C V V	7 J L						

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			ſ		38	38	72	71	38	72	72	2				29	50	30	63	63		58	67	51	75	50	1.46	66		
		Min.	Depth of	Cover	2.:	2.38	2.7	2.7	2.38	2.77	2.7	2.7				2.2	2.5(	2.3(	2.63	2.63		2.58	2.67	2.51	2	2.5(	1.4	2.66		
	42			-	6(	3	1	4	M Li	1	1	8				0	2	15	:2	9		0	9	0	8	8	M 6	.54		
		Min.	Depth		6.09	6.13	6.51	6.54	6.21	6.51	6.51	6.58				6.00	6.22	6.05	6.42	6.46		6.30	6.46	6.30	6.58	6.38	5.29	6.5		
		Ŀ.	h of	ver	2.34	2.34	2.68	2.67	2.34	2.68	2.68	2.66			2.25	2.25	2.45	2.26	2.59	2.59	1.41	2.54	2.63	2.47	2.71	2.45	1.42	2.62		2.33
	36	Min.	Depth of	Cover					M																					Μ
	.,	Min.	Depth		5.55	5.59	5.97	6.00	5.67	5.97	5.97	6.04			5.42	5.46	5.67	5.51	5.88	5.92	4.58	5.76	5.92	5.76	6.04	5.83	4.75	6.00		5.50
					2.29	30	53	53	30	53	53	52			21	21	11	22	55	2.55	37	20	59	13	57	11	.38	.58		63
		Min.	Depth of	Cover	2.2	2.30	2.63	2.63	2.30	2.63	2.63	2.62			2.21	2.2	2.41	2.22	2.55	2.5	1.3	2.50	2.59	2.43	2.67	2.47	-	2.5		2.29
	30			-	5.00	5.05	5.42	5.46	5.13 W	5.42	5.42	.50			4.88	4.92	5.13	4.97	5.34	5.38	4.04	5.22	5.38	5.22	5.50	5.29	21	5.46		4.96 W
sizes		Min.	Depth		2'	2.0	- 2	- 2	2.	5.	5.	-2			4.	4.	. 9	4.	2.3	2.	4.	- 9	2.3	- 2	-2	2	4.	- 2		4.
Pipe Sizes		Min.	Depth of	Cover	2.25	2.26	2.59	2.59	2.26	2.59	2.59	2.58	2.16	1.38	2.17	2.17	2.37	2.17	2.51	2.50	1.33	2.45	2.54	2.38	2.63	2.37	1.34	2.54	2.16	2.25
	24	M	Dep	ပိ																										
		Min.	Depth		4.46	4.51	4.88	4.92	4.59	4.88	4.88	4.96	4.28	3.50	4.34	4.38	4.59	4.42	4.80	4.83	3.50	4.67	4.83	4.67	4.96	4.75	3.67	4.92	4.28	4.42
	-	_		L	.21	2.22	2.55	2.55	2.22	2.55	2.55	2.54	2.12	.34	2.13	2.13	2.33	2.13	2.47	2.46	.29	2.41	2.50	2.34	2.59	2.33	1.30	2.50	.12	2.21
	~	Min.	Depth of	Cover	2	2	2	2	2	2	2	2	2	-	2	2	2	2	2	2	-	2	2	2	2	2	-	2	2	2
	18				3.92	3.97	4.34	4.38	4.05	4.34	4.34	4.42	3.74	2.96	3.80	3.84	4.05	3.88	4.26	4.29	2.96	4.13	4.29	4.13	4.42	4.21	3.13	4.38	3.74	3.88
		Min	Depth		3	3	4	4	4	4	4	4	3	2	3	3	4	3	4	4	2	4	4	4	4	4	3	4	3	3
		Min.	Depth of	Cover																										
	15			с С																										
		Min.	Depth																											
Мах.	Depth				40.00	40.00	40.00	40.00	20.00	40.00	28.00	28.00	6.00	4.58	28.00	40.00	28.00	40.00	40.00	40.00	28.00	28.00	40.00	28.00	40.00	28.00	20.00	28.00	4.58	20.00
Μ				e									12	12	<u></u>						17 2								12	
Drop	Across	Bottom	of	Structure	0.21	0.25	0.29	0.33	0.33	0.29	0.29	0.38	0.12	0.12	0.1	0.2	0.22	0.25	0.29	0.33	0.1	0.22	0.29	0.29	0.33	0.38	0.33	0.38	0.12	0.17
	4	Ξ		StI																										
Cell	Name				AIC	AIC	AIC	AIC	3	<b>CB7DIAC</b>	<7C	(9C	CB32X80C	CB32X32M	(4M	CB5DIAM	CB62X62M	<b>CB6DIAM</b>	<b>CB7DIAM</b>	<b>CB8DIAM</b>	44M	CB62X62M	<b>CB7DIAM</b>	ML)	<b>CB8DIAM</b>	M9	(4M	M9	CB32X32B	(3B
Ŭ	z				CB5DIA	CB6DIA	<b>CB7DIA</b>	<b>CB8DIA</b>	CB8X3	CB7I	CB7X7C	CB9X9C	CB32	CB32	CB4X4M	CB5I	CB62	CB6[	CB7I	CB8I	CB4X4M	CB62	CB7I	CB7X7M	CB8[	CB9X9M	CB8X4M	CB9X9M	CB32	CB4X3B
					et	et	et	et	et	t	t	t	t																ŧ	t
	~				ate Inl	" Mountable Curb & Grate Inlet	ate Inl	ate Inl	" Mountable Curb & Grate Inlet	te Inle	te Inle	te Inle	te Inle																te Inle	te Inle
Node	Description				å Gr	å Gr	a Gr	å Gr	å Gr	& Gra	& Gra	& Gra	& Gra	e	e	e	e	e	e	e	e	е	e	e	e	e	e	e	& Gra	& Gra
N	Desci				e Curb	e Curb	e Curb	e Curb	e Curb	Curb	Curb	Curb	Curb	n Grat	Curb	Curb														
					ntable	intable	Intable	intable	Intable	arrier	arrier	arrier	arrier	n Ditch	arrier	arrier														
					4" Mountable Curb & Grate Inlet	4" Mou	4" Mountable Curb & Grate Inlet	4" Mountable Curb & Grate Inlet	4" Mou	Med. Barrier Curb & Grate Inlet	Median Ditch Grate	Med. Barrier Curb & Grate Inlet	Med. Barrier Curb & Grate Inlet																	
a`					7	7	4	7	7													'2"								
Drainage	Node	Name		irate	5' DIA	6' DIA	7' DIA	8' DIA	8X3	7' DIA	TX7	6X6	CB#32 32"X80'	CB#38 32"X32	4X4	CB#38 5' DIA	CB#38 5'2"X5'2"	6' DIA	CB#38 7' DIA	8' DIA	4X4	CB#39 5'2"X5'2"	CB#39 7' DIA	LXT	8' DIA	9X9	8X4	6X6	CB#41 32"X32"	4X3
D	~	2		ype: Grate	CB#28 5' DIA	CB#28 6' DIA	CB#28 7' DIA	CB#28 8' DIA	CB#29 8X3	CB#31 7' DIA	CB#31 7X7	CB#31 9X9	B#32.	B#38.	CB#38 4X4	B#38.	B#38 :	CB#38 6' DIA	B#38	CB#38 8' DIA	CB#39 4X4	B#39 :	B#39	CB#39 7X7	CB#39 8' DIA	CB#39 9X9	CB#40 8X4	CB#40 9X9	B#41.	CB#41 4X3
				ŕ	Ü	Ü	U	Ü	U	Ü	Ü	U	Ü	Ü	Ü	Ü	C	Ü	Ü	Ü	U	Ü	Ü	C	Ü	Ü	Ü	Ü	Ü	C

