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# CHAPTER 9 – Hydraulic Design

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# Chapter 9

## 9.1 Hydraulic Design & Stormwater Management

### 9.1.1 Introduction

To maintain CADD file conformity statewide, all hydraulic design files need to be created in accordance with this manual. Erosion and Sediment Control (ESC) items are placed in a separate CADD file. See [Section 9.2](#) Procedures for ESC Design for details.

All Hydraulic and Erosion and Sediment files shall be maintained in the Hydraulic directory as noted in [Chapter 1, Section 4](#).

### 9.1.2 Hydraulic Design CADD Procedures

#### 9.1.2.1 Development and Application of Drainage Design

For development and application of drainage design, refer to the [VDOT Drainage Manual and Hydraulic Design Advisories](#). Instructions for VDOT policy and procedures can be found in the [Location and Design Instructional & Informational Memorandum](#). For details of standard drainage structures, see the [VDOT Road & Bridge Standards](#)

#### 9.1.2.2 CADD File for the Drainage Design

A separate CADD file for the drainage design should be created for each project. Hydraulic design files should be created using the seed file `geopakdes.dgn` and the naming convention `h12345.dgn`. Generally, the stormwater management basin design is included in the master hydraulic file and basin detail sheets are separate files.

#### 9.1.2.3 Hydraulic CADD Level Structure

The standard VDOT Hydraulic CADD level structure is located in [Appendix D Section D.4.2.3](#) and below:

Level	Description
Level 1	Pipes from 4" to 42" (Custom Line Style)
Level 2	Pipes 48" and Larger (Custom Line Style)
Level 3	Standard Box Culverts LC = 0, WT = 5
Level 4	Endwalls (Cells)

Level	Description
Level 5	End Sections (Cells)
Level 6	Ditches and Flumes WT = 4, LC = 0 (Custom Line Style)
Level 7	Energy Dissipaters, Pipe Spillout, and Spring Boxes (Cells)
Level 8	Manholes and Junction Boxes (Cells)
Level 9	Drop Inlets DI - 1, DI - 5, and DI - 9 Series (Cells)
Level 10	Drop Inlets DI - 2 Series (Cells)
Level 11	Drop Inlets DI - 3 Series (Cells)
Level 12	Drop Inlets DI - 4 Series (Cells)
Level 13	Drop Inlets DI - 7 Series (Cells)
Level 14	Drop Inlets DI - 10 Series (Cells)
Level 15	Drop Inlets DI - 11 and DI - 13 Series (Cells)
Level 16	Drop Inlets DI - 12 Series (Cells)
Level 17	Drop Inlets DI - 14 Series (Cells)
Level 18	Special Design Items (Endwalls, Inlets, etc.)
Level 19	Underdrains (CD-1 & 2, UD-1 & 2, etc.) (Custom Line Style)
Level 20	Underdrain Outlet Pipe and EW-12 Endsections (Custom Line Style & Cells)
Level 21	Stone & Outlet Protection

Level	Description
	(EC-1, RipRap Channel, etc.)(Cells)
Level 22	SWM Basin Items (Basin, Risers, Weirs, Etc.)
Level 23	SWM Basin (Baseline/Alignment)
Level 24	SWM Basin (Plan-View/Contours)
Level 25	SWM Basin (Miscellaneous Items)
Level 26	SWM Basin (Descriptions/Notes)
Level 27	Typical Ditch Details
Level 28 - 30	Not Assigned
Level 31 - 60	Annotation for Levels 1 - 30 Note: All Drainage Structure Labels on Level 31 Text Size = B, Unless Noted Otherwise
Level 61	Base Plan Sheet, Scale Bar North Arrow, Match Lines WT = 5, LC = 0
Level 62	Not Assigned
Level 63	Project Notes

#### 9.1.2.4 Drainage and Stormwater Management General Notes

Drainage and stormwater management General Notes can be placed using the procedures detailed in [Chapter 3 Section 3.5](#)

#### 9.1.2.5 Drainage Description Guidelines

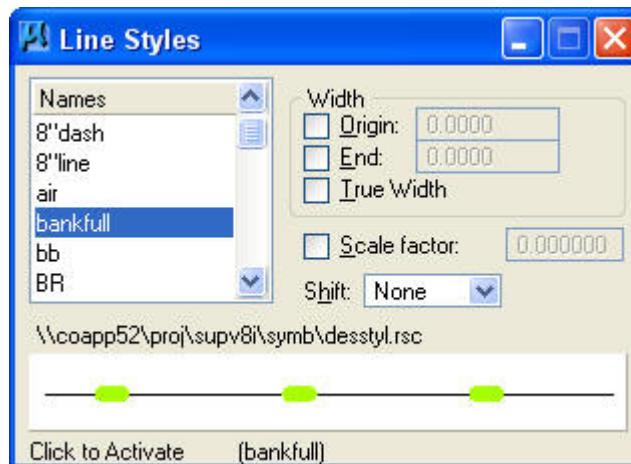
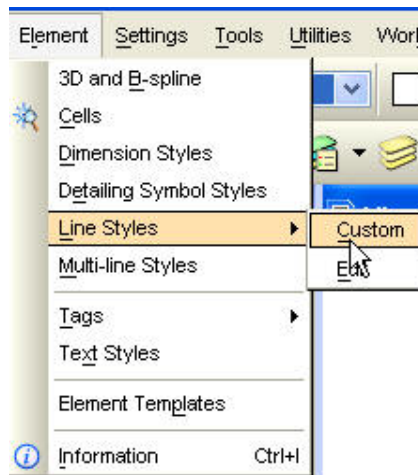
Drainage description guidelines can be found in Drainage Design Memorandum #2 (DDM2) in Chapter 15 of the [VDOT Drainage Manual](#). The structure designation numbers are to be shown within ellipses. The single and double ellipses are cells located in the drainage cell library (drainage.cel) and are named RECDSD and RECDD.

### 9.1.3 Graphical Representations of Drainage Items

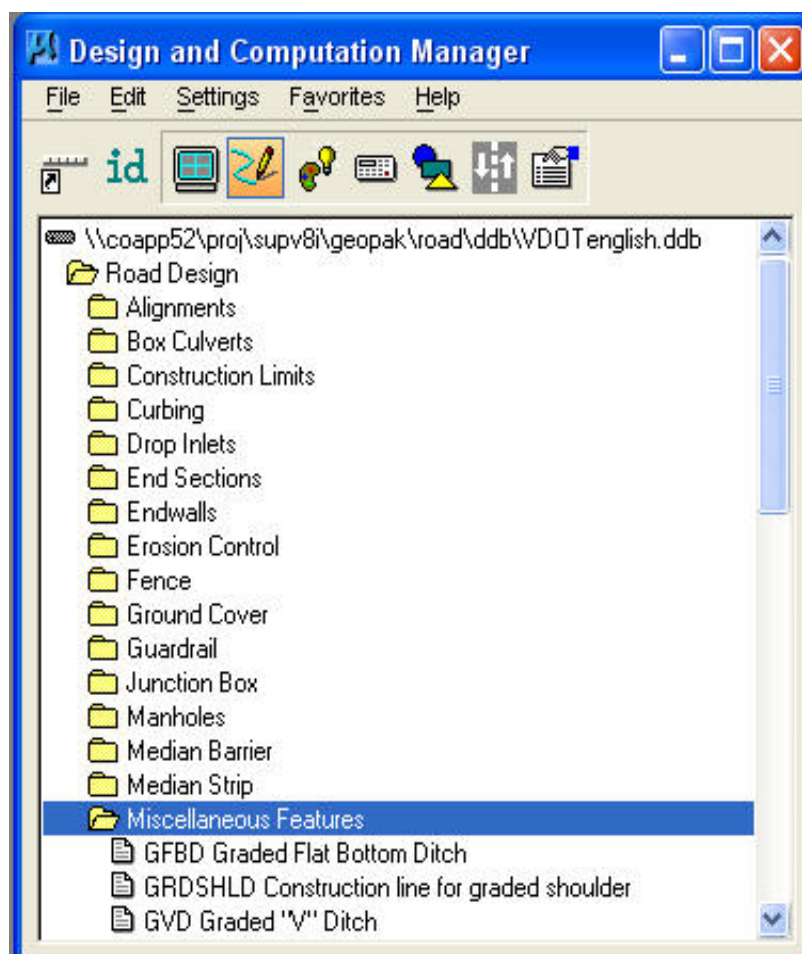
Graphical representations of drainage items are custom line styles and cells. They can be accessed in MicroStation by the following methods

#### 9.1.3.1 Custom Line Styles

If you use GEOPAK drainage software, placements of links (pipes) are part of the design process. Otherwise, drafting and quantity tabulation can be accomplished by using the **Design & Computation Manager** (D&C manager) in the VDOT MicroStation-GEOPAK package. From the GEOPAK D&C manager select: **Road Design/** and choose the folder (miscellaneous features, paved ditches, pipes, or underdrains) with the desired drainage item. Or, from the MicroStation Menu select: **Element/Line Styles/Custom** and pick the desired custom line style.



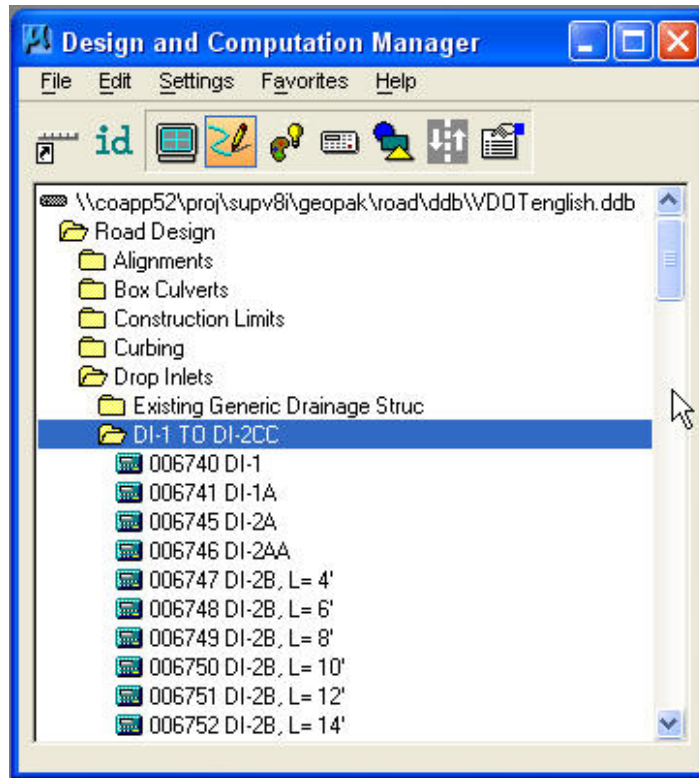
A list of hydraulic custom line styles is located along with the road design custom line styles in [Appendix D](#). Note: The graded ditch custom line styles are located in the **Miscellaneous Features folder** in the **GEOPAK Design & Computation Manager**.



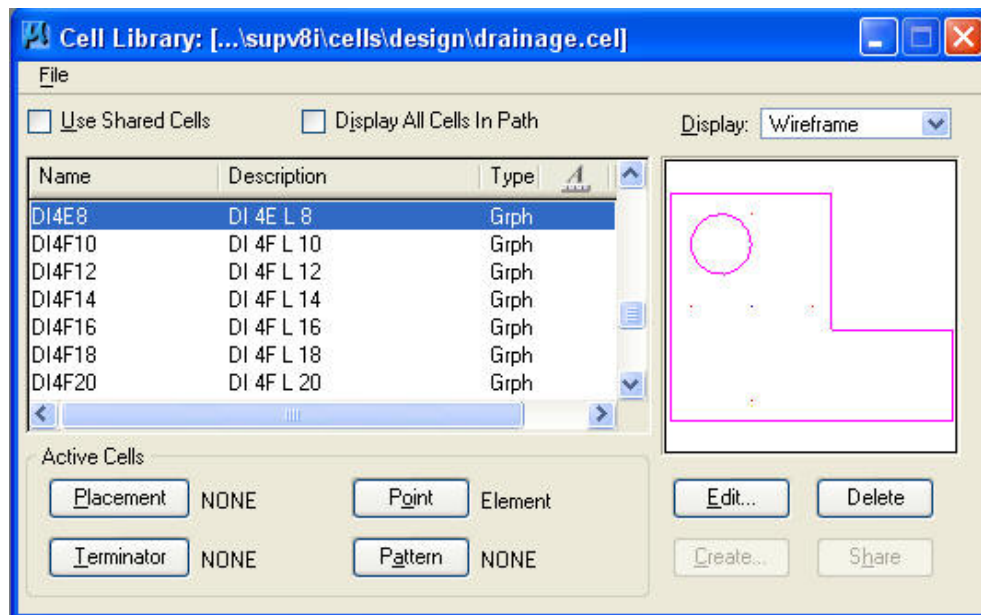
### 9.1.3.2 Cells

If you use GEOPAK drainage software, placements of the nodes (drop inlets, junctions and end sections) are part of the design process. Otherwise, drafting and quantity tabulation can be accomplished by using the **Design & Computation Manager** in the VDOT MicroStation GEOPAK package. From the **GEOPAK D&C Manager** select: **Road Design/** and choose the folder (drop inlets, end sections, end walls, manholes or paved ditches) with the desired drainage item.





Or, from the MicroStation Menu select: **Element/Cells** and pick the desired cell from the drainage cell library ([drainage.cel](#) for English units and mdrainage.cel for metric units.)



A list of cells and descriptions are contained in the drainage cell library located in [Appendix D Section 8](#)

### 9.1.3.3 Box Culverts

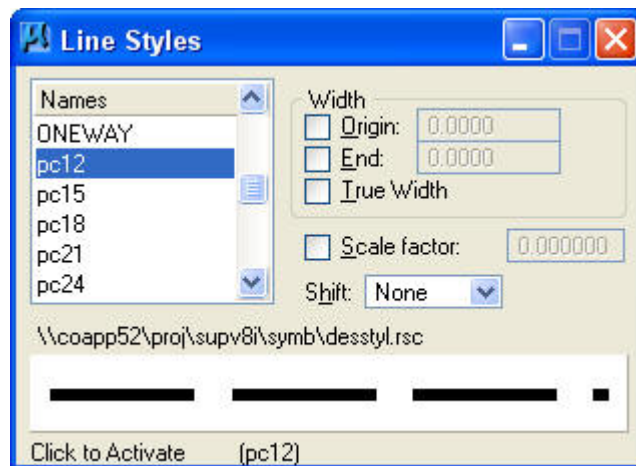
Box culverts, box culvert extensions, three-sided structures and their wingwalls/headwalls are drafted to scale using the appropriate symbology. Quantities are obtained from tables in Section 1000 of the VDOT [Road & Bridge Standards](#) and specific special design sheets. Box Culvert Line Style: LV= 3, LC= 0, WT= 5.

### 9.1.3.4 Engineering and Plan Preparation of Stormwater Management (SWM)

Engineering and plan preparation of stormwater management (SWM) facilities can be found in [Instructional and Informational Memorandum IIM-LD-195](#). The SWM design shall contain the following: baseline/alignment, contours of the proposed basin and their tie-in to the existing ground contours, structure details, spillway details, SWM dam details and other notes, cross-sections, profiles, typical sections or details specifically for the basin.

### 9.1.3.5 Underdrain Procedures

Underdrain procedures are located in Drainage Design Memorandum #5 (DDM5) in Chapter 15 of the [VDOT Drainage Manual](#). Underdrains are drafted through the **GEOPAK Design & Computation Manager** or by selecting the custom line style in MicroStation. If custom line style is used in MicroStation, underdrains must be placed scaled, dependant on size of the UD's. For example, a 6" underdrain should be placed using the settings below:



### 9.1.3.6 Drainage Summary Guidelines

Drainage summary guidelines can be found in Drainage Design Memorandum #1 (DDM1) in Chapter 15 of the [VDOT Drainage Manual](#) and page 2G-7 of the VDOT Road Design Manual. An example drainage summary sheet is located on page 2G-32 of the [VDOT Road Design Manual](#)

### 9.1.4 Insertable Sheets

The creation and maintenance of all insertable sheets is the responsibility of the Standards/Special Design Section, in cooperation with the CADD Support Group.

Insertable sheets can be copied into a MicroStation file by means of referencing the desired drawing. VDOT personnel can locate the insertable sheets through the **Falcon Document Manager** under the **eng-ser folder**. For the entire list of insertable sheets, set your Falcon/DMS database to Central Office. Then scroll to the eng-ser Folder and select **insert** for imperial sheets or **minsert** for metric sheets. Consultants can locate the insertable sheets under the download folder within their FTP server site provided by VDOT.

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## 9.2 Erosion and Sediment Control (ESC)

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### 9.2.1 Introduction

The project scope and complexity will determine the appropriate ESC plan. Some projects will be able to show all of the ESC measures on the construction plans. Others will require additional sheets to depict multiple phases to correctly show items needed to be installed before grubbing operations and measures to be installed as grading and drainage operations progress. For details about the Erosion and Sediment Control Program guidelines, see [VDOT's Instructional and Information Memorandum IIM-LD-11](#).

### 9.2.2 Erosion and Sediment Control CADD Procedures

The Erosion and Sediment Control (ESC) Plan Details are contained in Appendix 10B of the [VDOT Drainage Manual](#).

#### 9.2.2.1 CADD File Creation for the Erosion and Sediment Control

A separate CADD file for the Erosion and Sediment Control design will be created for each project. ESC design files should be created using the seed file geopakdes.dgn and the naming convention h12345esc.dgn.

#### 9.2.2.2 Erosion and Sediment Control Level Structure

The standard VDOT CADD Erosion and Sediment Control level structure is located in [Appendix D](#) of this manual and below. Note: Levels for the ESC plan are setup in two (2) phases for use with multi-phased plans.

Level	Description
Level 1	PHASE I Erosion Control Items (TFB, TSF, Turb. Curtain)(Custom Line Style)
Level 2	PHASE I Erosion Control Ditch Items (EC-2, EC-3, etc.)(Custom Line Style)
Level 3	PHASE I Erosion Control Stone (EC-1, RipRap, Check Dams)(Cells)
	PHASE I Erosion Control Items

Level	Description
Level 4	(Sediment Traps & Basins)
Level 5	PHASE I Erosion Control Items (Diversion Dikes & Ditches)(Custom Line Style)
Level 6	PHASE I Erosion Control Items (Temporary Diversion Channels)(Custom Line Style)
Level 7	PHASE I Erosion Control Items (Miscellaneous Diversion Items)
Level 8	PHASE I Erosion Control Items (Brush Barriers, Level Spreaders, etc.)
Level 9	PHASE I Miscellaneous Erosion Control Items
Level 10	PHASE I Temporary Drainage (Pipes)(Custom Line Style)
Level 11	PHASE I Proposed Drainage (Pipes)(Custom Line Style)
Level 12	PHASE I Proposed Drainage (SWM)
Level 13	PHASE I Existing Contours (LC=1, WT=1)
Level 14	PHASE I Proposed Contours
Level 15	PHASE I Symbols, Legend and Notes

Level	Description
Level 16	PHASE II Erosion Control Items TFB, TSF, Turb. Curtain)(Custom Line Style)
Level 17	PHASE II Erosion Control Ditch Items (EC-2, EC-3, etc.)(Custom Line Style)
Level 18	PHASE II Erosion Control Stone (EC-1, RipRap, Check Dams)(Cells)
Level 19	PHASE II Erosion Control Items (Sediment Traps & Basins)
Level 20	PHASE II Erosion Control Items (Diversion Dikes & Ditches)(Custom Line Style)
Level 21	PHASE II Erosion Control Items (Temporary Diversion Channels)(Custom Line Style)
Level 22	PHASE II Erosion Control Items (Miscellaneous Diversion Items)
Level 23	PHASE II Erosion Control Items (Brush Barriers, Level Spreaders, etc.)
Level 24	PHASE II Miscellaneous Erosion Control Items
Level 25	PHASE II Temporary Drainage (Pipes)(Custom Line Style)
Level 26	PHASE II Proposed Drainage (Pipes)(Custom Line Style)

Level	Description
Level 27	PHASE II Proposed Drainage (SWM)
Level 28	PHASE II Existing Contours (LC=1, WT=1)
Level 29	PHASE II Proposed Contours
Level 30	PHASE II Symbols, Legend and Notes
Level 31 - 60	Annotation for Levels 1 – 30 Note: All Drainage Structure Labels on Level 31 Text Size = B, Unless Noted Otherwise
Level 61	Base Plan Sheet, Scale Bar North Arrow, etc. WT = 5, LC = 0
Level 62	Not Assigned
Level 63	Project Notes

Note: For text size designations (A, B, etc.), see [Appendix D Section 5](#)

### 9.2.2.3 Erosion and Sediment Control General Notes

Erosion and Sediment Control General Notes can be placed using the procedures detailed in [Chapter 3 Section 5](#). General Note E-8 is the ESC legend and its location in the plan assembly should be referenced from the plan sheet where applicable. See example below:

.

E-8 The following symbols are used to depict Erosion Control items in the plan assembly:

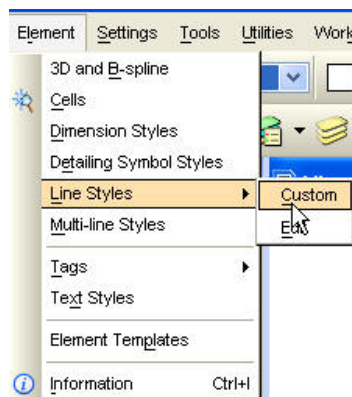
	(EC-2)	Denotes Protective Covering, St'd. EC-2
	(EC-3A)	Denotes Soil Stabilization Mat. St'd. EC-3 Type A, B or C
	(EC-3B)	
	(EC-3C)	
	(TFB)	Denotes Temporary Filter Barrier, St'd EC-5
	(TSF)	Denotes Temporary Silt Fence, St'd EC-5
	(TDC)	Denotes Temporary Diversion Channel, St'd TD-CL
	(DD)	Denotes Temporary Diversion Dike, St'd EC-9
	(TC-I)	Denotes Turbidity Curtain, Type - Impervious
	(TC-P)	Denotes Turbidity Curtain, Type - Pervious
	(RCD-1)	Denotes Rock Check Dam, Type I; St'd EC-4
	(RCD-2)	Denotes Rock Check Dam, Type II; St'd EC-4
	(DIST-A)	Denotes Drop Inlet Silt Trap Type A; St'd EC-6
	(DIST-B)	Denotes Drop Inlet Silt Trap Type B; St'd EC-6

### 9.2.3 Graphical Representation of ESC Items

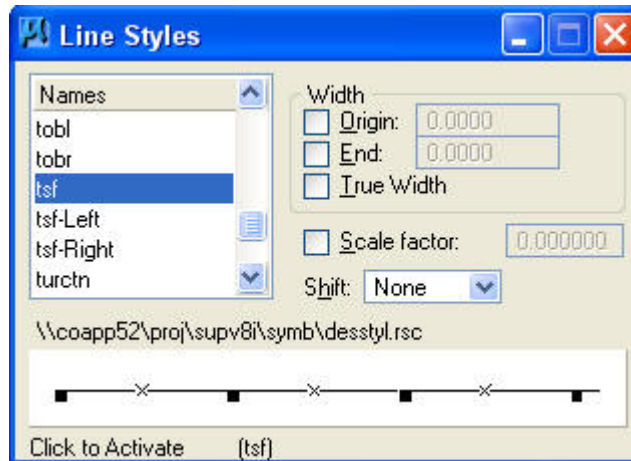
ESC plan elements include: custom line styles, cells and labels. They can be accessed in MicroStation by the following methods:

#### 9.2.3.1 Custom Line Styles

Custom Line Styles: Drafting and quantity tabulation can be accomplished by using the **Design & Computation Manager** in the VDOT MicroStation-GEOPAK package. From the GEOPAK D&C manager select: **Road Design/Erosion Control** and choose the desired erosion control item. Or, from the MicroStation Menu select: **Element/Line Styles/Custom** and pick the desired custom line style. See example below:



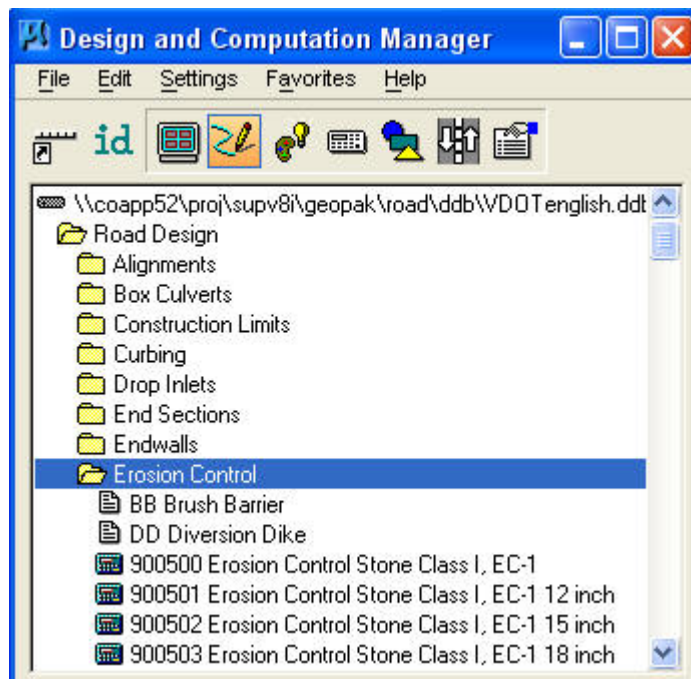




A list of ESC custom line styles is located along with the road design custom line styles in [Appendix D Section 7](#).

- Erosion Control Treatment St'd. EC – 2
- Erosion Control Treatment St'd. EC – 3
- Diversion Channel
- Diversion Dike
- Temp. Filter Barrier
- Temp. Silt Fence
- Turbidity Curtain

Note: The ESC custom line styles are located in the **Erosion Control** folder in the **GEOPAK Design & Computation Manager**.



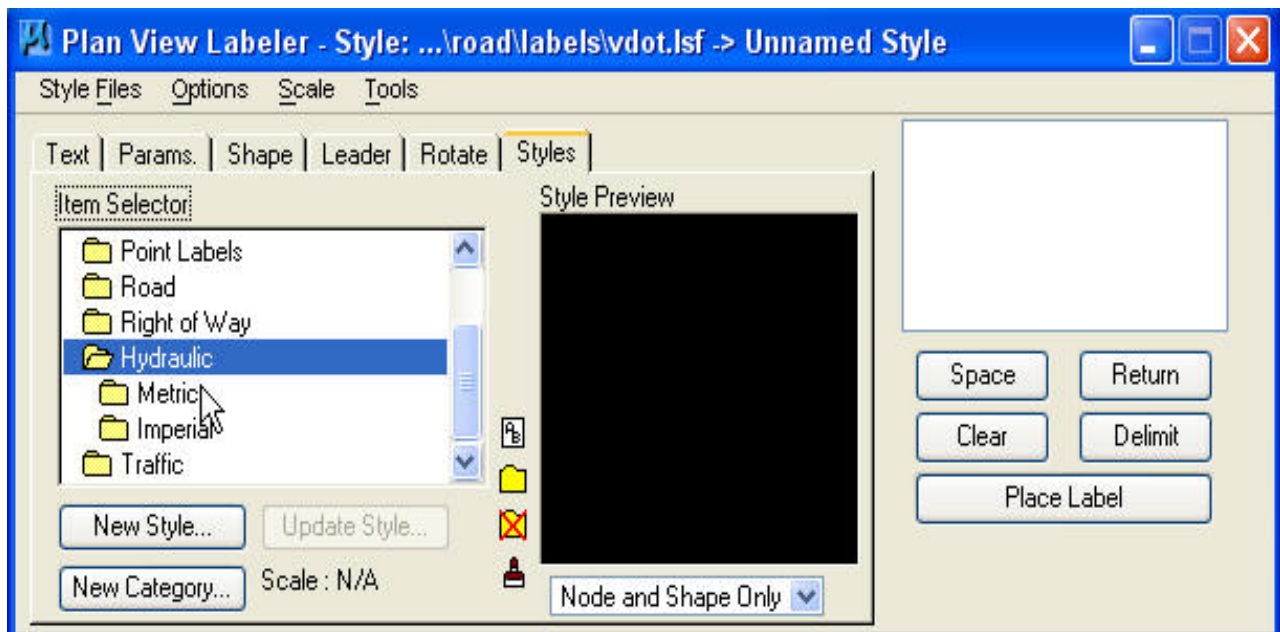
### 9.2.3.2 Cells

Drafting and quantity tabulation can be accomplished by using the **Design & Computation Manager** in the VDOT MicroStation-GEOPAK package. From the GEOPAK D&C Manager select: **Road Design/Erosion Control** and choose the desired erosion control item. Or, from the MicroStation Menu select: **Element/Cells** and pick the desired cell from the drainage cell library ([drainage.cel](#) for English units and [mdrainage.cel](#) for metric units). The following is a partial list of cells contained in the drainage cell library:

- RCDAM1 – Rock Check Dam Type I
- RCDAM2 – Rock Check Dam Type II
- ROCKY – Rip Rap
- TST – Temporary Sediment Trap
- DIST-A – Drop Inlet Silt Trap Type A
- DIST-B – Drop Inlet Silt Trap Type B

### 9.2.3.3 Labels

The automated technique for Labeling uses the VDOT MicroStation-GEOPAK package. From **GEOPAK ROAD** select: **Plan Preparation/Plan-View Labeling / Styles/Hydraulic/Imperial** or **Metric/scale** and choose the desired label. Or, create the labels using MicroStation drafting methods.