# Table A Pipe Sizes 15" - 42"

ge         Fine Stass         Coll         Mode         Coll         Min         Min <t< th=""><th>Table A Pip</th><th>Table A Pipe Sizes 15" - 42"</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></t<>	Table A Pip	Table A Pipe Sizes 15" - 42"															
	Drainage	Node	Cell	Drop	Мах.						Pipe :	Sizes					
e         Min.         Mi	Node	Description	Name	Across	Depth		15		18		24		30		36		42
Normed Barrier Curb & Grate Intel         Open         Deptn of Leptn         Deptn of Leptn <thdeptn leptn<="" of="" th="">         Deptn of Leptn         <th< th=""><th>Name</th><th></th><th></th><th>Bottom</th><th></th><th>Min.</th><th>Min.</th><th>Min.</th><th>Min.</th><th>Min.</th><th>Min.</th><th>Min.</th><th>Min.</th><th>Min.</th><th>Min.</th><th>Min.</th><th>Min.</th></th<></thdeptn>	Name			Bottom		Min.	Min.										
Med. Barrier Curb & Grate Inter         CB4XdB         0.17         28.00         3.38         2.21         4.42         2.25         5.00         2.29           AT         Med. Barrier Curb & Grate Inter         CB5D/ABB         0.21         4.000         392         2.21         4.46         2.25         5.00         2.29           AT         Med. Barrier Curb & Grate Inter         CB5D/ABB         0.23         4.000         347         2.24         5.52         5.00         2.39           A         Med. Barrier Curb & Grate Inter         CB5D/ABB         0.29         4.000         347         2.24         5.52         5.42         5.46         2.53           A         Med. Barrier Curb & Grate Inter         CB5D/ABB         0.29         8.000         4.34         2.35         4.47         2.45         5.34         2.46           A         Med. Barrier Curb & Grate Inter         CB5D/ABB         0.33         28.000         4.34         3.50         1.47         2.45         5.34         2.46         2.47         2.46         2.47         2.46         2.47         2.46         2.47         2.46         2.47         2.46         2.47         2.46         2.47         2.46         2.47         2.47	Tvpe: Grate	-		of Structure		Depth	Lepth of Cover	Deptn	Lepth of Cover	Depth	Depth of Cover	Deptn	Lepth of Cover	Depth	Depth of Cover	Depth	Depth of Cover
A         Med Barrier Curb & Grate Inlet         CB5DAB         0.21         4.00         2.25         5.00         2.29           X52*         Med Barrier Curb & Grate Inlet         CB6XXAB         0.22         40.00         4113         2.41         4.67         2.56         5.00         2.39           A         Med Barrier Curb & Grate Inlet         CB6XAB         0.29         40.00         411         2.36         4.81         2.45         5.26         5.00         2.39           A         Med Barrier Curb & Grate Inlet         CB7DAB         0.29         40.00         411         2.36         4.81         2.43         5.26         5.46         2.43         5.46         2.43         5.46         2.43         5.46         2.43         5.46         2.43         5.46         2.43         5.46         2.43         5.46         2.43         5.46         2.43         5.46         2.43         5.46         2.43         5.46         2.43         5.46         2.43         5.46         2.43         5.46         2.43         5.46         2.45         2.45         5.46         2.45         5.46         2.45         5.46         2.45         5.46         2.45         5.46         2.45         5.46	CB#41 4X4	Med. Barrier Curb & Grate Inlet	CB4X4B	0.17	28.00			3.88	2.21	4.42	2.25		2.29		2.33		
K52*         Med Barrier Curb & Grate Inlet         CB62X6:2B         0.22         28.00         4.13         2.41         4.67         2.26         5.23         2.30           A         Med Barrier Curb & Grate Inlet         CBDABB         0.25         4.00         3.97         2.26         4.50         2.47         2.69         5.46         2.69         2.69         2.63         2.63         2.63         2.64         2.64         2.63         2.64         2.64         2.63         2.63         2.63         2.64         2.64         2.63         2.63         2.64         2.64         2.63         2.63         2.64         2.64         2.63         2.64	CB#41 5' DIA	Med. Barrier Curb & Grate Inlet	CB5DIAB	0.21	40.00			3.92	2.21	4.46	2.25		2.29		2.34	6.09	2.38
A         Med. Barrier Curb & Grate Intel         CB6DIAB         0.25         4.00         3.97         2.22         4.51         2.26         5.05         2.33           A         Med. Barrier Curb & Grate Intel         CB7DIAB         0.29         4.000         4.33         2.55         4.97         2.43         2.45         2.43           A         Med. Barrier Curb & Grate Intel         CB7DIAB         0.29         4.000         4.33         2.55         4.97         2.43         2.45         2.43           A         Med. Barrier Curb & Grate Intel         CB8DIAB         0.33         4.000         4.35         2.33         4.79         2.47         2.46         2.47         2.45         2.43         2.46         2.47         2.45         2.46         2.47         2.45         2.47         2.45         2.45         2.47         2.45         2.47         2.45         2.47         2.45         2.47         2.46         2.47         2.45         2.47         2.45         2.47         2.45         2.47         2.45         2.47         2.45         2.47         2.45         2.47         2.45         2.47         2.45         2.47         2.45         2.47         2.45         2.47         2.45 <td>CB#41 5'2"X5'2"</td> <td>Med. Barrier Curb &amp; Grate Inlet</td> <td>CB62X62B</td> <td>0.22</td> <td>28.00</td> <td></td> <td></td> <td>4.13</td> <td>2.41</td> <td>4.67</td> <td>2.45</td> <td></td> <td>2.50</td> <td></td> <td>2.54</td> <td>6.30</td> <td>2.58</td>	CB#41 5'2"X5'2"	Med. Barrier Curb & Grate Inlet	CB62X62B	0.22	28.00			4.13	2.41	4.67	2.45		2.50		2.54	6.30	2.58
A         Med Barrier Curb & Grate Intet         CB7/DB         0.29         400         4.34         2.55         4.88         2.59         5.42         2.63           A         Med Barrier Curb & Grate Intet         CB7/TB         0.29         28.00         4.17         2.38         4.79         2.54         2.46         2.46           A         Med Barrier Curb & Grate Intet         CB9XPB         0.33         30.00         4.35         2.49         2.45         2.46         2.46         2.46           3.32         Drop Intel Grate         D132X32         0.17         5.08         2.43         3.50         1.38         2.71         4.92         2.25         2.41         4.88         2.71         4.92         2.21         4.41         2.25         2.41         4.88         2.71         4.92         2.21         4.41         2.22         2.41         4.88         2.71         4.97         2.25         2.41         2.55         2.41         2.55         2.41         2.55         2.41         2.55         2.41         2.55         2.51         2.51         2.51         2.51         2.51         2.51         2.51         2.51         2.51         2.51         2.55         2.51         2.51<	CB#41 6' DIA	Med. Barrier Curb & Grate Inlet	CB6DIAB	0.25				3.97	2.22	4.51	2.26		2.30		2.34	6.13	2.38
Med. Barrier Curb & Grate Inlet         CB777B         0.22         28.00         4.17         2.38         4.72         2.43         5.26         2.47           (32)         Med. Barrier Curb & Grate Inlet         CB8DIAB         0.33         40.00         —         4.31         3.50         1.34         5.51         5.46         2.63           (32)         Mod. Barrier Curb & Grate Inlet         CB8DIAB         0.33         40.00         —         4.43         3.50         1.34         5.51         5.49         5.46         2.63           (32)         Mod. Barrier Curb & Grate Inlet         CB8DIAB         0.33         40.00         2.45         3.50         1.34         2.17         4.92         2.21           (32)         Drop Inlet Grate         D17A         0.21         400         3.80         2.13         4.34         2.17         4.92         2.21           (57)         Drop Inlet Grate         D16DIA         0.22         40.00         3.80         2.13         4.42         2.17         4.92         2.51         5.31         2.41         2.55         5.33         2.41         2.55         2.55         2.55         2.55         2.55         2.55         2.55         2.55         2.5	CB#41 7' DIA	Med. Barrier Curb & Grate Inlet	<b>CB7DIAB</b>	0.29				4.34	2.55	4.88	2.59		2.63		2.68	6.51	2.72
A         Med. Barrier Curb & Grate Inlet         CB8DIAB         0.33         40.00         Med. Barrier Curb & Grate Inlet         CB8DIAB         0.33         40.00         Med. Barrier Curb & Grate Inlet         CB8DYBB         0.33         2.65         4.79         2.59         5.46         2.63           737         Drop Inlet Grate         D132X32         0.12         5.08         0         3.80         2.17         4.92         2.37         5.13         2.41           74         Drop Inlet Grate         D132X32         0.17         2800         3.84         2.13         4.92         2.21         4.92         2.21           757         Drop Inlet Grate         D16DIA         0.22         40.00         3.84         2.13         4.43         2.17         4.92         2.21           757         Drop Inlet Grate         D16DIA         0.25         40.00         3.88         2.13         4.42         2.17         4.97         2.24           757         Drop Inlet Grate         D16DIA         0.23         40.00         3.88         2.17         4.97         2.24         2.55           757         Drop Inlet Grate         D16DIA         0.23         40.00         2.46         4.83         2.	CB#41 7X7	Med. Barrier Curb & Grate Inlet	CB7X7B	0.29				4.17	2.38	4.72	2.43	5.26	2.47		2.51	6.34	2.55
Med. Barrier Curb & Grate Inlet         CB9X9B         0.38         28.00         1         4.25         5.33         2.46           332*         Drop Inlet Grate         D13X32         0.12         5.08         1         3         5.0         1         3         5.0         1         3         2         1         4         2         3         2         4         7         2         5         3         2         4         7         3         3         5.0         1         3         2         3         2         3         2         3         2         3         2         3         2         3         2         3         2         3         2         3 <td< td=""><td>CB#41 8' DIA</td><td>Med. Barrier Curb &amp; Grate Inlet</td><td>CB8DIAB</td><td>0.33</td><td></td><td></td><td></td><td>4.38</td><td>2.55</td><td>4.92</td><td>2.59</td><td></td><td>2.63</td><td></td><td>2.67</td><td>6.54</td><td>2.71</td></td<>	CB#41 8' DIA	Med. Barrier Curb & Grate Inlet	CB8DIAB	0.33				4.38	2.55	4.92	2.59		2.63		2.67	6.54	2.71
(32*       Drop Intel Grate       D132X32       0.11       5.08       1.34       3.50       1.38       2.11       4.88       2.21         A       Drop Intel Grate       D14X4       0.17       28.00       3.80       2.13       4.34       2.17       4.92       2.21         K       Drop Intel Grate       D16DIA       0.21       400       3.84       2.13       4.33       2.17       4.92       2.21         K52*       Drop Intel Grate       D16DIA       0.22       2800       9       4.05       2.33       4.59       2.31       5.13       2.41       2.91       2.95         A       Drop Intel Grate       D17DIA       0.29       4000       9       2.47       4.80       2.51       5.34       2.55         A       Drop Intel Grate       D17DIA       0.29       4000       9       4.29       2.46       4.81       2.51       5.34       2.55         A       Drop Intel Grate       D17DIA       0.33       4000       9       4.29       2.46       4.81       2.56       5.34       2.55         A       Drop Intel Grate       D17DIA       0.33       4000       9       4.29       2.46       4.8	CB#41 9X9	Med. Barrier Curb & Grate Inlet	CB9X9B	0.38				4.25	2.38	4.79	2.42		2.46		2.51	6.42	2.55
Drop Intel Grate         D14X4         0.17         28.00         3.80         2.13         4.34         2.17         4.88         2.21           A         Drop Intel Grate         D15DIA         0.21         4.00         3.84         2.13         4.38         2.11         4.92         2.21           K52"         Drop Intel Grate         D16DIA         0.21         4.00         3.84         2.13         4.38         2.17         4.92         2.21         4.91         2.25           A         Drop Intel Grate         D17DIA         0.22         4.000         3.88         2.13         4.42         2.17         4.97         2.25         5.34         2.55           A         Drop Intel Grate         D17DIA         0.23         4.000         4.26         2.47         4.80         2.51         5.34         2.55         5.34         2.55           A         Drop Intel Grate         D18DIA         0.33         4.000         7.3         2.30         4.67         2.31         4.93         2.55         5.34         2.55         5.34         2.55         5.34         2.55         5.34         2.55         5.34         2.55         5.34         2.55         5.34         2.55 </td <td>CB#42 32"X32"</td> <td>Drop Inlet Grate</td> <td>DI32X32</td> <td>0.12</td> <td></td> <td></td> <td></td> <td>2.96</td> <td>1.34</td> <td>3.50</td> <td>1.38</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	CB#42 32"X32"	Drop Inlet Grate	DI32X32	0.12				2.96	1.34	3.50	1.38						
ADrop Intel GrateDI5DIA $0.21$ $4.00$ $3.84$ $2.13$ $4.38$ $2.17$ $4.92$ $2.21$ $K57^{\circ}$ Drop Intel GrateDI6JX62 $0.22$ $28.00$ $0.22$ $28.00$ $3.88$ $2.13$ $4.59$ $2.37$ $5.13$ $2.41$ $K57^{\circ}$ Drop Intel GrateDI6DIA $0.22$ $40.00$ $3.88$ $2.13$ $4.42$ $2.17$ $4.97$ $2.25$ $A$ Drop Intel GrateDI7DIA $0.29$ $40.00$ $3.88$ $2.17$ $4.80$ $2.51$ $5.34$ $2.55$ $A$ Drop Intel GrateDI7V7 $0.29$ $28.00$ $4.26$ $2.47$ $4.80$ $2.51$ $5.34$ $2.55$ $A$ Drop Intel GrateDI7V7 $0.23$ $40.00$ $4.26$ $2.47$ $4.80$ $2.51$ $5.34$ $2.55$ $A$ Drop Intel GrateDI8DIA $0.33$ $20.00$ $4.20$ $2.46$ $4.83$ $2.50$ $5.38$ $2.74$ $A$ Drop Intel GrateDI8DIA $0.33$ $20.00$ $4.29$ $2.46$ $4.83$ $2.56$ $5.34$ $2.56$ $A$ Drop Intel GrateDI8DIA $0.33$ $20.00$ $0.33$ $20.00$ $4.29$ $2.24$ $4.83$ $2.56$ $5.34$ $2.56$ $A$ Drop Intel GrateDI8DIA $0.33$ $20.00$ $0.33$ $20.00$ $4.29$ $2.46$ $4.83$ $2.56$ $5.34$ $2.54$ $A$ Drop Intel GrateDI8DIA $0.33$ $20.00$ $0.33$ $2.04$ <td>CB#42 4X4</td> <td>Drop Inlet Grate</td> <td>DI4X4</td> <td>0.17</td> <td>28.00</td> <td></td> <td></td> <td>3.80</td> <td>2.13</td> <td>4.34</td> <td>2.17</td> <td>4.88</td> <td>2.21</td> <td>5.42</td> <td>2.25</td> <td></td> <td></td>	CB#42 4X4	Drop Inlet Grate	DI4X4	0.17	28.00			3.80	2.13	4.34	2.17	4.88	2.21	5.42	2.25		
K57*       Drop Inlet Grate       DI62X62       0.22       28.00       4.05       2.33       4.59       2.37       5.13       2.41         A       Drop Inlet Grate       DI6DIA       0.25       40.00       3.88       2.13       4.42       2.17       4.97       2.22         A       Drop Inlet Grate       D17DIA       0.29       40.00       2.61       2.47       4.80       2.51       5.34       2.55         A       Drop Inlet Grate       D17X7       0.29       40.00       2.61       4.42       2.17       4.97       2.24       2.55         A       Drop Inlet Grate       D17X7       0.29       28.00       2.41       4.80       2.51       5.34       2.55         Y       Drop Inlet Grate       D18DIA       0.33       40.00       4.42       2.30       4.97       2.34       2.55         Z       Drop Inlet Grate       D18X4       0.33       20.00       3.88       2.05       4.42       2.34       2.55       2.34       2.55         Z       Drop Inlet Grate       D18X4       0.33       20.00       2.41       4.83       2.50       5.42       2.54         Med. Barrier Curb & Grate Inlet	CB#42 5' DIA	Drop Inlet Grate	DI5DIA	0.21	40.00			3.84	2.13	4.38	2.17	4.92	2.21	5.46	2.25	6.00	2.29
A         Drop inlet Grate         D16DIA         0.25         4.00         3.88         2.13         4.42         2.17         4.97         2.22           A         Drop inlet Grate         D17DIA         0.29         40.00         4.26         2.47         4.80         2.51         5.34         2.55           A         Drop inlet Grate         D17X1         0.29         28.00         4.26         2.47         4.80         2.51         5.34         2.55           A         Drop inlet Grate         D18DIA         0.33         4.000         4.26         2.47         4.80         2.51         5.34         2.55           A         Drop inlet Grate         D18DIA         0.33         20.00         4.13         2.30         4.67         2.34         5.22         2.39           2         Drop inlet Grate         D18X4         0.33         20.00         4.13         2.30         4.67         2.34         5.20         5.38         2.55           7         Drop inlet Grate         D18X4         0.33         20.00         4.13         2.42         2.46         4.87         2.56         5.38         2.56         5.38         2.56         5.38         2.56         5.4	CB#42 5'2"X5'2"	Drop Inlet Grate	DI62X62	0.22	28.00			4.05	2.33	4.59	2.37	5.13	2.41	5.67	2.45	6.22	2.50
IA         Drop Inlet Grate         D17DIA         0.29         40.00         4.26         2.47         4.80         2.51         5.34         2.55           A         Drop Inlet Grate         D17X7         0.29         28.00         4.26         2.47         4.80         2.51         5.34         2.55           A         Drop Inlet Grate         D18DIA         0.33         40.00         4.29         2.46         4.83         2.50         5.38         2.55           2"         Drop Inlet Grate         D18DIA         0.33         20.00         3.88         2.05         4.42         2.09         4.97         2.14           2"         Drop Inlet Grate         D18X42         0.33         20.00         8.13         2.05         4.42         2.03         5.36         2.35           4         Drop Inlet Grate         D18X42         0.33         20.00         8.13         2.30         4.67         2.34         5.20         5.38         2.56           7         Drop Inlet Grate         D18X42         0.33         20.00         8.13         2.40         4.81         2.56         5.38         2.55           7         Drop Inlet Grate         D18X48         0.33	CB#42 6' DIA	Drop Inlet Grate	DI6DIA	0.25				3.88	2.13	4.42	2.17	4.97	2.22		2.26	6.05	2.30
Drop Inlet Grate         DIX7         0.29         28.00         4.26         2.47         4.80         2.51         5.34         2.55           A         Drop Inlet Grate         DIBDIA         0.33         40.00         9.3         2.05         5.38         2.55           2         Drop Inlet Grate         DIBVA         0.33         20.00         9.42         2.06         5.38         2.55           2         Drop Inlet Grate         DIBVA         0.33         20.00         9.41         2.30         4.67         2.34         5.52         2.39           2         Drop Inlet Grate         DIBVA         0.33         20.00         9.41         2.30         4.67         2.34         5.52         2.39           3         Drop Inlet Grate         DIBVA         0.33         20.00         9.43         2.46         4.83         2.56         5.38         2.55           Med. Barrier Curb & Grate Inlet         CB8X4B         0.33         20.00         9.43         2.40         2.46         4.87         2.36         5.51         2.36           Med. Barrier Curb & Grate Inlet         CB8X4B         0.33         20.00         9.43         2.40         2.46         4.67         2.	CB#42 7' DIA	Drop Inlet Grate	DI7DIA	0.29				4.26	2.47	4.80	2.51	5.34	2.55		2.59	6.42	2.63
IA         Drop Inlet Grate         DIBDIA         0.33         4.00         7.25         5.38         2.55         5.38         2.55         5.38         2.55         5.38         2.55         5.38         2.55         5.38         2.55         5.38         2.55         5.33         2.03         4.07         2.34         5.22         2.39         2.54         5.25         2.33         2.55         2.34         5.25         2.33         2.55         2.54         2.55         2.34         5.25         2.33         2.56         5.38         2.55         2.33         2.55         2.34         5.25         2.33         2.55         2.34         2.55         2.35         2.35         2.55         2.36         2.38         2.55         2.34         2.35         2.35         2.36         2.36         2.38         2.55         2.34         2.35         2.35         2.36         2.36         2.33         2.30         2.46         4.87         2.36	CB#42 7X7	Drop Inlet Grate	DI7X7	0.29				4.26	2.47	4.80	2.51	5.34	2.55		2.59	6.42	2.63
Drop Intel Grate         DI8X4         0.33         20.00         3.88         2.05         4.42         2.09         4.97         2.14           2"         Drop Intel Grate         DI8X62         0.33         20.00         4.13         2.30         4.67         2.34         5.22         2.39           A         Drop Intel Grate         DI8X62         0.33         20.00         4.13         2.30         4.67         2.34         5.22         2.39           A         Drop Intel Grate         DI9X9         0.33         40.00         4.13         2.46         4.83         2.50         5.38         2.55           Med. Barrier Curb & Grate Intet         CB8X4B         0.33         20.00         4.42         2.45         4.86         2.56         5.42         2.30           Med. Barrier Curb & Grate Intet         CB8X4B         0.33         20.00         4.42         2.54         4.96         2.65         5.42         2.50           K52"         Retaining Wall Curb & Grate Intet         CB9X9C         0.38         28.00         4.42         2.56         4.67         2.46         4.67         2.45         5.20         5.42         2.50           K52"         Retaining Wall Curb & Grate Inte	CB#42 8' DIA	Drop Inlet Grate	DI8DIA	0.33				4.29	2.46	4.83	2.50	5.38	2.55		2.59	6.46	2.63
2"       Drop Inlet Grate       DI8X62       0.33       2000       4.13       2.30       4.67       2.34       5.22       2.39         A       Drop Inlet Grate       DI8DIA       0.33       4.000       4.13       2.30       4.67       2.34       5.22       2.39         A       Drop Inlet Grate       DI8DIA       0.33       4.000       4.29       2.46       4.83       2.50       5.38       2.55         Med. Barrier Curb & Grate Inlet       CB8X4B       0.33       20.00       4.13       2.45       4.88       2.50       5.42       2.30         K52"       Retaining Wall Curb & Grate Inlet       CB8X4B       0.33       20.00       4.13       2.47       2.46       4.83       2.50       5.42       2.30         K52"       Retaining Wall Curb & Grate Inlet       CB8X4B       0.33       20.00       4.13       2.41       4.67       2.46       5.70       2.52       2.50       5.42       2.50         K52"       Retaining Wall Curb & Grate Inlet       CB9X2K2       0.23       28.00       4.13       2.46       4.67       2.46       5.67       2.52       2.50       5.42       2.50       5.42       2.50       5.42       2.50 <t< td=""><td>CB#438X4</td><td>Drop Inlet Grate</td><td>DI8X4</td><td>0.33</td><td></td><td></td><td></td><td>3.88</td><td>2.05</td><td>4.42</td><td>2.09</td><td></td><td>2.14</td><td></td><td>2.18</td><td>6.05</td><td>W 2.22</td></t<>	CB#438X4	Drop Inlet Grate	DI8X4	0.33				3.88	2.05	4.42	2.09		2.14		2.18	6.05	W 2.22
A         Drop Inlet Grate         DI8DIA         0.33         4.00         4.29         2.46         4.83         2.50         5.38         2.55           Drop Inlet Grate         DI9X9         0.38         28.00         4.33         2.45         4.83         2.50         5.42         2.54           Med. Barrier Curb & Grate Inlet         CB8X4B         0.33         20.00         4.05         2.22         4.59         2.26         5.13         2.30           Med. Barrier Curb & Grate Inlet         CB9X9C         0.33         20.00         4.405         2.54         4.96         2.56         5.51         2.52           K52*         Retaining Wall Curb & Grate Inlet         CB9X9C         0.38         28.00         4.13         2.41         4.67         2.45         5.50         2.50           K52*         Retaining Wall Curb & Grate Inlet         CB9X2K2R         0.22         28.00         4.13         2.41         4.67         2.45         5.52         2.50           K52*         Retaining Wall Curb & Grate Inlet         CB92X62R         0.23         28.00         4.33         2.41         2.67         2.62         2.63           K52*         Retaining Wall Curb & Grate Inlet         CB92X62R <td< td=""><td>CB#43 8X5'2"</td><td>Drop Inlet Grate</td><td>DI8X62</td><td>0.33</td><td></td><td></td><td></td><td>4.13</td><td>2.30</td><td>4.67</td><td>2.34</td><td>5.22</td><td>2.39</td><td></td><td>2.43</td><td>6.30</td><td>2.47</td></td<>	CB#43 8X5'2"	Drop Inlet Grate	DI8X62	0.33				4.13	2.30	4.67	2.34	5.22	2.39		2.43	6.30	2.47
Drop Inlet Grate         DI9X9         0.38         28.00         4.33         2.45         4.88         2.50         5.42         2.54           Med. Barrier Curb & Grate Inlet         CB8X4B         0.33         20.00         4.05         2.22         4.59         2.26         5.13         2.30           Med. Barrier Curb & Grate Inlet         CB9X9C         0.33         20.00         4.05         2.22         4.59         2.26         5.13         2.30           K52*         Retaining Wall Curb & Grate Inlet         CB9X9C         0.38         28.00         4.13         2.41         4.67         2.45         5.50         2.50           K52*         Retaining Wall Curb & Grate Inlet         CB62X62R         0.22         28.00         4.13         2.41         4.67         2.45         5.52         2.50           K52*         Retaining Wall Curb & Grate Inlet         CB7X7R         0.29         28.00         4.34         2.55         4.88         2.56         5.67         2.63           Retaining Wall Curb & Grate Inlet         CB7X7R         0.28         28.00         4.58         2.71         5.13         2.76         5.67         2.63           Retaining Wall Curb & Grate Inlet         CB9X9R         0.38<	CB#43 8' DIA	Drop Inlet Grate	DI8DIA	0.33				4.29	2.46	4.83	2.50	5.38	2.55		2.59	6.46	2.63
Med. Barrier Curb & Grate Inlet         CB8X4B         0.33         20.00         4.05         2.22         4.59         2.26         5.13         2.30           Med. Barrier Curb & Grate Inlet         CB9X9C         0.38         28.00         4.42         2.54         4.96         2.56         5.50         2.62           X52*         Retaining Wall Curb & Grate Inlet         CB9X9C         0.38         28.00         4.13         2.41         4.67         2.45         5.22         2.50           K52*         Retaining Wall Curb & Grate Inlet         CB62X62R         0.22         28.00         4.13         2.41         4.67         2.45         5.42         2.63           Retaining Wall Curb & Grate Inlet         CB7X7R         0.29         28.00         4.34         2.55         4.88         2.56         5.63           Retaining Wall Curb & Grate Inlet         CB9X9R         0.38         28.00         4.58         2.71         5.13         2.70         5.67         2.80           Retaining Wall Curb & Grate Inlet         CB9X9R         0.38         28.00         4.58         2.71         5.13         2.70         5.67         2.80	CB#44 9X9	Drop Inlet Grate	DI9X9	0.38				4.33	2.45	4.88	2.50	5.42	2.54		2.58	6.50	2.62
Med. Barrier Curb & Grate Inlet         CB9X9C         0.38         28.00         4.42         2.54         4.96         2.58         5.50         2.62           X52*         Retaining Wall Curb & Grate Inlet         CB62X62R         0.22         28.00         4.13         2.41         4.67         2.45         5.22         250           Retaining Wall Curb & Grate Inlet         CB7X7R         0.29         28.00         4.13         2.41         4.67         2.45         5.22         2.50           Retaining Wall Curb & Grate Inlet         CB7X7R         0.29         28.00         4.34         2.55         4.88         2.69         5.42         2.63           Retaining Wall Curb & Grate Inlet         CB9X9R         0.38         28.00         4.58         2.71         5.13         2.76         5.67         2.80           Retaining Wall Curb & Grate Inlet         CB9X9R         0.38         28.00         4.58         2.71         5.13         2.76         5.67         2.80	CB#45 8X4	Med. Barrier Curb & Grate Inlet	CB8X4B	0.33				4.05	2.22	4.59	2.26		2.30		2.34	6.21	<b>W</b> 2.38
X52*         Retaining Wall Curb & Grate Inlet         CB62X62R         0.22         28.00         4.13         2.41         4.67         2.45         5.22         2.50           Retaining Wall Curb & Grate Inlet         CB7X7R         0.29         28.00         4.34         2.55         4.88         2.69         5.42         2.63           Retaining Wall Curb & Grate Inlet         CB9X9R         0.38         28.00         4.58         2.71         5.13         2.76         5.67         2.80           Retaining Wall Curb & Grate Inlet         CB9X9R         0.38         28.00         4.58         2.71         5.13         2.76         5.67         2.80           Retaining Wall Curb & Grate Inlet         CB9X9R         0.38         28.00         4.58         2.71         5.13         2.76         5.67         2.80	CB#46 9X9	Med. Barrier Curb & Grate Inlet	CB9X9C	0.38				4.42	2.54	4.96	2.58		2.62		2.66	6.58	2.70
Retaining Wall Curb & Grate Inlet         CB7X7R         0.29         28.00         4.34         2.55         4.88         2.59         5.42         2.63           Retaining Wall Curb & Grate Inlet         CB9X9R         0.38         28.00         4.58         2.71         5.13         2.76         5.67         2.80           Retaining Wall Curb & Grate Inlet         CB9X9R         0.38         28.00         4.58         2.71         5.13         2.76         5.67         2.80           Retaining Wall Curb & Grate Inlet         CB9X9R         0.38         28.00         4.58         2.71         5.13         2.76         5.67         2.80	CB#51 5'2"X5'2"	Retaining Wall Curb & Grate Inlet	CB62X62R	0.22				4.13	2.41	4.67	2.45		2.50		2.54	6.30	2.58
Retaining Wall Curb & Grate Inlet         CB9X9R         0.38         28.00         4.58         2.71         5.13         2.76         5.67         2.80           Retaining Wall Curb & Grate Inlet         CB9X9R         0.38         28.00         4.58         2.71         5.13         2.76         5.67         2.80	CB#51 7X7	Retaining Wall Curb & Grate Inlet	CB7X7R	0.29				4.34	2.55	4.88	2.59		2.63		2.68	6.51	2.72
Retaining Wall Curb & Grate Inlet CB9X9R 0.38 28.00 4.58 2.71 5.13 2.76 5.67 2.80	CB#51 9X9	Retaining Wall Curb & Grate Inlet	CB9X9R	0.38				4.58	2.71	5.13	2.76		2.80		2.84	6.75	2.88
	CB#52 9X9	Retaining Wall Curb & Grate Inlet	CB9X9R	0.38	28.00			4.58	2.71	5.13	2.76	5.67	2.80		2.84	6.75	2.88