## 9.2.4 Placement of Erosion Control Stone

Placement of erosion control stone is accomplished by patterning an area. Instructions, pattern names and scales can be found in [Appendix D Section 3](#). *Note: When using the erosion control stone cells, you must drop element status of the cell before patterning.* Cells as listed below are from the **drainage.cel** cell library:

- EC112-EC184 – EC Stone EW 1 or 2, 12” to 84”
- ECS12-ECS60 – EC Stone ES 1, 12” to 60”

## 9.2.5 Insertable Sheets

The creation and maintenance of all insertable sheets is the responsibility of the Standards/Special Design Section, in cooperation with the CADD Support Group.

Insertable sheets can be copied into a MicroStation file by means of referencing the desired drawing. VDOT personnel can locate the insertable sheets through the **Falcon Document Manager** under the **eng-ser folder**. For the entire list of insertable sheets, set your Falcon/DMS database to Central Office, then scroll to the **eng-ser folder** and select **2008 Insertable Sheets**. Consultants can locate the insertable sheets under the download folder within their FTP server site provided by VDOT.

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## 9.3 *GEOPAK Drainage*

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### 9.3.1 Introduction

All projects with **storm sewer systems** as defined by Chapter 9, Section 9.2.1 of the [VDOT Drainage Manual](#) are to have **Storm Sewer Profiles** included in the project plan assembly. **GEOPAK Drainage** is the preferred design package for the production of **Storm Sewer Profiles**.

A **storm sewer system** is defined as a drainage system (existing and/or proposed) consisting of a series of at least two interconnecting pipes and two structures (drop inlets, manholes, junction boxes, etc) designed to intercept and convey stormwater runoff from a specific storm event without surcharge.

### 9.3.2 Files

The following section describes several different types of files utilized by the GEOPAK Drainage software, including both their uses and creation.

#### 9.3.2.1 GEOPAK Drainage File (GDF)

This file contains all the hydraulic information about the drainage system. Each GEOPAK Drainage Project contains **Preferences**, which include hydrologic and hydraulic computation options, visualization symbologies, and project file references to the **Drainage Library** and **GEOPAK GPK** files. Spatial data, connectivity and hydraulic properties for each drainage feature are stored in this external file. Sufficient data is maintained to rebuild the graphical representation of the Drainage Project with the exception of certain features, which are defined by MicroStation elements.

#### 9.3.2.2 GDF Seed File

When an internal user requests GEOPAK access through SARA, a seed file (*VDOT\_Seed.gdf*) will be used to create a project **GDF (GEOPAK Drainage File)** for each individual project. All of the **Project Preferences**, as well as, server links to the **Drainage Library (DLB)**, **Drainage Cell Library (CEL)** and the **Design Computation Manager Database (DDB)** will be pre-set in this file. The new project **GEOPAK Drainage File (GDF)** will be named corresponding to the projects UPC code, and placed in the project GEOPAK folder on the appropriate District or Central Office CADD server. Consultants may obtain this seed file, and assistance in properly configuring it to their CADD workspace, from the CADD Support Group.

**EXAMPLE:** *h3850.gdf* (GEOPAK Drainage File for UPC# 3850)

### 9.3.2.3 File Types Utilized by GEOPAK Drainage

The following table lists all of the relevant file types utilized by the GEOPAK Drainage software, and a short description of their function. Many of these file types are directly associated with the Visual Basic Applications outlined in [Section 9.3.3](#).

**Table 9-1 File Types Utilized by GEOPAK Drainage**

File Common Name	File Type	File Function
GEOPAK Drainage File	*.gdf	Contains all the hydraulic information about the drainage system
MicroStation Cell Library	*.cel	Contains the graphic cells utilized by both <b>MicroStation</b> and <b>GEOPAK</b>
GEOPAK Design & Computation Manager	*.ddb	Stores pay item and computational quantity data associated with the graphical cells
GEOPAK Drainage Library File	*.dlb	Contains the Rainfall Parameters, standard inlet types, standard pipes configurations, spread sections, and land use symbology tables utilized by the software
GEOPAK Drainage Preference File	*.dpf	Used to store the <b>Drainage Project Preferences</b> utilized by the *.gdf file
GEOPAK Drainage Profile Preferences File	*.ppf	Used to store the settings and symbology associated with the "design process" Drainage Profiles (i.e. the program generated Drainage Profiles before the <b>Drainage Profile Labeler VBA</b> is run)
Drainage Report Preferences File	*.drp	The *.dpf file exported to an ASCII format for use with both the Spread Analysis <b>Tabulation Report VBA</b> & the <b>Storm Sewer Tabulation Report VBA</b>

File Common Name	File Type	File Function
Utility Test Hole VBA Data File	*thd	Stores settings and data for the <b>Utility Test-Hole Data VBA</b> either directly from the user input dialog or from the imported <b>Utility Test-Hole Information Spreadsheet</b>
Drainage X-Section VBA Settings File	*.dxs	Stores settings and data for the <b>Drainage X-Section VBA</b>
Drainage Descriptions VBA Settings File	*.ddd	Stores settings and data for the <b>Drainage Descriptions VBA</b>
Drainage Input VBA Dialog Settings File	*.did	Stores settings and data for the <b>Drainage Input VBA</b> either directly from the user input dialog or from the imported <b>Ensoft LD-204 &amp; LD-229 forms</b>

### 9.3.3 Visual Basic Applications (VBAs)

Bentley & VDOT have collaborated to create nine (9) new Visual Basic Applications (VBAs) to work in conjunction with the GEOPAK Drainage software. These applications will help to streamline and support, in GEOPAK Drainage, the workflow process essential to VDOT drainage design. The following sections provide a brief description of each of the nine (9) applications.

#### 9.3.3.1 Spread Analysis Tabulation Report VBA

The application creates an Excel formatted **Inlet Spread Tabulation Report**, similar in content to the **LD-204** form report, from the design and analysis information contained within the project **GEOPAK Drainage File (\*.gdf)**. See [Section 9.4](#) for full usage instructions.

#### 9.3.3.2 Storm Sewer Tabulation Report VBA

The application creates an Excel formatted **Storm Sewer Tabulation Report**, similar in content to the **LD-229** form report with additional hydraulic grade-line (HGL) information, from the design and analysis information contained within the project **GEOPAK Drainage File (\*.gdf)**. An additional tab in the Excel file provides duplicate data in the original **LD-229** format. See [Section 9.4](#) for full usage instructions.

### 9.3.3.3 Utility Test-Hole VBA

The application imports user provided utility data to GEOPAK Drainage to be used for plotting on the **Storm Sewer Profiles**. The data can be either manually entered through the VBA dialog or imported from the **VDOT Utility Test Hole Information Spreadsheet**. See [Section 9.4](#) and [Section 9.5](#) for full usage instructions.

### 9.3.3.4 Drainage Profile Labeler VBA

The application reformats the symbology of the GEOPAK Drainage “design process” profiles, and drafts the utility data as provided by the **Utility Test Hole Data File (\*.thd)** onto the resultant **Storm Sewer Profiles**. The application allows the user to select any of the labeling placed by this tool and move its location so as not to interfere with another label or drainage object. See [Section 9.4](#) for full usage instructions.

### 9.3.3.5 Drainage Pattern Lines VBA

This application draws pattern lines (lines used to cut GEOPAK x-sections) in plan-view along the project alignment, at locations obtained from the **GEOPAK Drainage project**. These pattern lines are used in turn to project the nodes (inlets), links (pipes) and utility data onto x-sections associated with the project alignment, utilizing the **Drainage X-Sections VBA**. See [Section 9.4](#) and [Section 9.5](#) for full usage instructions.

### 9.3.3.6 Drainage X-Sections VBA

This application draws GEOPAK Drainage elements, nodes (inlets), links (pipes) and utility data, in x-section at locations obtained from the GEOPAK Drainage project, utilizing the pattern lines created by the **Drainage Pattern Lines VBA**. See [Section 9.4](#) and [Section 9.5](#) for full usage instructions.

### 9.3.3.7 Drainage Descriptions VBA

This application imports the nodes and links from a **GEOPAK Drainage file**, and plots each item with a standard or user-defined description into a standard VDOT plan sheet. The application allows the user to modify the standard descriptions for each drainage item, as well as arrange the drainage items into sheet categories to match the plan sheets. See [Section 9.4](#) for full usage instructions.

### 9.3.3.8 Drainage Summary VBA

This application reads a **GEOPAK Drainage file**, and populates a pre-formatted drainage summary spreadsheet in Excel. The spreadsheet can then be cut and pasted into a standard VDOT plan sheet to create the project **Drainage Summary Sheet**. See [Section 9.4](#) for full usage instructions.

### 9.3.3.9 Drainage Input VBA

The purpose of this application is to provide a method for importing drainage designs, created utilizing other methods or software, into GEOPAK Drainage. The application will read and accept user input into the application dialog for import into the GEOPAK Drainage software. The application also allows for direct import of **Ensoft LD-229** and **LD-204** output files into the application dialog, for subsequent importation into the GEOPAK Drainage software.

The user is advised that this process is far from being totally automated, and that a great deal of manual manipulation of the graphic elements and editing of the **GEOPAK Drainage File (\*.gdf)** are required. See [Section 9.4](#) and [Section 9.5](#) for full usage instructions.

### 9.3.4 Storm Sewer Profiles

The finished **Storm Sewer Profiles** will be a product of the GEOPAK Drainage “design process” profiles, the **Utility Test-Hole VBA**, and the **Drainage Profile Labeler VBA**. The **Storm Sewer Profiles** will be referenced into **Storm Sewer Profile Sheet Cells** and incorporated into the project plan assembly.

#### 9.3.4.1 Storm Sewer Profile Sheet Cell

For presentation, the **Storm Sewer Profiles** are to be referenced into **Storm Sewer Profile Sheet Cells**. The Storm Sewer Profile Sheet Cells are named **SSProfile** and **SSProfile2**. The **SSProfile** cell contains all of the original utility notes and is intended for use when utility test hole data is to be placed on the finished **Storm Sewer Profiles**. The **SSProfile2** cell contains just the notes relative to the drainage system and is intended for use without the test hole data being placed on the finished **Storm Sewer Profiles**. The cells are part of the MicroStation **sheet2000 cell library** located in [\\coapp52\proj\supv8\cells\design](#). See [Figure 9-3](#).

The cells contain text dialog instructions & guidelines for the placement and sizing of the profile elements. These instructions can be deleted or simply turned off before plotting. Users should familiarize themselves with these instructions in order to understand the size limitations associated with the **Profile Sheet Cells**. This will aid greatly in the creation and/or cutting of the GEOPAK Drainage “design process” profiles, before running the **Drainage Profile Labeler VBA** and subsequent placement of the “finished” drainage profiles on the sheets.

#### 9.3.4.2 Placement in the Project Plan Assembly

The project **Drainage Descriptions** and **Storm Sewer Profile Sheets** shall be grouped together and assigned their own sheet number. The sheet number following the last roadway profile sheet, or entrance profile sheet, whichever comes last shall be assigned to the **Drainage Descriptions** and **Storm Sewer Profile Sheets** group.



All **Drainage Descriptions** and **Storm Sewer Profile Sheets** are assigned one number with the total number of sheets afterwards in parentheses, such as Sheet No. 7 (1 thru 10). The drainage description sheets should be placed in front of the Storm Sewer Profile Sheets, within the series. The **Drainage Descriptions** and **Storm Sewer Profile Sheets** shall be appropriately named as shown in the following table.

**Table 9-2 Description and Profile Sheet Numbering**

<b>Sheet Number</b>	<b>Description</b>
Plan Sheet 3	(1 <sup>st</sup> roadway plan sheet)
Plan Sheet 4	(2 <sup>nd</sup> roadway plan sheet)
Plan Sheet 5	(3 <sup>rd</sup> roadway plan sheet)
Plan Sheet 6	(last roadway plan sheet)
Plan Sheet 6A	(profile sheet for Plan Sheet 6)
Plan Sheet 6B	(ES&C plan for Plan Sheet 6)
Plan Sheet 6C	(Entrance Profiles)
<b>Plan Sheet 7</b>	<b>(1<sup>st</sup> sheet of Drainage Descriptions)</b>
<b>Plan Sheet 7(1)</b>	<b>(2<sup>nd</sup> sheet of Drainage Descriptions)</b>
<b>Plan Sheet 7(2)</b>	<b>(1<sup>st</sup> sheet of Storm Sewer Profiles)</b>
<b>Plan Sheet 7(3)</b>	<b>(2<sup>nd</sup> sheet of Storm Sewer Profiles)</b>
<b>Plan Sheet 7(4)</b>	<b>(3<sup>rd</sup> sheet of Storm Sewer Profiles)</b>
Plan Sheet 8	(1 <sup>st</sup> sheet of Sign Plans, if applicable)

Figure 9-3 Storm Sewer Profile Sheet

# STORM SEWER PROFILES

**NOTES:**

- 1) The existing profiles are shown as the "Old" Profile. The proposed profile is shown as the "New" Profile.
- 2) The vertical curve data is shown in the "Vertical Curve Data" table.
- 3) The proposed profile is shown as the "New" Profile. The existing profile is shown as the "Old" Profile.
- 4) The proposed profile is shown as the "New" Profile. The existing profile is shown as the "Old" Profile.
- 5) The proposed profile is shown as the "New" Profile. The existing profile is shown as the "Old" Profile.
- 6) The proposed profile is shown as the "New" Profile. The existing profile is shown as the "Old" Profile.
- 7) The proposed profile is shown as the "New" Profile. The existing profile is shown as the "Old" Profile.
- 8) The proposed profile is shown as the "New" Profile. The existing profile is shown as the "Old" Profile.
- 9) The proposed profile is shown as the "New" Profile. The existing profile is shown as the "Old" Profile.
- 10) The proposed profile is shown as the "New" Profile. The existing profile is shown as the "Old" Profile.

Station	Elevation	Profile	Profile	Profile	Profile	Profile	Profile

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## 9.4 *Bentley Instructions for GEOPAK Drainage VBA's*

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### 9.4.1 VDOT Spread Analysis Tabulation

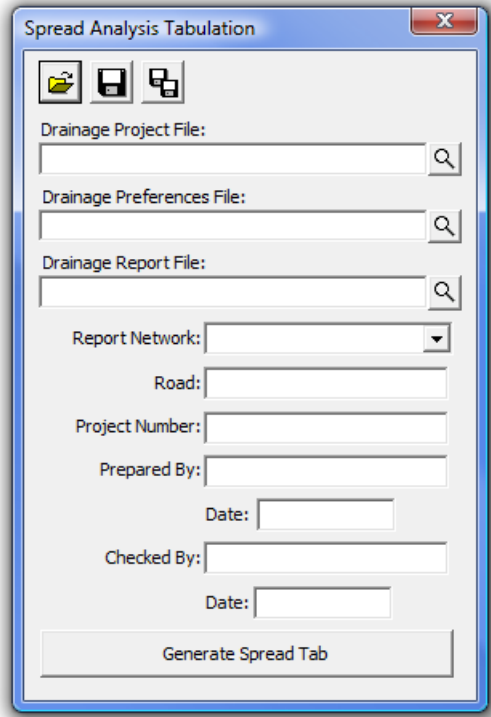
The Spread Analysis Tabulation application will read a **GEOPAK Drainage file**, a **GEOPAK Drainage Preferences file**, and a **GEOPAK Drainage Report file**, and populate the **Spread Analysis table** in Excel format.

Prior to processing the **Spread Analysis Tabulation** application, the user must have Three (3) files created. First, the **GEOPAK Drainage (.gdf)** file must be created with at least one drainage network completed and saved. If multiple networks are created in the drainage file, the desired network for the table can be selected in the **Spread Analysis Tabulation dialog**.

The second file is the ASCII form of the GEOPAK Drainage Preferences file used for the **GEOPAK Drainage network**. Once the preferences have been set, in GEOPAK Drainage the user goes to **Project > Export > Preferences** to ASCII to create the drainage preferences (.drp) file.

The third file is a **GEOPAK Drainage Report file**. Once a GEOPAK Drainage file is opened (**Project > Open**), and an active network is set (**Network > Active Network**), the user can go to **Reports > Generate** in the GEOPAK Drainage toolbar to create the GEOPAK Drainage Report file. The file **SpreadAnalysisReport.drf** needs to be selected as the format file. This process will create a .csv file that is used in the **Spread Analysis Tabulation** application.

In addition to the **GEOPAK Drainage file (.gdf)**, the **GEOPAK Drainage Preferences file (.drp)**, and the **GEOPAK Drainage Report file (.csv)**, the user needs to select the appropriate drainage network, and can provide the road name, project number, name of the person creating the drainage network and the date it was created, and the name of the person checking the project and the date it was checked.



The user has the opportunity to save the dialog settings into a settings file. When the **Spread Analysis Tabulation** application is opened, it will search the current directory for a settings file. If a settings file is found, the dialog will be populated with the information from the first settings file it finds. If the user desires another set of settings to be used, they can use the **Open Settings File** on the dialog to search for another settings file. Also available on the dialog are a **Save Settings** and **Save Settings to Another File** option. The user will also be prompted when closing the dialog to save the settings file.

When ready to create the tabulation report, the user presses the **Generate Spread Tab** button. This will copy the seed report, and populate the table with the current drainage network spread information. Once the table is complete, the user is prompted that the process is complete, and allows the user to open the created file.

YDOT ROADWAY SPREAD ANALYSIS REPORT																						
Road: Mainline		Units: U.S. Customary X										Sheet: _____ of _____										
Project #: 17268		Metric (SI)										Prepared by: Heath		Date: 9/5/2010								
												Checked by: Alex		Date: 9/8/2010								
Structure No.	Station	Offset	YDOT Standard	Drainage Area (acres)	Composite Runoff Coefficient	Rainfall Intensity (in/hr)	Inlet Discharge (cfs)	Previous Inlet Bypass (cfs)	Total Discharge	Cross Slope (ft/ft)	Logitudinal Slope (ft/ft)	Gutter Width (ft)	Gutter Slope (ft/ft)	Manning's "n"	Calculated Spread (ft)	Allowable Spread (ft)	Computed Slot Length (100% Eff.) (ft)	Sumped Spread (ft)	Ponded Depth (ft)	Intercepted Flow (cfs)	Bypass Flow to Next Inlet (cfs)	Bypass to Structure No.
OUTLET	206+36.00	-42.00	ESR	n/a	n/a	n/a	134	0.00	134	0.082	0.0000	n/a	0.0201	0.015	3.01	8.00	N/A	N/A	0.19	134	0.00	
2-2	206+36.00	-26.00	DI-3C 6	0.09	0.82	5.77	0.30	0.00	0.30	0.083	1.9000	2.0000	0.0095	0.015	1.07	8.00	24.12	N/A	0.06	N/A	0.00	
3-1	206+86.00	-26.00	DI-3B 10	0.21	0.81	5.77	0.68	0.00	0.68	0.035	0.0761	2.0000	0.0867	0.015	8.67	8.00	22.00	N/A	0.30	0.68	0.00	
3-3	206+86.00	-26.00	DI-3B 8	0.10	0.61	5.77	0.24	0.00	0.24	0.083	3.2644	2.0000	0.0106	0.015	1.36	8.00	26.04	N/A	0.11	0.24	0.00	
3-5	206+36.00	26.00	DI-2A	0.09	0.82	5.77	0.30	0.00	0.30	0.083	16703	2.0000	0.0068	0.015	1.07	8.00	23.22	N/A	0.06	N/A	0.00	
3-4	206+86.00	26.00	DI-3B 16	1.01	0.56	5.77	2.27	0.00	2.27	0.029	0.0761	2.0000	0.1481	0.015	4.81	8.00	41.02	N/A	0.42	2.27	0.00	
3-6	206+86.00	26.00	DI-3B 8	0.19	0.86	5.77	0.65	0.00	0.65	0.083	3.2644	2.0000	0.0198	0.015	1.98	8.00	39.54	N/A	0.16	0.65	0.00	
MH-1	207+35.00	26.00	MH-12	n/a	n/a	n/a	150	0.00	150	0.021	4.8266	n/a	0.0398	0.015	3.98	8.00	N/A	N/A	0.21	150	0.00	
3-7	208+00.00	26.00	DI-3B 8	0.40	0.86	5.77	1.34	0.00	1.34	0.082	6.8990	2.0000	0.0201	0.015	3.01	8.00	79.88	N/A	0.16	1.34	0.00	

Remarks:  
 HEC-12 is used for spread and bypass computations  
 All other computations done using GEOPAK Drainage

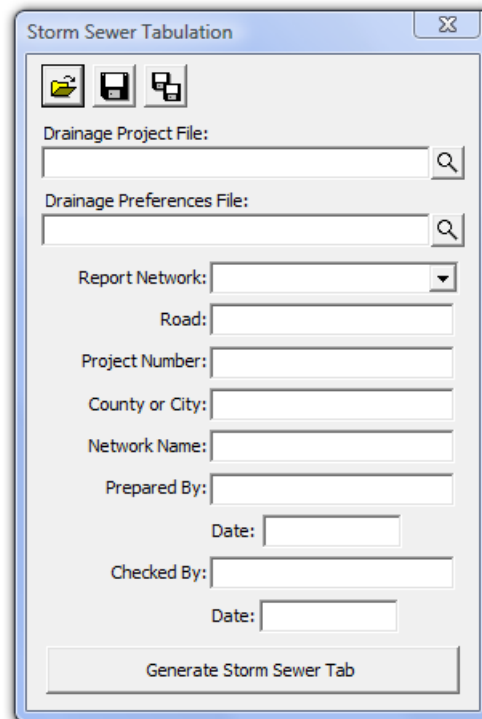
## 9.4.2 VDOT Storm Sewer Tabulation

The Storm Sewer Tabulation application will read a **GEOPAK Drainage file**, and populate the Storm Sewer table in **Excel** format. When the Storm Sewer Table is completed, the LD-229 report will also be completed.

Prior to processing the Storm Sewer Tabulation application, the user must have two (2) files created. First, the **GEOPAK Drainage (.gdf) file** must be created with at least one (1) drainage network completed and saved. If multiple networks are created in the drainage file, the desired network for the table can be selected in the **Storm Sewer Tabulation dialog**.

The second file is the ASCII form of the **GEOPAK Drainage Preferences file** used for the **GEOPAK Drainage network**. Once the preferences have been set, in GEOPAK Drainage the user goes to **Project > Export > Preferences** to ASCII to create the drainage preferences (.drp) file.

In addition to the **GEOPAK Drainage file (.gdf)** and the **GEOPAK Drainage Preferences file (.drp)** the user needs to select the appropriate drainage network, and can provide the road name, project number, county, the name of the network to show on the tabulation, name of the person creating the drainage network and the date it was created, and the name of the person checking the project and the date it was checked.



The image shows a screenshot of the "Storm Sewer Tabulation" dialog box. The dialog has a title bar with the text "Storm Sewer Tabulation" and a close button. Below the title bar are three icons: a folder, a floppy disk, and a document. The main area of the dialog contains several input fields and a dropdown menu. The fields are: "Drainage Project File:" with a search icon, "Drainage Preferences File:" with a search icon, "Report Network:" with a dropdown arrow, "Road:", "Project Number:", "County or City:", "Network Name:", "Prepared By:", "Date:" (with a date picker), "Checked By:", and "Date:" (with a date picker). At the bottom of the dialog is a button labeled "Generate Storm Sewer Tab".

The user has the opportunity to save the dialog settings into a settings file. When the **Storm Sewer Tabulation** application is opened, it will search the current directory for the settings file. If a settings file is found, the dialog will be populated with the

information from the first settings file it finds. If the user desires another set of settings to be used, they can use the **Open Settings File** on the dialog to search for another settings file. Also available on the dialog are a **Save Settings** and **Save Settings to Another File** option. The user will also be prompted when closing the dialog to save the settings file.

When ready to create the tabulation report, the user presses the **Generate Storm Sewer Tab button**. This will copy the seed report, and populate the table with the current drainage network information. Once the table is complete, the user is prompted that the process is complete, and allows the user to open the created file. The **Storm Sewer Tabulation Report** is found on the first worksheet. The **LD-229** report can be found on the second worksheet tab at the bottom of the Excel window.

VDOT STORM SEWER TABULATION REPORT

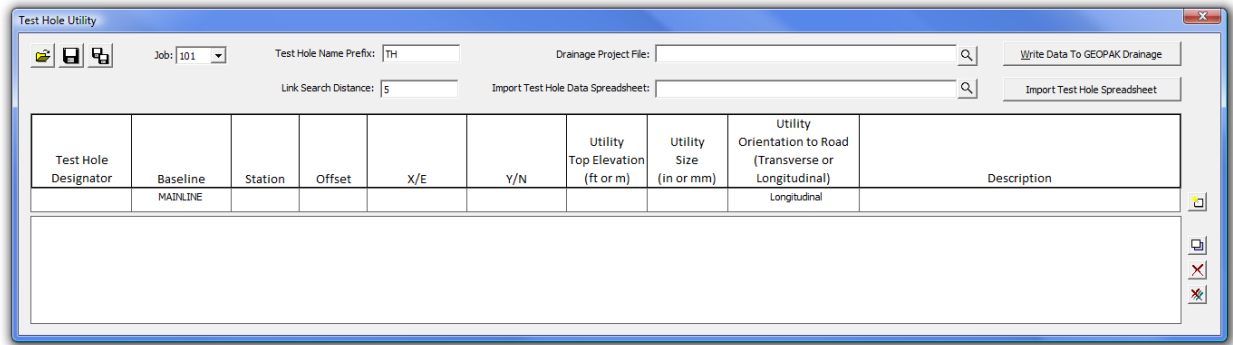
LOCATION OF UPPER END		STRUCTURE NO.	VDOT STANDARD (UPPER)	TYPE OF STRUCTURE (UPPER)	DRAINAGE AREA (ac. or ha.)			CUMULATIVE TIME OF CONCENTRATION (min)	INTENSITY (in/hr OR mm/hr)	TOTAL ACCUMULATED (C/A)	TOTAL RUNOFF Q (cfs OR cms)	INLET THROAT OR MANHOLE TOP ELEVATION (ft or m)	HGL CLEARANCE (ft or m)	HYDRAULIC GRADE LINE ELEVATION			PIPE LENGTH (ft or m)	PIPE SIZE (in or mm)	NUMBER OF BARRELS	FRICTION SLOPE (%)	FLOW VELOCITY (fps or mps)	PIPE CAPACITY (cfs or cms)	TIME OF FLOW IN SECTION (min)	NOTES AND REMARKS	
ALIGNMENT NAME	STATION				OFFSET DISTANCE (ft)	SIDE	BASE							COMPOSITE	SUB-TOTAL (C/A)	UPPER END (ft or m)									LOWER END (ft or m)
STATION	OFFSET DISTANCE (ft)	SIDE	VDOT STANDARD (UPPER)	TYPE OF STRUCTURE (UPPER)	C VALUE	AREA	SUB-TOTAL (C/A)	CUMULATIVE TIME OF CONCENTRATION (min)	INTENSITY (in/hr OR mm/hr)	TOTAL ACCUMULATED (C/A)	TOTAL RUNOFF Q (cfs OR cms)	INLET THROAT OR MANHOLE TOP ELEVATION (ft or m)	HGL CLEARANCE (ft or m)	UPPER END (ft or m)	LOWER END (ft or m)	FALL (ft or m)	PIPE LENGTH (ft or m)	PIPE SIZE (in or mm)	NUMBER OF BARRELS	FRICTION SLOPE (%)	FLOW VELOCITY (fps or mps)	PIPE CAPACITY (cfs or cms)	TIME OF FLOW IN SECTION (min)	NOTES / REMARKS	
208+00.00	26.00	Rt	MH-1	DI-3B 8	Curb	0.500	0.396	0.198	10.00	5.77	0.336	1.94	2026.81	3.41	2023.40	2019.08	4.32	62.98	15	1	5.991%	8.74	17.02	0.12	
207+35.00	26.00	Rt	MH-12	Junction		0.849	0.396	0.336	10.00	5.77	0.336	1.94	2023.03	3.55	2023.81	2020.03	3.78	43.87	15	1	4.599%	7.96	14.89	0.09	
206+86.00	26.00	Rt	3-5	DI-3B 8	Curb	0.500	0.587	0.293	10.00	5.77	0.500	2.88	2021.01	3.71	2017.81	2016.78	1.03	49.40	15	1	2.092%	6.71	10.05	0.12	
205+86.00	26.00	Rt	3-5	DI-3B 16	Curb	0.500	1.009	0.505	10.00	5.77	0.568	3.28	2019.34	3.14	2016.20	2015.70	0.50	49.40	15	1	0.492%	4.02	4.91	0.20	
206+36.00	26.00	Rt	3-5	DI-3C 6	Curb	0.500	1.688	0.843	10.00	5.77	1.143	6.59	2019.78	4.08	2015.70	2015.32	0.38	53.32	18	1	0.500%	4.75	7.99	0.19	
206+86.00	-26.00	Lt	3-2	DI-3B 8	Curb	0.500	0.100	0.050	10.00	5.77	0.061	0.35	2021.01	3.62	2017.39	2015.69	1.70	49.40	15	1	2.492%	3.87	10.98	0.21	
205+86.00	-26.00	Lt	3-1	DI-3B 10	Curb	0.500	0.210	0.105	10.00	5.77	0.169	0.98	2019.99	3.62	2016.78	2015.88	0.48	49.40	15	1	0.492%	2.94	4.91	0.28	
206+36.00	-26.00	Lt	3-2	DI-3C 6	Curb	0.500	2.088	1.043	10.00	5.77	1.447	8.35	2019.78	4.51	2015.27	2013.63	1.63	12.66	21	1	8.524%	14.58	49.78	0.01	