42"
15"
Sizes
Pipe
A

Node Name Tvne- Lunction											222					
Name Type: Lunction	Description	Name	Across	Depth	15	2	Ĺ	18		24	ľ	30		36		42
Type: Junction			Bottom of		Min. Donth	Min. Denth of	Min. Denth	Min. Donth of	Min. Donth	Min. Denth of	Min. Denth	Min. Denth of	Min. Denth	Min. Donth of	Min. Denth	Min. Denth of
			Structure	-			nepul	Cover		Cover		Cover	nehili	Cover	nehili	Cover
MH#3 4' DIA Manhole	le	MH4DIA	0.17	40.00			3.54	1.87	4.08	1.91						
	le	MH5DIA	0.21	40.00			3.54	1.83	4.08	1.87	4.63	1.92	5.17	1.96		
MH#3 5'2"X5'2" Manhole	le	MH62X62	0.22	28.00			4.19	2.47	4.73	2.51	5.27	2.55	5.81	2.59	6.35	2.63
MH#3 6' DIA Manhole	le	MH6DIA	0.25	40.00			3.63	1.88	4.17	1.92	4.71	1.96	5.25	2.00	5.79	2.04
MH#3 7' DIA Manhole	le	MH7DIA	0.29	40.00			3.63	1.84	4.17	1.88	4.71	1.92	5.25	1.96	5.79	2.00
MH#3 7X7 Manhole		MH7X7	0.29	28.00			4.40	2.61	4.94	2.65	5.48	2.69	6.02	2.73	6.56	2.77
MH#3 8' DIA Manhole	e	MH8DIA	0.33	40.00			3.71	1.88	4.25	1.92	4.79	1.96	5.33	2.00	5.88	2.05
MH#3 9' DIA Manhole		MH9DIA	0.38	40.00			3.71	1.83	4.25	1.87	4.79	1.91	5.33	1.95	5.88	2.00
MH#3 9X9 Manhole	e	0X9HM	0.38	28.00			4.40	2.52	4.94	2.56	5.48	2.60	6.02	2.64	6.56	2.68
MH#3 10' DIA Manhole	e	MH10DIA	0.42	40.00			3.71	1.79	4.25	1.83	4.79	1.87	5.33	1.91	5.88	1.96
JB#1 32"X32" Junction Box*	n Box*	JB32X32	0.12	50.00			3.29	1.67	3.83	1.71						
JB#2 4X4 Junction Box*	n Box*	JB4X4	0.17	50.00			3.29	1.62	3.83	1.66	4.38	1.71	4.92	1.75		
JB#3 5'2"X5'2" Junction Box*	n Box*	JB62X62	0.22	50.00			3.63	1.91	4.17	1.95	4.71	1.99	5.25	2.03	5.79	2.07
JB#4 7X7 Junction Box	n Box*	JB7X7	0.29	30.00			3.83	2.04	4.38	2.09	4.92	2.13	5.46	2.17	6.00	2.21
JB#5 9X9 Junctior	unction Box*	9X9L	0.38	30.00			4.17	2.29	4.71	2.33	5.25	2.37	5.79	2.41	6.33	2.45
JB#6 4' DIA Junction Box'	n Box*	JB4DIA	0.17	20.00			3.88	2.21	4.42	2.25						
JB#6 5' DIA Junction Box*	n Box*	JB5DIA	0.21	40.00			3.92	2.21	4.46	2.25	5.00	2.29	5.55	2.34	6.09	2.38
JB#6 6' DIA Junction Box'	n Box*	JB6DIA	0.25	40.00			3.97	2.22	4.51	2.26	5.05	2.30	5.59	2.34	6.13	2.38
JB#6 7' DIA Junction Box*	n Box*	JB7DIA	0.29	40.00			4.34	2.55	4.88	2.59	5.42	2.63	5.97	2.68	6.51	2.72
JB#6 8' DIA Junction Box'	n Box*	JB8DIA	0.33	40.00			4.38	2.55	4.92	2.59	5.46	2.63	6.00	2.67	6.54	2.71
JB#6 9' DIA Junction Box'	n Box*	JB9DIA	0.38	40.00			4.42	2.54	4.96	2.58	5.50	2.62	6.04	2.66	6.58	2.70
JB#6 10' DIA Junction Box	n Box*	JB10DIA	0.42	40.00			4.46	2.54	5.00	2.58	5.54	2.62	6.08	2.66	6.63	2.71
Stub Stub inte	Stub into Culvert	STUB	00.00	none (	0.00	0.00	0.00	00.00	00.00	00.00	00'0	0.00	00'0	00.0	00'0	0.00

Table A Pipe Sizes 15" - 42"

Maximum Depth for use in Geopak equals tabulated depth (to top of structure) + Minimum Depth based on pipe size. Add an additional 2 feet for mimimum cover over structure to Minimum Depth of Cover if junction box is within the clear zone.

0.00 0.00 3.50 0.00 0.00 0.00 0.00 0.00 3.00 0.00 0.00 0.00 0.00 0.0 2.50 0.00 0.00 0.00 0.00 0.00 2.00 0.00 0.00 0.00 0.00 0.00 1.50 0.00 0.0 0.00 0.00 0.00 1.25 0.0 0.0 Pipe Size\* none none 0.00 0.00 0.00 STUB STUB ΕV Endwall for outlet pipe(generic) Stub into existing structure Special ditch end **Fype: Outlet** utlet Stub Ditch Outlet Endwall

During initial design, set the Maximum Depth to a value greater than the expected pipe size and the Minimum Depth of Cover to 0.00. Once pipe size is determined, reset the Maximum Depth to the designed pipe size + the distance to the top lip of the endwall to be used with the pipe and reset the Minimum Depth of Cover to the distance to the top lip of the endwall.