Remarks: Computations done using Geopak Drainage

LD-229 STORM SEWER DESIGN COMPUTATIONS															PROJECT: 17682		Designed by: Heath Oeltjen	
STORM FREQUENCY 10															LOCATION: Mainline		Checked by: Alex Mabrich	
															COUNTY: Wabasha		UNITS: ENGLISH	
FROM POINT REFERENCE	TO POINT REFERENCE	DRAIN. AREA "A" Acre	RUNOFF COEFF. "C"	CA INCRE-MENT	ACCUM-ULATED	INLET TIME Minutes	RAIN FALL In/Hr	RUNOFF Q CFS	INVERT UPPER END	ELEVATIONS LOWER END	LENGTH of Pipe Ft.	SLOPE Ft./Ft.	SIZE (Dia. Or Span/Rise) In.	CAPACITY CFS	VELOCITY Ft/Sec	FLOW TIME Minutes	REMARKS	
3-7	MH-1	0.793	0.674	0.534	0.336	10.00	5.77	1.94	2022.56	2018.78	62.98	0.06	15.00	17.02	8.74	0.120		
MH-1	3-6	0.000		0.000	0.336	10.00	5.77	1.94	2018.78	2016.76	43.87	0.05	15.00	14.89	7.96	0.092		
3-6	3-5	0.777	0.588	0.457	0.500	10.00	5.77	2.88	2016.56	2015.53	49.40	0.02	15.00	10.05	6.71	0.123		
3-4	3-5	2.019	0.532	1.073	0.568	10.00	5.77	3.28	2015.09	2014.85	49.40	0.01	15.00	4.91	4.02	0.205		
3-5	3-2	1.776	0.516	0.918	1.143	10.00	5.77	6.59	2014.60	2014.33	53.32	0.01	18.00	7.99	4.75	0.187		
3-3	3-2	0.199	0.554	0.110	0.061	10.00	5.77	0.35	2016.76	2015.53	49.40	0.02	15.00	10.98	3.87	0.213		
3-1	3-2	0.420	0.653	0.274	0.169	10.00	5.77	0.98	2015.74	2015.49	49.40	0.01	15.00	4.91	2.94	0.280		
3-2	OUTLET	2.176	0.513	1.117	1.447	10.00	5.77	8.35	2014.08	2013.00	12.66	0.09	21.00	49.78	14.58	0.014		

### 9.4.3 VDOT Test Hole Utility

The **Test Hole Utility application** imports user provided utility data to GEOPAK Drainage to be used for plotting on the drainage profiles. The data can be either manually entered or imported from the **VDOT Utility Test Hole Information spreadsheet**.



The **Test Hole Utility application** requires the job number, and a **GEOPAK Drainage file** to be selected. The user can provide a **Test Hole Name Prefix** and a **Link Search Distance**. The **Test Hole Name Prefix** is appended to the beginning of the test hole designator to use for the name of the drainage nodes and links. The **Link Search Distance** determines how far from the test hole the application will search for an intersecting link.

Once the job number, drainage file, name prefix, and search distance are selected, enter the utility data into the appropriate fields for each test hole.

Test Hole Designator – Enter Name/Number of the test hole.

Baseline – Select the chain name along which the station/offset are measured.

Station – (Optional; see below) Station of test hole along baseline. (Entered by the user)

Offset – (Optional; see below) Offset of test hole measured from baseline. (Entered by the user)

X/E – (Optional; see below) X (Easting) coordinate of test hole. (Entered by the user)

Y/N – (Optional; see below) Y (Northing) coordinate of test hole. (Entered by the user)


Top Elevation – Elevation of the top of the utility. (Entered by the user)


Utility Size – Diameter (in inches or millimeters) of the utility. (Entered by the user)

Utility Orientation to the Road – Select if the utility runs longitudinal (along the roadway) or transverse (perpendicular) to the roadway.

Description – Text to describe the utility. (Entered by the user)

Note: Either the station and offset or the X and Y coordinates must be entered. If both station/offset and coordinates are entered, the coordinates will be used.

Once all of the pertinent data is entered, press the **Add button**  to the right of the data fields to add it to the list. Additional utilities can be added to the list as needed.

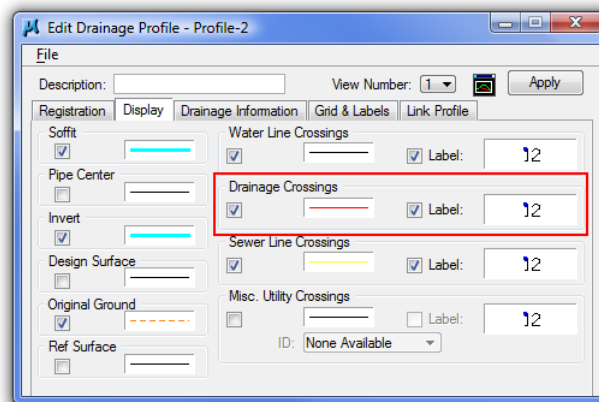
To modify an entry in the list, select the entry in the list. This displays the entry in the entry fields. Make the desired changes. Press the **Modify button**  to make the changes in the list.

The **Delete button**  or the **Delete All button**  will delete the selected entry or all of the entries from the list respectively.

Data can be imported from the **VDOT Utility Test Hole Information spreadsheet**. This data will be imported directly to the utility list.

Once all data has been entered, press the **Write Data to GEOPAK Drainage button** to import the data to GEOPAK Drainage. For each test hole, the application compares the test hole location to each link in the drainage project. If the distance between the test hole and the link is less than or equal to the search distance, then a drainage link is added to the drainage library. The link is created to be perpendicular to the drainage link at the test hole location. This link can then be used to plot the utility location and size on the drainage link profile. The utility link is create with the name of the test hole name prefix and the test hole name. (i.e. For test hole 1A and prefix TH, the link name will be TH1A). The nodes used for the utility link are given a name using the test hole name prefix, the test hole name, and the location of the node, at the test hole (TH) or at the link (LNK). (i.e. For test hole 1A, prefix TH, and located at the link end, the node name will be TH1ALNK.) If more than one link is found within the search distance for the link, the link and node names will be numerically incremented. (i.e. TH1A-1, TH1A-2, etc. and TH1ALNK-1, TH1ALNK-2, etc.)

To plot the utility on the drainage profile, in the **GEOPAK Drainage > Edit Drainage Profile dialog**, select the **Display tab**, and toggle on **Drainage Crossings**. When apply is selected, the profile will be drawn/updated with the utility crossing links.





The user has the opportunity to save the dialog settings into a settings file. When the **Test Hole Utility application** is opened, it will search the current directory for the settings file. If a settings file is found, the dialog will be populated with the information from the first settings file it finds. If another settings file is desired, the **Open Settings File icon** on the dialog is used to search for another settings file. Also available on the dialog are a **Save Settings** and **Save Settings to Another File** option.

#### 9.4.4 Drainage Profile Labeler

This application labels multiple drainage objects in a profile view from both the graphics and objects obtained from a **GEOPAK Drainage project**.

In order for this application to run GEOPAK must be activated. If GEOPAK is not activated the user will be notified and the application will not start.

When started, this application will present the following dialog:

The dialog box is titled "Drainage Profile Labeler". It features a blue title bar with a close button (X) on the right. The main area is light gray and contains the following elements:

- Job:** A dropdown menu showing "101".
- Reference Chain:** A dropdown menu showing "EBL460".
- Drainage Project:** A text input field containing "C:\VBA\VirginiaDOT\DrainageApps\DrainageProfileLabeler\FromHeath\h17682.gdf" with a search icon on the right.
- Test Hole File:** A text input field containing "C:\VBA\VirginiaDOT\DrainageApps\DrainageProfileLabeler\FromHeath\h17682Utilit;" with a search icon on the right.
- Identify Profile Cell:** A button.
- Profile Name:** A text input field.
- Profile Objects to Label:** A section containing a table with five columns: "Nodes", "Links", "Crossing Links", "Test Hole Utilities", and "Misc. Utilities". The table is currently empty.
- Move Label:** A button at the bottom left.
- Label Profile Objects:** A button at the bottom right.

The **Job Combo box** will contain all **GEOPAK COGO job files (.gpk)** in the active directory (either that of the current design file or that set in **GEOPAK Preferences**) and the first one will be selected. The **Reference Chain Combo Box** will automatically be

filled in from all chains in the selected Job and the first one will be selected. The **Drainage Project** and **Test Hole File** will be filled in automatically from a resource file created the last time the application was used.

The user will first select the **COGO job** that contains the chain they wish to reference stationing from, and then select the reference chain itself. These may already be selected by default but the user should check to make sure.

Next the user will select the **GEOPAK Drainage file (.gdf)** the profile to be labeled was generated from. This is done through a standard Windows file selector presented when the magnifying glass icon is clicked next to the **Drainage Project field**.

If any test holes were dug for this project and the **Test Hole Utility VBA** used to store the test holes the user should identify the **Test Hole Data file (.thd)**. This is done through a standard Windows file selector presented when the magnifying glass icon is clicked next to the **Test Hole File field**.

The next step is to identify the profile cell in which labels will be placed. This is done by clicking the **Identify Profile Cell button**, issuing a data point anywhere on the profile cell object in graphics (grid line, border line, axis text, etc.), and issuing another data point to accept the highlighted graphics as the profile cell to evaluate.

Once the profile cell is identified the application will extract information from that cell and the elements contained within its boundaries and enter it into the dialog. The result will look similar to the following:

**Drainage Profile Labeler**

Job: 101      Reference Chain: EBL460

Drainage Project: C:\VBA\VirginiaDOT\DrainageApps\DrainageProfileLabeler\FromHeath\h17682.gdf

Test Hole File: C:\VBA\VirginiaDOT\DrainageApps\DrainageProfileLabeler\FromHeath\h17682Utilit

Identify Profile Cell      Profile Name: Profile-1

Profile Objects to Label				
Nodes	Links	Crossing Links	Test Hole Utilities	Misc. Utilities
<input checked="" type="checkbox"/> 3-4	<input checked="" type="checkbox"/> pipe-3	<input checked="" type="checkbox"/> pipe-5	<input checked="" type="checkbox"/> TH2	<input checked="" type="checkbox"/> MU-1
<input checked="" type="checkbox"/> 3-5	<input checked="" type="checkbox"/> pipe-6	<input checked="" type="checkbox"/> pipe-1	<input checked="" type="checkbox"/> TH3	<input checked="" type="checkbox"/> MU-2
<input checked="" type="checkbox"/> 3-2	<input checked="" type="checkbox"/> pipe-7	<input checked="" type="checkbox"/> pipe-2	<input checked="" type="checkbox"/> TH2-1	<input checked="" type="checkbox"/> MU-3
<input checked="" type="checkbox"/> OUTLET				<input checked="" type="checkbox"/> MU-4

Move Label      Label Profile Objects

Any of the **Profile Objects to Label** can be unchecked if the user does not wish to label them.

Once the user has reviewed those objects found within the profile to be labeled they will click the **Label Profile Objects button** which will commence the labeling process.

The **Move Label button** allows the user to click on a label placed by this tool and move its location so as not to interfere with another label or **Drainage object**. Depending on the label identified the user will either simply identify the new label location, or identify the new location as well as the leader line placement.

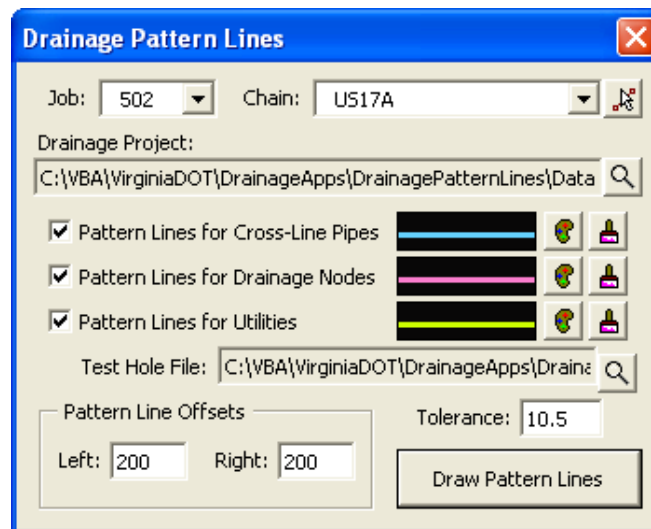
When the dialog is closed the GPK and THD file names and locations will be saved to a resource file that will be read the next time the application is started.

## 9.4.5 Drainage Pattern Lines

This application draws pattern lines (lines used to cut GEOPAK cross-sections) in plan view at locations obtained from a **GEOPAK Drainage project**.

In order for this application to run GEOPAK must be activated. If GEOPAK is not activated the user will be notified and the application will not start.

When started, this application will present the following dialog:



The **Job Combo Box** will contain all **GEOPAK COGO** job files (.gpk) in the active directory (either that of the current design file or that set in **GEOPAK Preferences**) and the first one will be selected. The **Chain Combo Box** will automatically be filled in from all chains in the Job selected. The remainder of the dialog will be filled in automatically from a resource file created the last time the application was used.

The user will select the **GEOPAK Drainage file (.gdf)** they wish to obtain pattern lines from. This is done through a standard Windows file selector presented when the magnifying glass icon is clicked.


Three pattern line options will determine the source(s) for pattern lines:

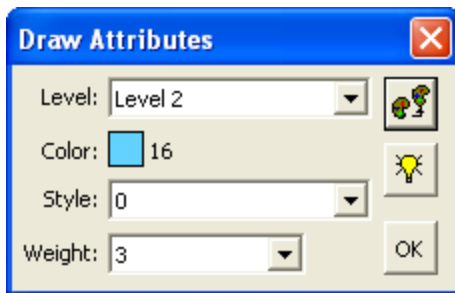
1. The first is used to generate pattern lines for all drainage pipes (links) that cross the chain specified. The pattern line will be created at the same skew as the pipe.
2. The second is used to generate pattern lines for all drainage inlets (nodes) that lay within the chain limits.
3. The third is used to generate pattern lines at each utility location defined by test holes created with the **Test Hole utility**. If this option is turned on the **Test Hole File** must be selected using the magnifying glass icon next to the field. As before, a standard Windows file selector will be presented for locating the desired file.


Each of these options allows the user to define the symbology to be used in creating the pattern line for that type:





The example graphic gives an approximation of the resulting pattern line look, and hovering over this image results in a pop-up help detailing the symbology currently set for this type of pattern line.

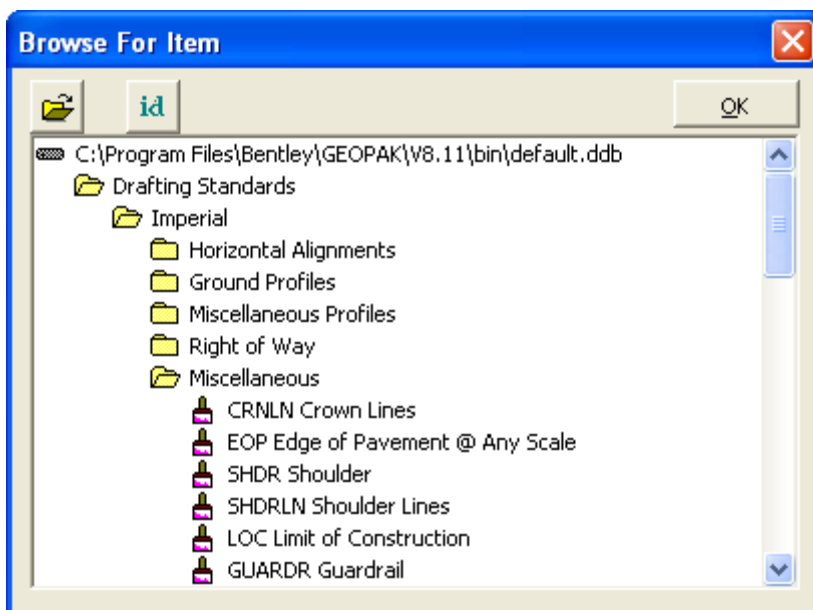
 The **symbology button** allows the user to select symbology from the standard MicroStation options for level, color, line style, and line weight through the use of an auxiliary dialog:





 This provides the ability to set the symbology from an element in the active design model. Simply click this button and select and accept an element.

 This provides the ability to highlight all elements in the active design model that match the set symbology in order to verify the settings are correct.

 The **D&C button** allows the user to select symbology from the **GEOPAK Design & Computation Manager** items through the use of another auxiliary dialog:



 This provides the ability to open a **D&C database (.ddb)** other than the default one.

 This provides the ability to select the D&C item by selecting a MicroStation element that was drawn with a given item.

Back on the main dialog there are two fields for defining the pattern line offsets. These values will define how far left and right of the alignment the pattern line will extend.

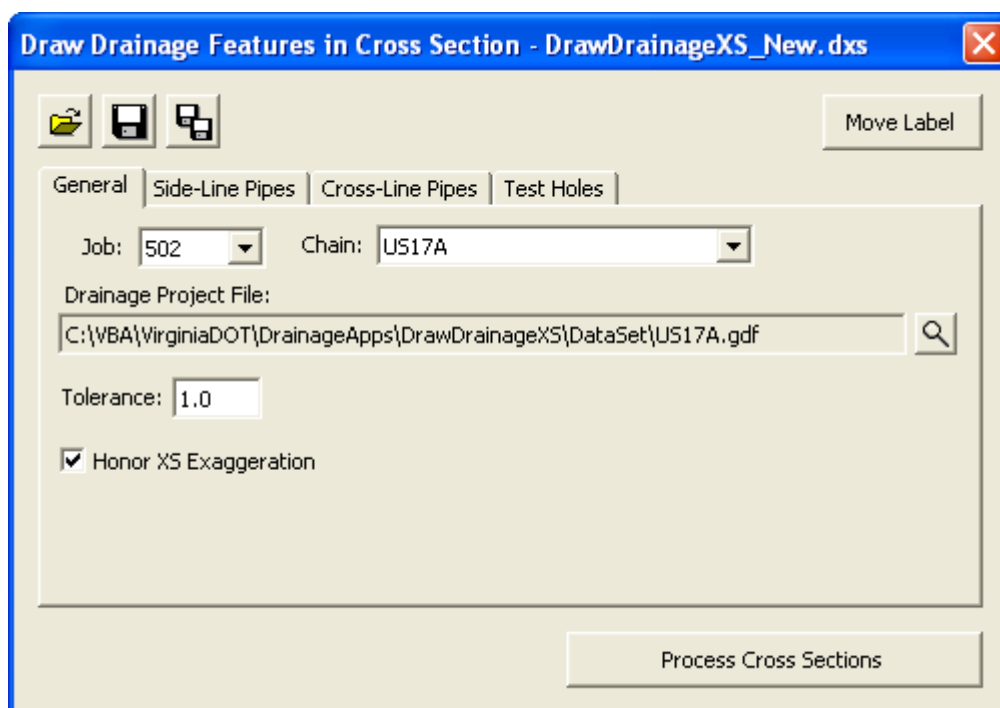
Finally, the **Tolerance field** defines the distance an object must be from another pattern line before it will be used to generate another pattern line. This helps eliminate pattern lines that are so close to each other they result in essentially the same cross-section.

### 9.4.6 Draw Drainage in Cross-Section

This application draws GEOPAK Drainage elements in cross-section at locations obtained from a **GEOPAK Drainage project**.

In order for this application to run GEOPAK must be activated. If GEOPAK is not activated the user will be notified and the application will not start.

When started, this application will present the following dialog:



The **Job Combo Box** will contain all **GEOPAK COGO job files (.gpk)** in the active directory (either that of the current design file or that set in **GEOPAK Preferences**) and the first one will be selected. The **Chain Combo Box** will automatically be filled in from all chains in the Job selected. The remainder of the dialog will be filled in automatically from a resource file created the last time the application was used. In addition, the user can open a previously saved resource file other than the most recent.

The user will select the **GEOPAK Drainage file (.gdf)** they wish to obtain drainage objects from. This is done through a standard Windows file selector presented when the magnifying glass icon is clicked.

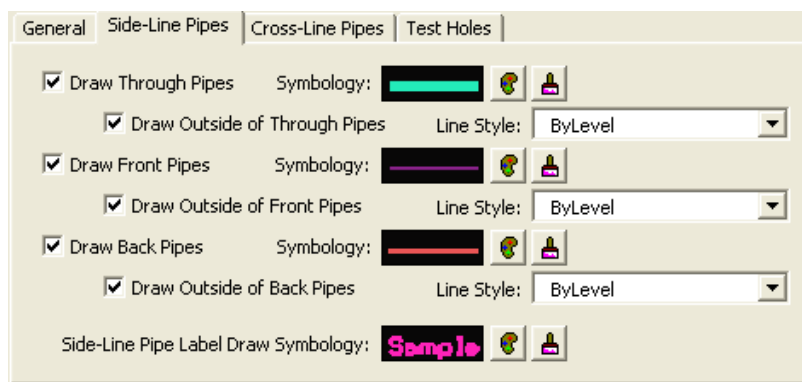
The **Tolerance field** indicates the distance within which a drainage object will be considered to fall on a cross-section. If a drainage object is farther away than this from the cross-section location (pattern line) it will not be drawn on the cross-section. Keep in mind that a cross-section must be cut at the pattern line location in order for drainage

objects to be drawn on that cross-section. A drainage objects proximity to a pattern line in plan-view does not necessarily mean it will be drawn in cross-section unless a cross-section exists for that pattern line.

The **Honor XS Exaggeration option** will, when turned on, distort the items drawn according to the exaggeration at which the cross-section was originally drawn. This most noticeably results in ellipses drawn rather than circles for round pipes.

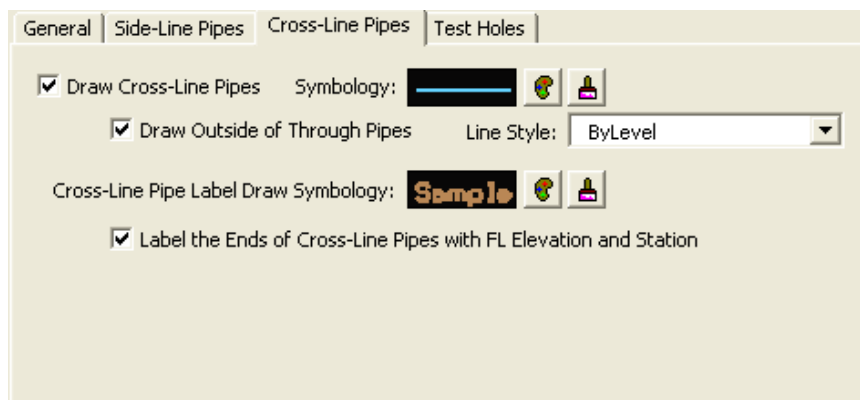
Three types of drainage objects can be drawn in cross-section and are turned on or off through three drawing tabs in the dialog which also allow the user to establish settings for the drawing of those objects:

1. The first drawing tab is used to generate **Side-Line Pipes** (longitudinal pipes) for all Drainage pipes (links) that cross the cross-section pattern line.



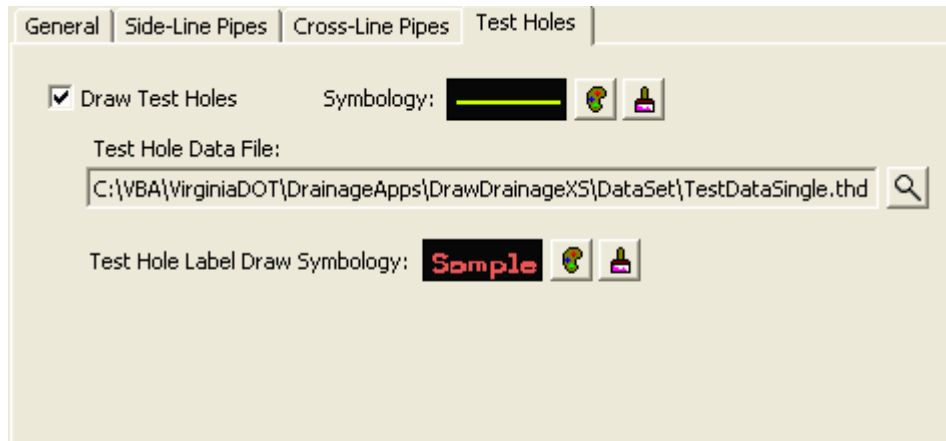
Several options allow the user to draw pipes that intersect the cross-section (Through Pipes), begin at the cross-section (Front Pipes), or end at the cross-section (Back Pipes) with options to draw the outside of the pipe with a different line style.

2. The second drawing tab is used to generate Cross-Line Pipes for all Drainage pipes (links) that cross the alignment and have both begin and end node that fall within the tolerance of the cross-section pattern line (typically from cross-sections created from pattern lines generated using the **Drainage Pattern Lines utility**).




Again, several check boxes allow the user to set options for this type of item including the outside of the pipe and labeling.


3. The third drawing tab is used to generate test holes for all Drainage pipes (links) added with the **Test Hole utility**.

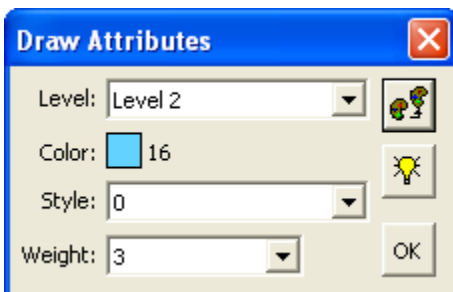


The **Test Hole File** must be selected by clicking on the **magnifying glass icon** next to the field which will present a standard Windows file selector for locating the desired file.


In each of the drawing tabs described above there are multiple symbology settings that can be established. This is done through a standard set of tools described as follows:


 The example graphic gives an approximation of the resulting look of the drawn object, and hovering over this image results in a pop-up help detailing the symbology currently set for this item.


 The **symbology button** allows the user to select symbology from the standard MicroStation options for level, color, line style, and line weight through the use of an auxiliary dialog:



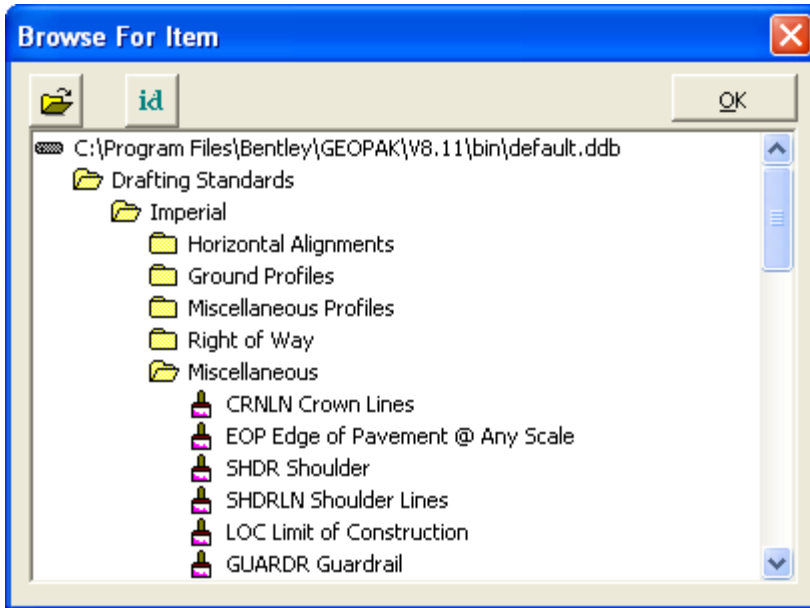
settings are correct.