Drainage	Drainage Node	Cell	Drop	Max.						Pipe Sizes	Sizes					
Node	Description	Name	Across	Depth		15		18		24		30		36		42
Name			Bottom of		Min. Depth	Min. Depth of	Min. Depth	Min. Depth of	Min. Depth	Min. Depth of	Min. Depth	Δ	Min. Depth	Min. Depth of	Min. Depth	Min. Depth of
Type: Other			Structure			Cover		Cover		Cover		Cover		Cover		Cover
EW Inlet	Endwall inlet into drainage system	EW	00.0	Pipe Size*	1.25	0.00	1.50	0.00	2.00	0.00	2.50	00.0	3.00	0.00	3.50	00.0
Ditch Begin	Begin special ditch	STUB	0.00	none	0.00	00.0	00.00	00.0	0.00	0.00	0.00	0.00		0.00	0	00.0
Ditch Change	Special ditch shape change	STUB	0.00	none	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
the distance to th	the distance to the top lip of the endwall to be used with the pipe and reset the Minimum Depth of Cover to the distance to the top lip of the endwall.	ith the pipe and	reset the Mini	mum Del	oth of Cov	er to the dist	ance to th	ie top lip of t	he endwa	=i					- - )	
Lype: Headwall Culvert Endwall	Pipe Culvert Endwall(generic)	EW	0.00	none	0.00	0.00	00.0	0.00	0.00	0.00	00.0	00.00	0.00	00.0	00.0	0.00
voe: Grate - Bridde Drains	de Drains								1							
BD 2'X8'7"	Bridae End Drain	BD2X8	00.0	3.50			3.50	2.00								
BD 4'X8'7"	Bridge End Drain	BD4X8	00.00	3.50			3.50	2.00								
"UVIC 0	Drideo Dook Decis			7		6 0.7E	1 60	9 0 7F								
BU 2 A9	blidge beck blalli	BU4A2	0.00	NC.1	CZ.I	C/'N	nc.1	C/.N	1							
Fype: Curb - Bridge Drains	ge Drains	_														
BD-PRPT	Bridge Deck Drain - Parapet	BDPRPT	0.00	none	0.00	0.00	00.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	00.00	0.00
<b>Ype: Slotted Drain</b>	in				12"	12" CMP	15"	CMP	18"	CMP	24"	CMP	30"	CMP	36"	CMP
SD 12"	Slotted Drain	SLOT12	00'0	1.50	1.50	0.50										
SD 15"	Slotted Drain	SLOT15	00.0	1.75			1.75	0.50								
SD 18"	Slotted Drain	SLOT18	0.00	2.00					2.00	0.50						
SD 24"	Slotted Drain	SLOT24	0.00	2.50							2.50	0.50				
SD 30"	Slotted Drain	SLOT30	0.00	3.00									3.00	0.50		
SD 36"	Slotted Drain	SLOT36	00.0	3.50											3.50	0.50

Drainage	Node	Cell	Drop	Мах.						Pipe	Pipe Sizes					
Node	Description	Name	Across	Depth		48		54		60		99		72		78
Name			Bottom		Min.	Min.	Min.	Min	Min	Min	Min	Min.	Min.	Min	Min.	Min.
			of		Depth	Depth of	Depth	Depth of		Depth of	Depth	Depth of	Depth	Depth of	Depth	Depth of
Type: Grate			Structure			Cover		Cover		Cover		Cover		Cover		Cover
CB#10 32"X26"	Lowered 6-30 Curb & Grate Inlet	CB32X26S	0.12	5.08												
CB#10 4X3	6" NonMount. Curb & Grate Inlet	CB4X3S	0.17	20.00												
CB#10 4' DIA	6" NonMount. Curb & Grate Inlet	<b>CB4DIAS</b>	0.17	20.00												
CB#10 4X4	6" NonMount. Curb & Grate Inlet	CB4X4S	0.17	20.00												
CB#12 32"X32"	6" NonMount. Curb & Grate Inlet	CB32X32	0.12	4.58												
CB#12 4X3	6" NonMount. Curb & Grate Inlet	CB4X3	0.17	20.00												
CB#12 4' DIA	6" NonMount. Curb & Grate Inlet	CB4DIA	0.17	20.00												
CB#12 4X4	6" NonMount. Curb & Grate Inlet	CB4X4	0.17	28.00												
CB#12 5' DIA	6" NonMount. Curb & Grate Inlet	CB5DIA	0.21	40.00	6.63	2.42										
CB#12 5'2"X5'2"	6" NonMount. Curb & Grate Inlet	CB62X62	0.22	28.00	6.84	2.62										
CB#12 6' DIA	6" NonMount. Curb & Grate Inlet	CB6DIA	0.25	40.00	6.67	2.42										
CB#12 7' DIA	6" NonMount. Curb & Grate Inlet	CB7DIA	0.29	40.00	7.05	2.76	7.59	2.80	8.13	2.84	8.67	2.88	9.22	2.93	9.76	2.97
CB#12 7X7	6" NonMount. Curb & Grate Inlet	CB7X7	0.29	28.00	6.88	2.59	7.42	2.63	7.97	2.68	8.51	2.72				
CB#12 8' DIA	6" NonMount. Curb & Grate Inlet	CB8DIA	0.33	40.00	7.08	2.75	7.63	2.80	8.17	2.84	8.71	2.88	9.25	2.92	9.79	2.96
CB#12 9' DIA	6" NonMount. Curb & Grate Inlet	CB9DIA	0.38	40.00	7.13	2.75	7.67	2.79	8.21	2.83	8.75	2.87	9.29	2.91	9.83	2.95
CB#12 9X9	6" NonMount. Curb & Grate Inlet	CB9X9	0.38	28.00	6.96	2.58	7.50	2.62	8.04	2.66	8.58	2.70	9.13	2.75	9.67	2.79
CB#12 10' DIA	6" NonMount. Curb & Grate Inlet	<b>CB10DIA</b>	0.42	40.00	7.17	2.75	7.71	2.79	8.25	2.83	8.79	2.87	9.33	2.91	9.88	2.96
CB#13 4X3	6" NonMount. Curb & Grate Inlet	CB4X3	0.17	20.00												
CB#13 4' DIA	6" NonMount. Curb & Grate Inlet	CB4DIA	0.17	20.00												
CB#13 5' DIA	6" NonMount. Curb & Grate Inlet	CB5DIA	0.21	40.00	6.63	2.42										
CB#13 6' DIA	6" NonMount. Curb & Grate Inlet	CB6DIA	0.25	40.00	6.67	2.42										
CB#13 7' DIA	6" NonMount. Curb & Grate Inlet	CB7DIA	0.29	40.00	7.05	2.76	7.59	2.80	8.13	2.84	8.67	2.88	9.22	2.93	9.76	2.97
CB#13 8' DIA	6" NonMount. Curb & Grate Inlet	<b>CB8DIA</b>	0.33	40.00	7.08	2.75	7.63	2.80	8.17	2.84	8.71	2.88	9.25	2.92	9.79	2.96
CB#13 9' DIA	6" NonMount. Curb & Grate Inlet	CB9DIA	0.38	40.00	7.13	2.75	7.67	2.79	8.21	2.83	8.75	2.87	9.29	2.91	9.83	2.95
CB#13 10' DIA	6" NonMount. Curb & Grate Inlet	CB10DIA	0.42	40.00	7.17	2.75	7.71	2.79	8.25	2.83	8.79	2.87	9.33	2.91	9.88	2.96
CB#14 8X3	6" NonMount. Curb & Grate Inlet	CB8X3	0.33	20.00	6.75	<b>W</b> 2.42	7.30	<b>W</b> 2.47	7.84	W 2.51						

	72 78	Min	h Depth of Depth De			9.29 2.91 9.83 2.95													9.13 2.75 9.67 2.79										
	66	Min	Depth of	Cover	1 2.88	5 2.87							5 2.54		0 2.55	7 2.88	1 2.72	1 2.88	8 2.70						5 2.54	0 2.55	7 2.88	1 2.88	
Pine Sizes		Min	Depth of Depth	Cover	2.84 8.71	2.83 8.75	/ 2.51	1 2.68					2.50 8.25		2.51 8.30	2.84 8.67	2.68 8.51	2.84 8.71	2.66 8.58	V 2.51	V 2.51				2.50 8.25	2.51 8.30	2.84 8.67	2.84 8.71	7 5 1
	60	Min	Depth		8.17	9 8.21	7 7.84 W	4 8.01 W					6 7.71		7 7.76	8.13	7.97	8.17	2 8.04	7 7.84 W	2				.6 7.71	7.76	8.13	80 8.17	7 2 8/ 10/
	54	ľ	th Depth of	Cover	7.63 2.80	7.67 2.79	7.30 W 2.47	7.47 W 2.64					7.17 2.46		7.22 2.47	.59 2.80	7.42 2.63	7.63 2.80	.50 2.62	7.30 W 2.47	7.30 W 2.47				.17 2.46	7.22 2.4	7.59 2.80	7.63 2.80	30 W 2.47
	╞	Min Min	of	Cover	2.75 7.	2.75 7.	2.42 7.	2.59 7.					2.42 7.	2.62	2.42 7.	2.76 7.	2.59 7.	2.75 7.	2.58 7.	2.42 7.	2.42 7.				2.42 7.	2.42 7.	2.76 7.	2.75 7.	7 47 T
	48		-	5	7.08	7.13	6.75 W	6.92					6.63	6.84	6.67	7.05	6.88	7.08	6.96	6.75 W	6.75 W				6.63	6.67	7.05	7.08	6 75 11
Мах	Denth				40.00	28.00	20.00	20.00	4.58	20.00	20.00	28.00	40.00	28.00	40.00	40.00	28.00	40.00	28.00	20.00	20.00	4.58	20.00	20.00	40.00	40.00	40.00	40.00	00 00
Dron	Across	Rottom	of	Structure	0.33	0.38	0.33	0.33	0.12	0.17	0.17	0.17	0.21	0.22	0.25	0.29	0.29	0.33	0.38	0.33	0.33	0.12	0.17	0.17	0.21	0.25	0.29	0.33	22 0
Cell	Name				CB8DIA	CB9X9	CB8X4	CB8X62	CB32X32	CB4X3	CB4DIA	CB4X4	CB5DIA	CB62X62	CB6DIA	CB7DIA	CB7X7	CB8DIA	CB9X9	CB8X3	CB8X4	CB32X32	CB4X3	CB4DIA	CB5DIA	CB6DIA	CB7DIA	CB8DIA	C RRY3
Node	Description				6" NonMount. Curb & Grate Inlet	6" Mountable Curb & Grate Inlet	4" Mountable Curb & Grate Inlet	A" Mountable Curb & Grate Inlet																					
Drainade	Node	Name		Type: Grate	CB#14 8' DIA	CB#14 9X9	CB#16 8X4	CB#17 8X5'2"	CB#25 32"X32"	CB#25 4X3	CB#25 4' DIA	CB#25 4X4	CB#25 5' DIA	CB#25 5'2"X5'2"	CB#25 6' DIA	CB#25 7' DIA	CB#25 7X7	CB#25 8' DIA	CB#25 9X9	CB#26 8X3	CB#27 8X4	CB#28 32"X32"	CB#28 4X3	CB#28 4' DIA	CB#28 5' DIA	CB#28 6' DIA	CB#28 7' DIA	CB#28 8' DIA	CB#20 8X3