 This provides the ability to set the symbology from an element in the active design model. Simply click this button and select and accept an element.


 This provides the ability to highlight all elements in the active design model that match the set symbology in order to verify the

 The **D&C button** allows the user to select symbology from the **GEOPAK Design & Computation Manager** items through the use of another auxiliary dialog:








 This provides the ability to open a **D&C database (.ddb)** other than the default one.

 This provides the ability to select the D&C item by selecting a MicroStation element that was drawn with a given item.

In order to save the user from having to input all of these settings again the next time they want to draw drainage objects in cross-section the application provides icons across the top of the dialog to save and retrieve these settings:

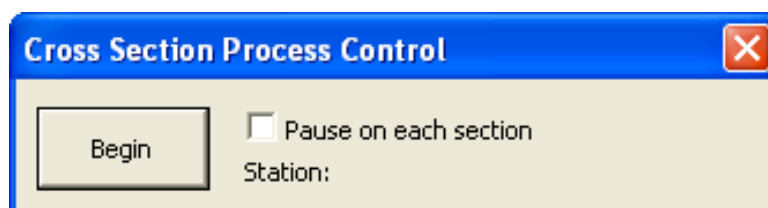
 Open a settings file previously saved. A dialog will open asking for the file name to open. The default folder will be the current design file folder.

 Save the current settings. If a settings file was opened during this session the same name will be used. Otherwise, a dialog will open asking for the file name to save.

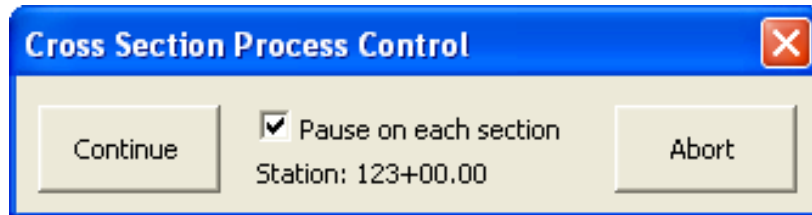
 Save the current settings to a different file name. A dialog will open asking for the file name to save.

When the application starts it will automatically open the most recent settings file found in the current design file folder. When the application is closed the user will be asked if they wish to save the settings if they haven't already done so. The file extension for **DrawDrainageXS settings files** will be .dxs.

Once all settings have been established and saved, the user will click the **“Process Cross Sections” button** to begin drawing drainage objects in the cross-sections. If the user isn't in a design file containing cross-sections for the indicated chain they will be notified and asked to open the appropriate cross-section file before they can continue. If cross-sections are found a process dialog will appear:



The user will have the option to pause as each cross-section is processed so they can review what has been drawn before continuing on to the next one. The **Begin button** will be clicked when the user is ready to start processing the cross-sections. If the **Pause option** is checked the first cross-section will be processed and centered in the view and the dialog will change as follows:

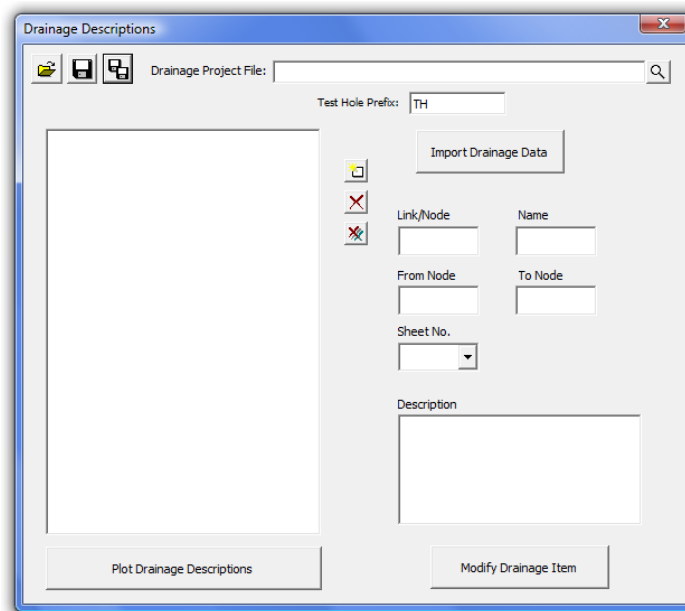


The user can continue to the next cross-section or abort processing and return to the main dialog. If the **Pause option** is not checked every cross-section will be processed in order and the user will be notified when it is complete.

**Move Label** One final tool at the top-right corner of the main dialog allows the user to move a label once it has been placed. This tool will prompt the user to select a label placed by this tool and enable them to change its location as well as the configuration of its leader lines.

### 9.4.7 VDOT Drainage Descriptions

The **Drainage Description application** will import the nodes and links from a **GEOPAK Drainage file**, and plots each item with a standard or user-defined description. The application allows the user to modify the standard descriptions for each drainage item, as well as arrange the drainage items into sheet categories to match the plan sheets.




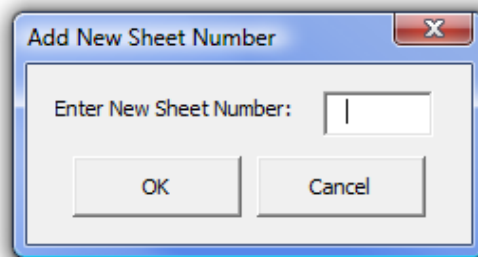
The user must first import the **Drainage Project File** by selecting the file and pressing the **Import Drainage Data button**. The drainage nodes and links will be placed in tree on the left side of the dialog. If any items are added to the drainage file, the file can be re-imported. Only the new items will be added to the drainage item list.



If there are test hole nodes or links present in the drainage project, they can be filtered out by specifying the **Test Hole Prefix** used to create the test hole data.

When the user selects a drainage item, the information for that item will be displayed in the fields to the right. The user can then key-in or select the sheet number. The selection option is only available after the user has created the sheet by either keying in the sheet number, or using the new sheet dialog (see below). The user can also adjust the description by editing or typing a new description in the **Description field**. Once the sheet and/or description changes have been made, the **Modify Drainage Item button** must be pressed to save the changes. Once the changes are made, the drainage item will be moved into the given sheet in the tree view.

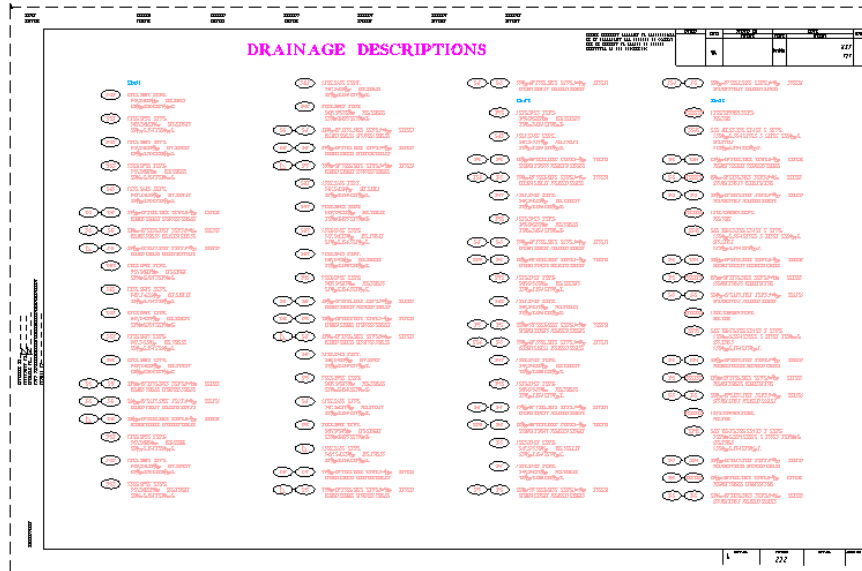
Drainage items can also be arranged into sheets using the tree view. Once the sheet has been created, drag the drainage items into the desired sheet. The order of the sheets or drainage items can also be changed by dragging the item to the desired location. The item being moved will be placed after the selected item.

In addition to keying-in or selecting a sheet number by editing the drainage items, new sheets can also be created by using the **Add New Sheet button** . The **Add New Sheet button** opens a dialog for the user to enter a new sheet number. This creates a new sheet in the tree, and allows drainage items to be placed in the sheet.



The **Delete button**  will delete the selected item. If the item is a sheet, the user is prompted to confirm the deletion of all elements in the sheet. The **Delete All button**  will delete all entries.

Once the drainage items and sheets are set, the descriptions can be plotted into the active **.dgn file** by pressing the **Plot Drainage Descriptions button**. This will delete any existing sheets in the **.dgn file**, and plot the new description sheets into the **.dgn file**.



The user has the opportunity to save the dialog settings into a settings file. When the **Drainage Descriptions application** is opened, it will search the current directory for the settings file. If a settings file is found, the dialog will be populated with the information from the latest settings file it finds. If the user desires another settings file to be used, they can use the **Open Settings File** on the dialog to search for another settings file. Also available on the dialog are a **Save Settings** and **Save Settings to Another File** option. The user will also be prompted when closing the dialog to save the settings file.

#### 9.4.7.1 Administrative

The **Drainage Descriptions Application** requires the use of the **DrainageDescriptions.dat** file. This file must reside in the same folder as the **DrainageDescriptions.mvba** file.

The **DrainageDescriptions.dat** file allows the CADD Administrators to define the following items:

Sheet Cell Library – cell library that contains the sheet border cell

Sheet Cell - name of the sheet border cell

Sheet Cell X Origin – X coordinate to place the first sheet

Sheet Cell Y Origin - Y coordinate to place the first sheet

Drainage Description Cell Library – cell library that contains the symbols for the node and link names

Drainage Description Cell – name of the cell to use for the node and link names

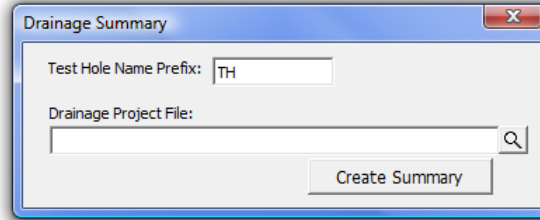
Drainage Description Sheet Title Plot Parameters – symbology for the sheet title.

Sheet Indicator Plot Parameters – symbology for the sheet names

Drainage Description Plot Parameters – symbology for the drainage item description

## 9.4.8 VDOT Drainage Summary

The **Drainage Summary application** reads a GEOPAK Drainage file, and populates the drainage summary spreadsheet in **Excel** format.



The user selects the **GEOPAK Drainage file**, and sets the **Test Hole Prefix**. The Test Hole Prefix allows any drainage nodes or links that are created as a part of the **Test Hole Utility application** to be excluded from the drainage summary.

Once the **GEOPAK Drainage file** is selected, and the test hole prefix is set, the user can press the **Create Summary button**. This will read the **GEOPAK Drainage file**, and import the data to the **Drainage Summary spreadsheet**.

Structure	Cover	Pipe			Concrete Pipe			EndSections			End Wall		Height of Drop Inlet	Inlets - Length, Type, and Manhole			Remarks	
		Elliptical/Arch			Elliptical/Arch			ES-1 or 2	ES-3		CY	CY		DI-2 SERIES	DI-3 SERIES	Manhole		
		15"	38" x 57"	85" x 116"	15"	18"	21"	42" x 27"	18"	28" x 20"				42" x 29"	EW-1: 36" Conc. Pipe	EW-2: 1.5:1 48" Conc. Pipe		FT
3-1		FT	FT	FT	FT	FT	FT	EA	EA	EA	CY	CY	4.25	EA	EA	EA		
3-2																		
3-1 to 3-2					48.78													
3-3									1									
3-3 to 3-2							50.00											
3-4													118.07					
3-5												79.57						
3-4 to 3-5		50.00																
MH-1																	1	
3-6													4.25		1			
MH-1 to 3-6				43.87														
3-6 to 3-5		50.70																
3-5 to 3-2					52.00													
OUTLET								1										
3-2 to OUTLET						16.00												
3-7													4.25		1			
3-7 to MH-1					62.98													
Summary		50.00	50.70	43.87	111.77	52.00	16.00	50.00	1	1	1	79.57	118.07	12.75	1	2	1	

### 9.4.8.1 Administrative

There are three (3) files needed for the **Drainage Summary** to work, DrainageSummary.dat, VDOT\_DropInletList.txt, and VDOT\_EndWallList.txt. Each of these files needs to be placed in the same folder as the **DrainageSummary.mvba** file.

The **DrainageSummary.dat** file sets the path and file to use for the spreadsheet seed file.

The **VDOT\_DropInletList.txt** file contains a list of pay item numbers for the drop inlets, the type of drop inlet, and the description for the pay item.

The **VDOT\_EndWallList.txt** file contains a list of pay item numbers for the end walls, the type of end walls, the description for the pay item, and the quantity of concrete in cubic yards for the end wall.

### 9.4.9 VDOT Drainage Input

The **Drainage Input application** will read accept user input, and export the user input to GEOPAK Drainage. The application also allows the **LD-229** and **LD-204** files to be imported into the application, and then exported to GEOPAK Drainage.