Drainage	Node	Cell	Drop	Мах.						Pipe	Pipe Sizes					
Node	Description	Name	Across	Depth		48		54		60		99		72	Ī	78
Name			Bottom of		Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.
Type: Grate			Structure		Depth	Depth of Cover	Depth	Depth of Cover	Depth	Depth of Cover	Depth	Depth of Cover	Depth	Depth of Cover	Depth	Depth of Cover
CB#31 7X7	Med. Barrier Curb & Grate Inlet	CB7X7C	0.29	28.00	7.05	2.76	7.59	2.80	8.13	2.84	8.67					
CB#31 9X9	Med. Barrier Curb & Grate Inlet	CB9X9C	0.38	28.00	7.13	2.75	7.67	2.79	8.21	2.83	8.75	2.87	9.29	2.91	9.83	2.95
CB#32 32"X80"	Med. Barrier Curb & Grate Inlet	CB32X80C	0.12	6.00												
CB#38 32"X32"	Median Ditch Grate	CB32X32M	0.12	4.58												
CB#38 4X4	Median Ditch Grate	CB4X4M	0.17	28.00												
CB#38 5' DIA	Median Ditch Grate	CB5DIAM	0.21	40.00	6.55	2.34	7.09	2.38	7.63	2.42	8.17	2.46				
CB#38 5'2"X5'2"	Median Ditch Grate	CB62X62M	0.22	28.00	6.76	2.54										
CB#38 6' DIA	Median Ditch Grate	<b>CB6DIAM</b>	0.25	40.00	6.59	2.34	7.13	2.38	7.67	2.42	8.22	2.47				
CB#38 7' DIA	Median Ditch Grate	CB7DIAM	0.29	40.00	6.97	2.68	7.51	2.72	8.05	2.76	8.59	2.80				
CB#38 8' DIA	Median Ditch Grate	CB8DIAM	0.33	40.00	7.00	2.67	7.54	2.71	8.08	2.75	8.63	2.80				
CB#39 4X4	Median Ditch Grate	CB4X4M	0.17	28.00												
CB#39 5'2"X5'2"	Median Ditch Grate	CB62X62M	0.22	28.00	6.84	2.62										
CB#39 7' DIA	Median Ditch Grate	<b>CB7DIAM</b>	0.29	40.00	7.00	2.71	7.54	2.75	80.8	2.79	8.63	2.84				
CB#39 7X7	Median Ditch Grate	CB7X7M	0.29	28.00	6.84	2.55	7.38	2.59	7.92	2.63	8.47	2.68				
CB#39 8' DIA	Median Ditch Grate	CB8DIAM	0.33	40.00	7.13	2.80	7.67	2.84	8.21	2.88	8.75	2.92				
CB#39 9X9	Median Ditch Grate	CB9X9M	0.38	28.00	6.92	2.54	7.46	2.58	8.00	2.62	8.54	2.66	9.08	2.70	9.63	2.75
CB#40 8X4	Median Ditch Grate	CB8X4M	0.33	20.00	5.83	<b>W</b> 1.50	6.38	<b>W</b> 1.55	6.92	<b>W</b> 1.59						
CB#40 9X9	Median Ditch Grate	CB9X9M	0.38	28.00	7.08	2.70	7.63	2.75	8.17	2.79	8.71	2.83	9.25	2.87	9.79	2.91
CB#41 32"X32"	Med. Barrier Curb & Grate Inlet	CB32X32B	0.12	4.58												
CB#41 4X3	Med. Barrier Curb & Grate Inlet	CB4X3B	0.17	20.00												
CB#41 4X4	Med. Barrier Curb & Grate Inlet	CB4X4B	0.17	28.00												
CB#41 5' DIA	Med. Barrier Curb & Grate Inlet	CB5DIAB	0.21	40.00	6.63	2.42	7.17	2.46	17.7	2.50	8.25	2.54				
CB#41 5'2"X5'2"	Med. Barrier Curb & Grate Inlet	CB62X62B	0.22	28.00	6.84	2.62										
CB#41 6' DIA	Med. Barrier Curb & Grate Inlet	<b>CB6DIAB</b>	0.25	40.00	6.67	2.42	7.22	2.47	7.76	2.51	8.30	2.55				
CB#41 7' DIA	Med. Barrier Curb & Grate Inlet	CB7DIAB	0.29	40.00	7.05	2.76	7.59	2.80	8.13	2.84	8.67	2.88				
CB#41 7X7	Med. Barrier Curb & Grate Inlet	CB7X7B	0.29	28.00	6.88	2.59	7.42	2.63	7.97	2.68	8.51	2.72				

		Min.	epth of	Cover		2.80												2.87		2.95			3.13	3.13
	78		Depth D		-	9.67												9.75		9.83			10.00	10.00
	72	Min.	Depth of	Cover		2.76												2.83		2.91			3.09	3.09
	2	Min.	Depth			9.13												9.21		9.29			9.46	9.46
	<b>66</b>	Min.	Depth of	Cover	2.88	2.71			2.46		2.47	2.80		2.80			2.80	2.79		2.87		2.88	3.05	3.05
Sizes	9		Depth		8.71	8.58			8.17		8.22	8.59		8.63			8.63	8.67		8.75		8.67	8.92	8.92
Pipe Sizes	60	Min.	Depth of	Cover	2.84	2.67			2.42		2.42	2.76	2.76	2.75	<b>W</b> 2.34	<b>W</b> 2.59	2.75	2.75	W 2.51	2.83		2.84	3.01	3.01
	9	Min.	Depth		8.17	8.04			7.63		7.67	8.05	8.05	8.08	7.67 V	7.92 V	8.08	8.13	7.84	8.21		8.13	8.38	8.38
	4	Min.	Depth of	Cover	2.80	2.63			2.38		2.38	2.72	2.72	2.71	V 2.30	V 2.55	2.71	2.70	<b>W</b> 2.47	2.79		2.80	2.96	2.96
	54	Min.	Depth		7.63	7.50			7.09		7.13	7.51	7.51	7.54	7.13 W	7.38 W	7.54	7.58	7.30 V	7.67		7.59	7.83	7.83
	~	Min.	Depth of	Cover	2.75	2.59			2.34	2.54	2.34	2.68	2.68	2.67	2.26	2.51	2.67	2.66	2.42	2.75	2.62	2.76	2.92	2.92
	48	Min.	Depth		7.08	6.96			6.55	6.76	6.59	6.97	6.97	7.00	6.59 W	6.84	7.00	7.04	6.75 W	7.13	6.84	7.05	7.29	7.29
Мах.	Depth				40.00	28.00	5.08	28.00	40.00	28.00	40.00	40.00	28.00	40.00	20.00	20.00	40.00	28.00	20.00	28.00	28.00	28.00	28.00	28.00
Drop	Across	Bottom	of	Structure	0.33	0.38	0.12	0.17	0.21	0.22	0.25	0.29	0.29	0.33	0.33	0.33	0.33	0.38	0.33	0.38	0.22	0.29	0.38	0.38
Cell	Name				CB8DIAB	CB9X9B	DI32X32	DI4X4	DI5DIA	DI62X62	DI6DIA	DI7DIA	DI7X7	DI8DIA	DI8X4	DI8X62	DI8DIA	DI9X9	CB8X4B	CB9X9C	CB62X62R	CB7X7R	CB9X9R	CB9X9R
Node	Description				Med. Barrier Curb & Grate Inlet	Med. Barrier Curb & Grate Inlet	Drop Inlet Grate	Med. Barrier Curb & Grate Inlet	Med. Barrier Curb & Grate Inlet	Retaining Wall Curb & Grate Inlet														
Drainage	Node	Name		Type: Grate	CB#41 8' DIA	CB#41 9X9	CB#42 32"X32"	CB#42 4X4	CB#42 5' DIA	CB#42 5'2"X5'2"	CB#42 6' DIA	CB#42 7' DIA	CB#42 7X7	CB#42 8' DIA	CB#43 8X4	CB#43 8X5'2"	CB#43 8' DIA	CB#44 9X9	CB#45 8X4	CB#46 9X9	CB#51 5'2"X5'2"	CB#51 7X7	CB#51 9X9	CB#52 9X9

- 78"
48" .
Sizes
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Drainage	Node	Cell	Drop	Мах.						Pipe Sizes	Sizes					
Node	Description	Name	Across	Depth		48		54		60	-	<b>66</b>		72	2	78
Name			Bottom		Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.
			of		Depth	Depth of	Depth	Depth of	Depth	Depth of	Depth	Depth of	Depth	Depth of	Depth	Depth of
Type: Junction			Structure			Cover		Cover		Cover		Cover		Cover		Cover
MH#3 4' DIA	Manhole	MH4DIA	0.17	40.00												
MH#3 5'DIA	Manhole	MH5DIA	0.21	40.00												
MH#3 5'2"X5'2"	Manhole	MH62X62	0.22	28.00	6.90	2.68										
MH#3 6' DIA	Manhole	MH6DIA	0.25	40.00	6.33	2.08										
MH#3 7' DIA	Manhole	MH7DIA	0.29	40.00	6.33	2.04	6.88	2.09	7.42	2.13						
MH#3 7X7	Manhole	MH7X7	0.29	28.00	7.10	2.81	7.65	2.86	8.19	2.90	8.73	2.94				
MH#3 8' DIA	Manhole	MH8DIA	0.33	40.00	6.42	2.09	6.96	2.13	7.50	2.17	8.04	2.21				
MH#3 9' DIA	Manhole	MH9DIA	0.38	40.00	6.42	2.04	6.96	2.08	7.50	2.12	8.04	2.16	8.58	2.20		
MH#3 9X9	Manhole	0X6HW	0.38	28.00	7.10	2.72	7.65	2.77	8.19	2.81	8.73	2.85	9.27	2.89	9.81	2.93
MH#3 10' DIA	Manhole	MH10DIA	0.42	40.00	6.42	2.00	6.96	2.04	7.50	2.08	8.04	2.12	8.58	2.16	9.13	2.21
JB#1 32"X32"	Junction Box*	JB32X32	0.12	50.00												
JB#2 4X4	Junction Box*	JB4X4	0.17	50.00												
JB#3 5'2"X5'2"	Junction Box*	JB62X62	0.22	50.00	6.33	2.11										
JB#4 7X7	Junction Box*	JB7X7	0.29	30.00	6.54	2.25	7.08	2.29	7.63	2.34	8.17	2.38				
JB#5 9X9	Junction Box*	9X9J	0.38	30.00	6.88	2.50	7.42	2.54	7.96	2.58	8.50	2.62	9.04	2.66	9.58	2.70
JB#6 4' DIA	Junction Box*	JB4DIA	0.17	20.00												
JB#6 5' DIA	Junction Box*	JB5DIA	0.21	40.00	6.63	2.42										
JB#6 6' DIA	Junction Box*	JB6DIA	0.25	40.00	6.67	2.42										
JB#6 7' DIA	Junction Box*	JB7DIA	0.29	40.00	7.05	2.76	7.59	2.80	8.13	2.84	8.67	2.88	9.22	2.93	9.76	2.97
JB#6 8' DIA	Junction Box*	JB8DIA	0.33	40.00	7.08	2.75	7.63	2.80	8.17	2.84	8.71	2.88	9.25	2.92	9.79	2.96
JB#6 9' DIA	Junction Box*	JB9DIA	0.38	40.00	7.13	2.75	7.67	2.79	8.21	2.83	8.75	2.87	9.29	2.91	9.83	2.95
JB#6 10' DIA	Junction Box*	JB10DIA	0.42	40.00	7.17	2.75	7.71	2.79	8.25	2.83	8.79	2.87	9.33	2.91	9.88	2.96
Stub	Stub into Culvert	STUB	0.00	none	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
* Maximum Depth fo	* Maximum Depth for use in Geopak equals tabulated depth (to top of structure) + Minimum Depth based on pipe size	th (to top of str	ucture) + Min	mum Dep	oth based	on pipe size										

Add an additional 2 feet for mimimum cover over structure to Minimum Depth of Cover if junction box is within the clear zone.

I ype: oullet																
				Pipe												
Endwall	Endwall for outlet pipe(generic)	EW	0.00		4.00	0.00	4.50	0.00	5.00	0.00	5.50	0.00	6.00	0.00	6.50	0.00
Outlet Stub	Stub into existing structure	STUB	00.00	none	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ditch Outlet	Special ditch end	STUB	0.00	none	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				-	1.11.2.4.4.1.1	-	0,	0 00 0	-				-			

During initial design, set the Maximum Depth to a value greater than the expected pipe size and the Minimum Depth of Cover to 0.00. Once pipe size is determined, reset the Maximum Depth to the designed pipe size + the distance to the top lip of the endwall.

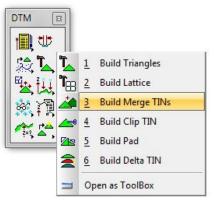
Drafmage         Node         Cell         Draf         Marx         States	Table B Pik	Table B Pipe Sizes 48" - 78"															
Node         Description         Name         Across         Depth         Across         Acrose         Acrose         Acrose<	Drainage	Node	Cell	Drop	Мах.						Pipe	Sizes					
Name         Name <th< th=""><th>Node</th><th>Description</th><th>Name</th><th>Across</th><th>Depth</th><th></th><th>48</th><th></th><th>54</th><th></th><th>60</th><th></th><th>66</th><th></th><th>72</th><th></th><th>78</th></th<>	Node	Description	Name	Across	Depth		48		54		60		66		72		78
Vpe: Other         of         Depth         <	Name			Bottom		Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.
Type: Other         Entrother         Entrother         of Cover				of		Depth	Depth	Depth	Depth	Depth	Depth	Depth	Depth	Depth	Depth	Depth	Depth
Endwaline         Endwaline(indicatinage system         Endwaline(indicatinage system <thendwaline(indicatinage< th=""><th>Type: Other</th><th></th><th></th><th>Structure</th><th></th><th></th><th>of Cover</th><th></th><th>of Cover</th><th></th><th>of Cover</th><th></th><th>of Cover</th><th></th><th>of Cover</th><th></th><th>of Cover</th></thendwaline(indicatinage<>	Type: Other			Structure			of Cover		of Cover		of Cover		of Cover		of Cover		of Cover
Dirtch Begin         Begin special dirtch         STUB         0.00         noid         0.00         <	EW Inlet	Endwall inlet into drainage system	EW	00.0	Pipe Size*	4.00	0.00	4.50	00'0	5.00	00.0	5.50	0.00			6.50	00.0
During initial design. set the Maximum Depth to a value greater than the expected pipe size and the Minimum Depth of Cover to 0.00         0.00<	<mark>Ditch Begin</mark>	Begin special ditch	STUB	0.00		00.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			00.0	0.00
<ul> <li>During initial design, set the Maximum Depth to a value greater than the expected pipe size and the Minimum Depth of Cover to 0.00. Once pipe size is determined, reset the Maximum Depth to the desi size + the distance to the top lip of the endwall.</li> </ul> <ul> <li>The distance to the top lip of the endwall to be used with the pipe and reset the Minimum Depth of Cover to the distance to the top lip of the endwall.</li> </ul> <ul> <li>The distance to the top lip of the endwall to be used with the pipe and reset the Minimum Depth of Cover to the distance to the top lip of the endwall.</li> <li>The distance the minimum Depth of Cover to 0.00</li> <li>0.00</li>            &lt;</ul>	<mark>Ditch Change</mark>	Special ditch shape change	STUB	0.00		0.00	0.00		0.00	00.0	00.0		0.0			00.00	00.00
dowall         Pipe Culvert Endwall(generic)         EW         0.00	Type: Headwall	the top lip of the endwall to be u	ised with the pip	e and reset th	e Minimu	um Depth	of Cover to th	he distan	ce to the top	lip of the	endwall.	5					0
te - Bridge Drains a Bridge End Drain BD2X8 0.000 BD4X8 0.000 BD4X8 0.000 00 BD9X2 0.000 00 b Bridge Deck Drain Parapet BDPRPT 0.000 00	Culvert Endwall	Pipe Culvert Endwall(generic)	EW	00.0	none	0.00	00.0	00.0	00.0	0.00	0.00	0.00	0.00			0.00	0.00
Ite - Bridge Drains     BD2X8     0.00       Bidge End Drain     BD4X8     0.00       Bridge Deck Drain     BD9X2     0.00       D - Bridge Deck Drain     BD9X2     0.00																	
"     Bridge End Drain     BD2X8     0.00     0.00       "     Bridge End Drain     BD4X8     0.00     0.00       Bridge Deck Drain     BD9X2     0.00     0.00       •     Bridge Deck Drain     BD9X2     0.00     0.00	Type: Grate - Brid	dge Drains															
* Bridge End Drain BD4X8 0.00 0.00 bridge Deck Drain BD9X2 0.00 0.00 bridge Deck Drain BD9X2 0.00 no	BD 2'X8'7"	Bridge End Drain	BD2X8	0.00	3.50												
Bridge Deck Drain     BD9X2     0.00       • Bridge Drains     0.00     no	BD 4'X8'7"	Bridge End Drain	BD4X8	0.00	3.50												
b - Bridge Drains Bridge Deck Drain - Parapet 0.00	BD 2'X9"	Bridge Deck Drain	BD9X2	0.00	1.50												
Bridge Deck Drain - Parapet BDPRPT 0.00	Tuno. Curb Brid	do Draine	F														
	BD-PRPT	Bridge Deck Drain - Parapet	BDPRPT	0.00	none												

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48"
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# **Completing Drainage Areas**

This exercise shows options for the user to calculate drainage areas not included in the survey TIN file.

- Step 1. Create a TIN Surface for areas outside the Survey TIN. Follow the processes outlined in the <u>Creating Geopak TIN Surfaces from USGS DEM Data</u> document available from the Roadway Design Division CADD Standards and Downloads website.
- Step 2. Merge the project Final TIN with the TIN surface created in Step 1.
  - a. Open DTM Tools by clicking Applications> GEOPAK> Road> DTM Tools.
  - b. Within the DTM Tools dialog select Build Merge TINs.



c. Set Old TIN: to the TIN File created in Step 1. Set Mrg TIN: to the <u>Final</u> <u>Project TIN</u> file. Create a unique name for the **New TIN**: file.

📕 Merge TIN Files	X
Old TIN: dem.tin	٩
Mrg TIN: final.tin	এ
New TIN: expanded.tin	এ
Process	

#### d. Click Process.

- **Step 3.** Visualize contours for the New Merged TIN utilizing steps from the <u>TDOT</u> <u>GEOPAK Road Course Guide</u>, Exercise 22b.
- **Step 4.** Use this process with DTM tools presented in this document in conjunction with MrSID images or other aerial photography to determine approximate flow paths and drainage areas.

**NOTE:** MrSID images can be attached by following the process in the <u>Using</u> <u>MrSID Image Files in MicroStation</u> document.



Example image with expanded surface information:

# Appendix C

# **Common Network Errors and Fixes**

This information shows common network errors experienced and possible solutions to correct them.

#### Error:

Link SS- # velocity less than minimum desired.

#### Solutions:

Increase the slope of the pipe/ditch.

Decrease the size of the pipe/ditch (if possible) (Smaller flow area means higher velocity).

Change the type of pipe/ditch (if possible) (Smoother pipes typically have higher velocities).

#### Error:

Link SS - # velocity greater than maximum desired.

#### Solutions:

Decrease the slope of the pipe/ditch.

Increase the size of the pipe/ditch (if possible) (Larger flow areas means lower velocity).

Change the type of pipe/ditch (if possible) (Rougher pipes typically have lower velocities).

#### Error:

Capacity for Inlet CB - # Exceeded Bypass Flow Unassigned.

#### Solutions:

Assign a downstream node to accept the bypass.

Use double or other multi-grate catch basin or drop inlet.

Add additional upstream catch basin(s) to ensure all runoff is captured within the system.

If none of the above are feasible/practical, ensure the bypass flow has a place to flow into another storm drain system or roadside ditch and the error can be ignored.

#### Error:

Computed Ponded Width for Inlet CB - # Exceeds Maximum.

#### Solutions:

Move closer to upstream catch basin.

Add additional catch basin upstream.

#### Error:

HGL Blowout upstream of Link SS - # minimum freeboard not achieved

#### Solutions:

For Storm Sewers:	Increase pipe size.
	Increase pipe slope.
For Ditches:	The top of node should be below the Hydraulic Grade Line (HGL). Confirm the HGL is below the soffit and ignore error.

#### Error:

Min/Max Depth Exceeded at Upstream/Downstream of Link SS- #.

#### Solutions:

For Storm Sewers:	Check held elevations and slopes in the <i>Link Configurations Conditions</i> dialog.
For Ditches:	Confirm node/link elevations are correct and ignore error.

#### Error:

Profile Warning for Link SS - #: ->Minimum Slope used for Positive Drainage ->Check Held Elevations and Slopes

#### Solutions:

Check held elevations and slopes in the *Link Configurations Conditions* dialog. Make changes as necessary.

#### Error:

Soffit elevation adjusted for ditches:

#### Solutions:

No correction required, normal adjustment required when ditch inverts are held at specific elevations.

#### Error:

Catch Basin Minimum Depth exceeded on most catch basins, depth gets progressively deeper from beginning of network to end.

#### Solutions:

Check Link preferences, turn off rounding of link slopes if on.

# Appendix D

## Manning's N and Intercept K Values

From Hydraulic Engineering Circular No. 22, Third Edition
URBAN DRAINAGE DESIGN MANUAL
USDOT & FHWA Pub No FHWA-NHI-10-009 September 2009

Table 3-2. Manning's Roughness Coefficient (n) for Overland Sheet Flow. <sup>(6)</sup>				
Surface Description n				
Smooth asphalt	0.011			
Smooth concrete	0.012			
Ordinary concrete lining	0.013			
Good wood	0.014			
Brick with cement mortar	0.014			
Vitrified clay	0.015			
Cast iron	0.015			
Corrugated metal pipe	0.024			
Cement rubble surface	0.024			
Fallow (no residue)	0.05			
Cultivated soils				
Residue cover ≤ 20%	0.06			
Residue cover > 20%	0.17			
Range (natural)	0.13			
Grass				
Short grass prairie	0.15			
Dense grasses	0.24			
Bermuda grass	0.41			
Woods*				
Light underbrush	0.40			
Dense underbrush	0.80			
*When selecting n, consider cover to a the plant cover that will obstruct shee	height of about 30 mm. This is only part of thow.			

Shallow Concentrated Flow Velocity. After short distances of at most 130 m (400 ft), sheet flow tends to concentrate in rills and then gullies of increasing proportions. Such flow is usually referred to as shallow concentrated flow. The velocity of such flow can be estimated using a relationship between velocity and slope as follows<sup>(6)</sup>:

$$V = K_{\mu} k S_{\mu}^{0.5}$$

(3-4)

where:

Ku	=	1.0 (3.28 in English units)
V	=	Velocity, m/s (ft/s)
k	=	Intercept coefficient (Table 3-3)
Sp	=	Slope, percent

 $V = (K_u/n) R^{2/3} S^{1/2}$ 

to estimate average flow velocities in pipes and open channels as follows:

where:

- n = Roughness coefficient (see Table 3-4)
- V = Velocity, m/s (ft/s)
- R = Hydraulic radius (defined as the flow area divided by the wetted perimeter), m (ft)
- S = Slope, m/m (ft/ft)
- K<sub>u</sub> = Units conversion factor equal to 1 (1.49 in English units)

For a circular pipe flowing full, the hydraulic radius is one-fourth of the diameter. For a wide rectangular channel (W > 10 d), the hydraulic radius is approximately equal to the depth. The travel time is then calculated as follows:

where:

- Tt = Travel time for Segment I, min
- L = Flow length for Segment I, m (ft)
- V = Velocity for Segment I, m/s (ft/s)

3-10

Table 3-3. Intercept Coefficients for Velocity vs. Slope Relationship of Equation 3-4. <sup>(6)</sup>		
Land Cover/Flow Regime	k	
Forest with heavy ground litter; hay meadow (overland flow)	0.076	
Trash fallow or minimum tillage cultivation; contour or strip cropped; woodland (overland flow)	0.152	
Short grass pasture (overland flow)	0.213	
Cultivated straight row (overland flow)	0.274	
Nearly bare and untilled (overland flow); alluvial fans in western mountain regions	0.305	
Grassed waterway (shallow concentrated flow)	0.457	
Unpaved (shallow concentrated flow)	0.491	
Paved area (shallow concentrated flow); small upland gullies	0.619	

Open Channel and Pipe Flow Velocity. Flow in gullies empties into channels or pipes. Open channels are assumed to begin where either the blue stream line shows on USGS quadrangle sheets or the channel is visible on aerial photographs. Cross-section geometry and roughness should be obtained for all channel reaches in the watershed. Manning's equation can be used

(3-5)

(3-6)

# Manning's N for Uniform Flow

# Appendix E

May 15, 2011

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Type of Channel and Description	Minimum	Normal	Maximum
LINED CHANNELS (Selected Linings) a. Concrete			
Trowel Finish	0.011	0013	0.015
Float Finish	0.013	0.015	0.016
Gunite, good section	0.016	0019	0.023
b. Asphalt	~ ~ 4 ~		
Smooth	0.013	0013	-
Rough	0.016	0016	-
EXCAVATED OR DREDGED			
a. Earth, straight and uniform			
Clean, recently completed	0.016	0018	0.020
Clean, after weathering	0.018	0.022	0.025
Gravel, uniform section, dean	0.022	0.025	0.030
With short grass, few weeds b. Earth, winding and sluggish	0.022	0027	0.033
<ul> <li>Earth, winding and sluggish</li> <li>No vegetation</li> </ul>	0.023	0.025	0.030
Grass, some weeds	0.025	0030	0.033
Dense weeds or aquatic plants in deep channels	0.030	0035	0.040
Earth bottom and rubble sides	0.025	0030	0.035
Stony bottom and weedy sides	0.025	0035	0.045
Cobble bottom and clean sides	0.030	0040	0.050
<ul> <li>Dragline excavated or dredged</li> </ul>			
No vegetation	0.025	0028	0.033
Light brush on banks	0.035	0.050	0.060
d. Rock Outs	0.005	r	
Smooth and uniform	0.025 0.035	0.035 0.040	0 D 40 0 D 50
Jagged and irregular e. Channels not maintained, uncut weeds and brush	0.035	0040	0 DOD
<ul> <li>Channels not maintained, uncut weeds and brush Dense weeds as high as flow depth</li> </ul>	0.050	0080	0.120
Clean bottom, brush on sides	0.040	0.050	0.080
Same, highest stage of low	0.045	0070	0.110
Dense brush, high stage	0.800	0.100	0.140
NATURAL STREAMS			
1. Minor streams (top width at flood_stage<100 ft) a. Streams on Plain			
a. Streams on Plain 1. Clean, straight, full stage, no ritts or deep pools	0.025	0.030	0.033
2. Same as above, but more stones and weeds	0.030	0035	0.040
3. Gean, winding, some pools and shoals	0.033	0.040	0.045
<ol><li>Same as above, but some weeds and stones</li></ol>	0.035	0.045	0.050
<ol><li>Same as above, lower stages, more</li></ol>			
ineffective slopes and sections	0.040	0.048	0.055
-			

Table 5A-1 Values of Roughness Coefficient 'n' (Uniform Flow) Reference: Chow, Ven T., *Open Channel Hydraulics* (1959) *Continue on following page* 

5A-11

### **Total Energy in Open Channel Flow**

**Appendix F** 

May 15, 2011

(5-7)

TOOT DESIGN DIVISION DRAIN AGE MANUAL

$$h_1 + \left(\frac{V_1^2}{2g}\right) = h_2 + \left(\frac{V_2^2}{2g}\right) + h_L$$

Where:

h<sub>1</sub> = upstream water surface elevation, (ft)

h<sub>2</sub> = downstream water surface elevation, (ft)

V<sub>1</sub> = mean velocity upstream, (ft/s)

 $V_2$  = mean velocity downstream, (ft/s)

h<sub>L</sub> = head loss due to local cross sectional changes and friction loss, (ft)

g = acceleration due to gravity, (32.2 ft/sec<sup>2</sup>)

Figure 5-3 illustrates the terms in the Energy equation. The equation states that the total energy head at the upstream location of a channel is equal to the sum of the energy head at the next downstream location plus the energy head losses between the two consecutive sections. To apply the energy equation, streamlines must be approximately straight and parallel so that vertical acceleration can be neglected.

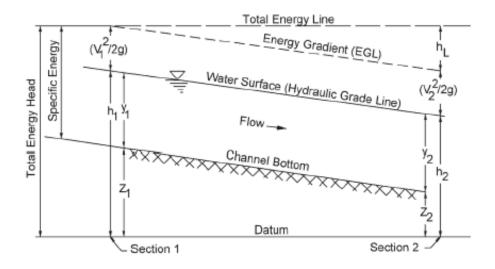


Figure 5-3 Total Energy in Open Channel Flow

#### 5.03.3 MANNING'S CHANNEL ROUGHNESS COEFFICIENTS

Manning's equation is an empirical relationship in which the roughness coefficient, n, is used to quantitatively express the degree of retardation of flow. The selection of a Manning's channel roughness coefficient is usually based on consideration of many factors, including the depth of flow, the season, the height of any obstructions, and the types of vegetation. Further, the selection of a coefficient for a natural stream channel is more dependent on engineering

5.8

# **Pipe Selection Criteria**

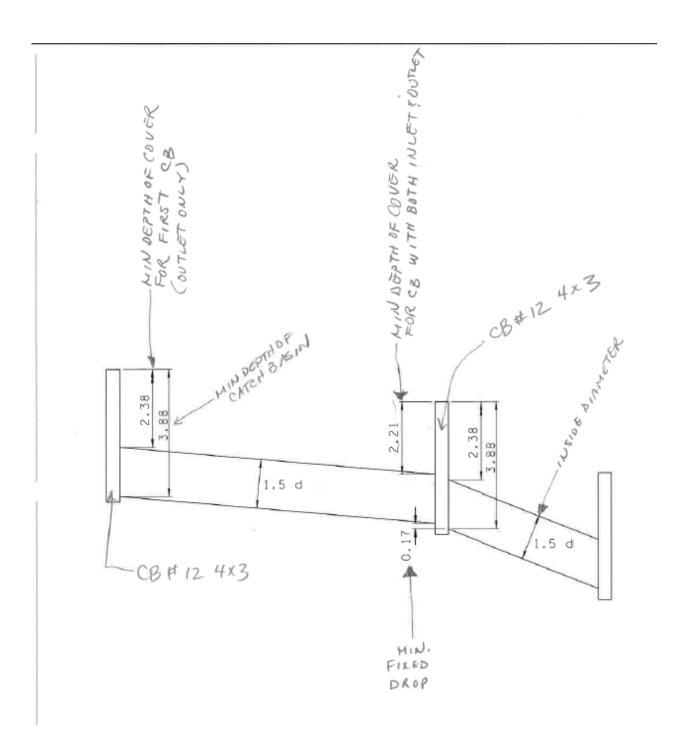
#### TDOT DESIGN DIVISION DRAINAGE MANUAL

#### June 15, 2016

Fill Height (feet)					
	≤ 10 ft	>10 ft and ≤ 16 ft	> 16 ft and ≤ 24 ft	> 24ft and ≤ 38ft	> 38 ft
Interstate system and	danyarterial with	full access control (	Freeways)		
Cross dialits, Transuerse median dialits & Longthodinal storm dialits	RCP CL III	RCP CLIII	RCPCLN	RCPCLV	note 1
Arterials					
Cross dia his & Trahisuerse miedian dia his	RCPCLIII CMP10g PVC HDPE/PP	RCP CLIII CMP 10 g PVC HDPE/PP	RCP CL IV PVC	RCPCLV	note 1
Longitudinaistom diains	RCPCLIII PVC Hdpe/Pp	RCP CLIII PVC Hdpe/Pp	RCP CL IV PVC	RCPCLV	note 1
Collectors					
Cross diains & Transuerse median diains	RCPCLIII CMP12g PVC SrTRP HDPE/PP	RCPCLIII CMP12g PVC SRTRP HDPE/PP	RCPCLIV CMP 12g PVC	RCPCLV CMP12g	108e 1
Longitudinaistom diains	RCPCLIII PVC HDPE/PP	RCP CLIII PVC HDP E/PP	RCP CLIV PVC	RCPCLV	note 1
Local Roads					
Cross diales	RCPCLIII CMP14g PVC SRTRP HDPE/PP	RCPCLIII CMP14g PVC SRTRAP HDPE/PP	RCPCLIV CMP14g PVC	RCPCLV CMP14g	108e 1
Longthd hai Storn Drahs	RCPCLIII PVC Srtrp Hdpe/PP	RCP CLIII PVC SRTRP HDP E/PP	RCP CLIV PVC	RCPCLV	note 1
For All Road Systems					
Side Drainn (Pipes under private difues, bushess or field entrances)	RCPCLIII CMP16g PVC SrTRP HDPE/PP	RCPCLIII CMP14g PVC SR7774P HDPE/PP	RCPCLIV CMP14g PVC	RCPCLV CMP14g	note 1
Longitudinsi Medisn Draini	RCPCLIII CMP16g PVC SRTRP HDPE/PP	RCP CLIII PVC SRTRP HDP E/PP	RCP CLIV PVC	RCPCLV	note 1

Table 6A-1 Pipe Selection Criteria Based on System and Fill Height (see notes on next page)

6A-12



# **IDF ZONE Location Map**

January 1, 2010 JOHNSON CITY KNOXVILLE NOLX CHATTANDOGA COOKEVILLE Figure 4.A-1 IDF Zone Location Map MARCON MANCHE STER LEBANON TWHSHM GILES CLARK SVILLE SHELBYVILLE с, LAWRENCEBURG WATNE TEWAR' HARDIN 000010 HENRY VEALURY. 1 0810M JACKSON FAYETTE SHELBY

TOOT DESIGN DIVISION DRAIN AGE MANUAL

4A-2

# Hydrologic Design Criteria

## **Appendix J**

TDOT DESIGN DIVISION DRAINAGE MANUAL

January 1, 2010

	Interstate System and Arterial With Full Access Control	Arterial Without Full Access Control	Collector	Local Road
Inlet Design Frequency	50-yr	10-yr <sup>1</sup>	10-yr <sup>1</sup>	10-yr
Sewer Design Frequency	50-yr	10-yr <sup>1</sup>	10-yr <sup>1</sup>	10-yr
Culvert Design Frequency	50-yr Check for 100-yr	50-yr Check for 100-yr	50-yr Check for 100-yr	50-yr Check for 100-yr
Roadway Freeboard <sup>2</sup>	50-yr	50-yr	50-yr	50-yr
Ditch Design Frequency	50-yr	10-yr <sup>1</sup>	10-yr <sup>1</sup>	10-yr

<sup>1</sup>50-year in Roadway Sag Sections

 $^{2}$  The design high water elevation should be at or below the bottom of the roadway subgrade.

Table 4-1 Hydrologic Design Criteria

## **Catch Basin Data Table**

# Appendix K

СВ	Drainage Area	Тс	Discharge	Spread Width
1	1.03	31.361	1.58	5.411
2	1.741	33.65	2.429	6.99
3	0.182	9.15	0.785	3.0179
4	0.581	3.724	1.877	6.029
5	1.275	34.154	1.282	3.073
6	0.257	1.595	1.343	5.5181
7	7.143	36.141	7	5.786
8	0.895	28.956	0.941	1.444
9	0.689	35.051	0.886	4.0723
10	2.733	37.2	2.63	1.725
11	0.191	34.8	0.337	1.759
12	0.199	1.421	1.106	4.836
13	0.156	1.238	0.877	7.273
14	0.286	2.372	1.767	4.81

#### **Exercise 5 Catch Basin Values**