STATION	OFFSET DISTANCE (ft or m)	NODE ID		NODE TYPE	NAME OF STRUCTURE	DRAINAGE AREA (ac or ha)		SPREAD CROSS SECTION			SHAPE	MATERIAL	TYPE	SIZE	NODE ELEVATION	INVERT ELEVATIONS	
		UPPER	LOWER			AREA 1	AREA 2	AREA 3	CROSS SLOPE 1	CROSS SLOPE 2						CROSS SLOPE 3	UPPER END (ft or m)
MAINLINE						C VALUE	AREA	LONGITUDINAL SLOPE (%)	WIDTH (ft or m)	DEPTH (ft or m)	ROUGHNESS						
205+86	-26	3-1	3-2	Curb	DI-3B 10	0.5	0.21	0.076	2.0	8.33	0.15	Circular	Concrete	15 Inch Dia. Cr.	2019.343	2016.81	2016.563
205+86	-26	3-3	3-2	Curb	DI-3C 6	0.5	0.1	0.1	2.0	8.33	0.15	Circular	Concrete	15 Inch Dia. Cr.	2021.014	2017.344	2016.110
205+86	26	3-4	3-5	Curb	DI-3B 16	0.5	1.009	0.076	2.0	8.33	0.15	Circular	Concrete	15 Inch Dia. Cr.	2019.343	2015.423	2015.176
208+00	26	3-7	3-6	Curb	DI-3B 16	0.5	0.396	6.899	2.0	8.33	0.15	Circular	Concrete	15 Inch Dia. Cr.	2026.807	2023.137	2017.944
206+86	26	3-6	3-5	Curb	DI-3B 8	0.5	0.19	3.264	2.0	8.33	0.15	Circular	Concrete	15 Inch Dia. Cr.	2021.014	2017.144	2016.110
206+36	26	3-5	3-2	Curb	DI-3C 6	0.5	0.09	0.1	2.0	8.33	0.15	Circular	Concrete	15 Inch Dia. Cr.	2019.780	2014.976	2014.710
206+36	-26	3-2	Out	Curb	DI-3C 6	0.5	0.09	0.1	2.0	8.33	0.15	Circular	Concrete	18 Inch Dia. Cr.	2019.780	2014.266	2013.00
206+36	-76	Out	Out	Outlet	EW1018									2015.00			

The **Drainage Input application** requires the job number, and a **GEOPAK Drainage file** to be selected. **Drainage Preferences** are set by pressing the Preferences button. This allows the **Time of Concentration**, the **Beginning Pipe Name**, and the link **minimum and maximum rise, slope and velocity** to be set.

**Drainage Input Preferences**

Time of Concentration:

Beginning Pipe Name:

Link Design Constraints

	Minimum	Maximum
Rise:	<input type="text" value="1.5"/>	<input type="text" value="6.0"/>
Slope:	<input type="text" value="0.4"/>	<input type="text" value="10"/>
Velocity:	<input type="text" value="2"/>	<input type="text" value="6"/>

Once the job number, drainage file, and preferences have been selected, enter the drainage data into the appropriate fields for each node/link.

Chain Name - Selected from the provided list.

Station – (Entered by the user)

Offset – (Entered by the user)

Upper Node ID (required) – Upper node id is required for all nodes. (Entered by the user)

Lower Node ID (required) – Lower node id is required for non-outlet type nodes. (Entered by the user)

Node Type (required) – Selected from the list Curb, Grate, Slotted Drain, Curb and Grate, Junction, Outlet, Other, Bottom, or Headwall. The node type is required by all nodes.

Name of Structure (required) – Selected from the list based on the Node Type provided. The name of structure is required by all nodes.

Drainage Area C Values (required) – The C value is only required by non-outlet type nodes. (Entered by the user for each sub area)

Drainage Area Areas (required) – The drainage area is only required by non-outlet type nodes. (Entered by the user for each sub area)

Longitudinal Slope – (Entered by the user)

Spread Cross-Section Cross Slope – (Entered by the user for each section)

Spread Cross-Section Width – (Entered by the user for each section)

Spread Roughness – (Mannings N value entered by the user for each section)

Pipe Shape – Selected from the list Arch, Box, Circular, Ellipse, or Pipe – Arch.


Pipe Material – Selected from the list based on the pipe shape, Aluminum, Concrete, Plastic, or Steel.

Pipe Type – Selected from the list based on the pipe shape.


Pipe Size (required) – Selected from the list based on the pipe shape, pipe material, and pipe type. The pipe size is only required by non-outlet type nodes.

Node Elevation (required) –The node elevation is required by all node types. (Entered by the user)

Invert Elevations Upper/Lower (required) –The upper/lower invert elevations are only required by non-outlet type nodes. (Entered by the user)

Once all of the pertinent data is entered, press the **Add button**  to the right of the data fields to add it to the list. Additional nodes/links can be added to the list as needed. Each lower node must have a matching upper node for the project to be imported.

The project outlet nodes can be stored by entering just the upper node information. No pipe or drainage area information will be used for the outlet nodes. The outlet node elevation is required.

To modify an entry in the list, select the entry in the list. This displays the entry in the entry fields. Make the desired changes. Press the **Modify button**  to make the changes in the list.

The **Delete button**  or the **Delete All button**  will delete the selected entry or all of the entries from the list respectively.

To import the data from the **LD-229** and **LD-204** spreadsheets, toggle on the **Use Ensoft Data toggle**. This will activate the required fields. Select the **LD-229** file and the **LD-204** file respectively. Select the chain name. Press the **Import Ensoft Data button** to import the data to the list. The list entries can then be modified to complete any missing data.

Note: GEOPAK Drainage requires some data that is currently not available from the **Ensoft spreadsheets**. This data will need to be manually entered.

Once all data has been entered, press the **Write Data to GEOPAK Drainage button** to import the data to GEOPAK Drainage. The **drainage project file (.gdf)** must be opened in GEOPAK Drainage prior to pressing the Write Data to GEOPAK Drainage button.

The user has the opportunity to save the dialog settings into a settings file. When the **Drainage Input application** is opened, it will search the current directory for the settings file. If a settings file is found, the dialog will be populated with the information from the first settings file it finds. If another settings file is desired, the **Open Settings File icon** on the dialog is used to search for another settings file. Also available on the dialog are a **Save Settings** and **Save Settings to Another File** option.

#### 9.4.9.1 Administrative

The Drainage Input uses several resource files found. These files should be placed in the same location as the **DrainageInput.mvba file**.

DrainageInputDefault.rsc – Sets the default preferences for the **Time of Concentration** and the **Beginning Pipe name**.

VDOT\_NodeList.txt – Contains the list of structure names for each node type.

VDOT\_LinkList.txt – Contains the list of pipe material, type and size for each pipe shape

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## 9.5 Supplemental Instructions on Project Preferences & VBA's

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### 9.5.1 Project Preferences

#### 9.5.1.1 Purpose

The purpose of this section is to inform the user of certain **Project Preferences** which are project specific, many of which cannot be preset.

#### 9.5.1.2 Project Components

- The locations of the **Drainage Library File (DLB)**, the **Drainage Cell Library (CEL)** and the **Design & Computation Manager Database (DDB)** will be preset to point to the appropriate servers.
- **TIN files** for the **Original Ground** and the **Design Surface** are project specific, and will need to be manually entered for each individual project.

#### 9.5.1.3 Rainfall Parameters

- The user must manually select the County or City, where the project is located. This represents the Rational Method rainfall source.

#### 9.5.1.4 Intensity Option

- The **Absolute Intensity** (for Inlet Computations Only) is preset to **4 in/hr.** however, the user should recognize that there are situations where roadway classification and design speed will dictate that an “actual” calculated rainfall intensity be used in lieu of the **Absolute Intensity** setting of **4 in/hr.** (Refer to Table 9-1 in Chapter 9 of the [VDOT Drainage Manual](#), for further guidance.) In these situations, the switch for Inlet Computation Only should be **Toggle OFF**; and the software will automatically compute the rainfall intensity for the inlet computations, based on the actual **Time of Concentration (Tc)**.

#### 9.5.1.5 Link Options

- The Training Manual incorrectly shows the selection for this option as **Design for Maximum Capacity**; however, this has been preset in the **Seed GDF file** to **Design for Full Capacity**.

#### 9.5.1.6 Plan Symbology

- **Plan-View Parameters:** The **Plan Symbology** dialog establishes the element symbology for drawing the drainage features during the “design process”. Since, these are “design process” symbology, they do not need to match **VDOT CADD standards**. When the design is completed, **GEOPAK Drainage** will automatically update all the CADD elements to be consistent with VDOT standards using the **Design & Computation Manager**

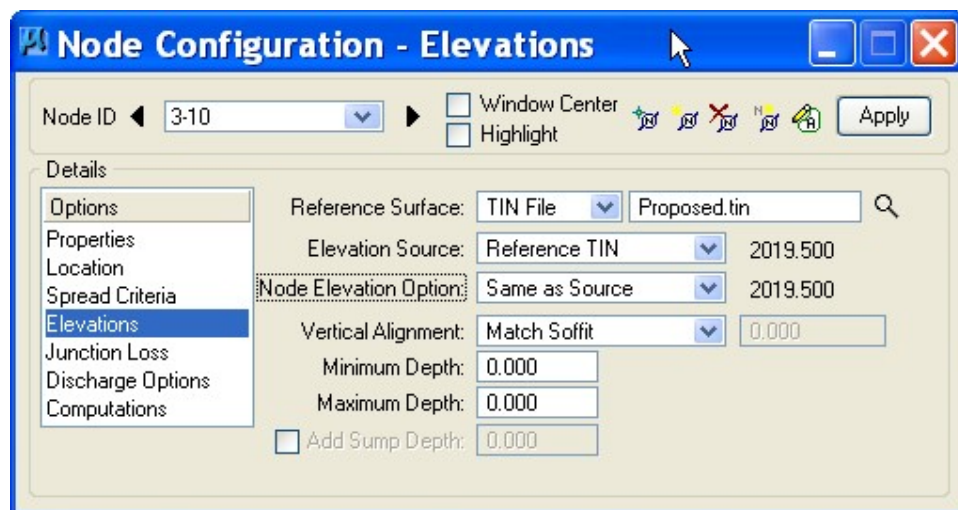
However, it is important for the user to remember that the text labeling for the “design” features is not automatically deleted or hidden, and will need to be placed on a level that can be turned-off prior to plotting any plan sheets that reference this **hydraulic design file**.

- **Node Cell Symbology:** It is recommended that this box remain unchecked, and that the standard VDOT CADD symbologies be utilized to depict the nodes (inlets, junctions, endwall, etc.) during the “design process”.

## 9.5.2 Additional Topics

### 9.5.2.1 Node Configuration (Elevations)

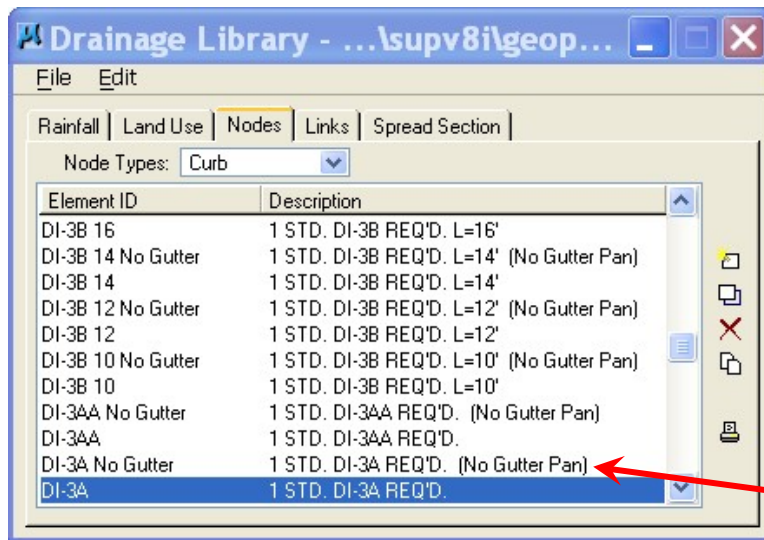
- The **Elevation Source** determines where the node gets the elevation data for the **Node Elevation Point**. The Node Elevation Point is a data point on the cell that sets the elevation for that cell. The Node Elevation Point for all VDOT curb drop inlets is located at the top of curb point; therefore, if **Referenced TIN** is selected as the **Elevation Source**, the program will automatically determine the top of curb elevation for a respective curb drop inlet from the selected **TIN model**.
- The **Node Elevation Option** is simply a way to adjust the **Node Elevation Point** data, if needed. If we utilize the proposed **TIN model**, as expected, no adjustment should be needed. **The Node Elevation Option** has absolutely nothing to do with the top of curb or inlet throat elevation and/or inlet spread computations.



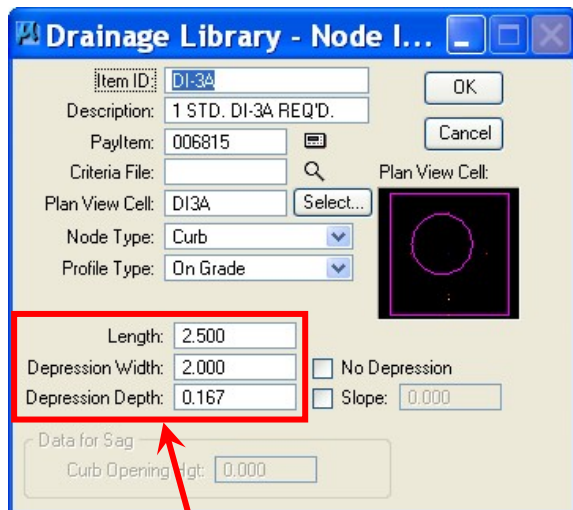
## 9.5.3 VDOT Inlet Configurations in GEOPAK Drainage

### 9.5.3.1 On-Grade Inlets (With and Without Gutter)

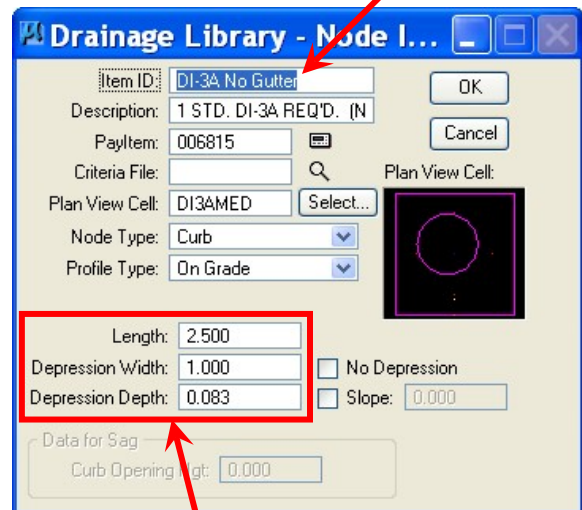
Since the settings for **Depression Width** (width of local depression) and **Depression Depth** (amount of local depression) are fixed within the **Node Library Item** (see illustration below). Therefore, two separate **Library Items** are needed to represent the standard inlet with gutter pan and one without (such as a median inlet).



Node Library Item specifies **No Gutter**

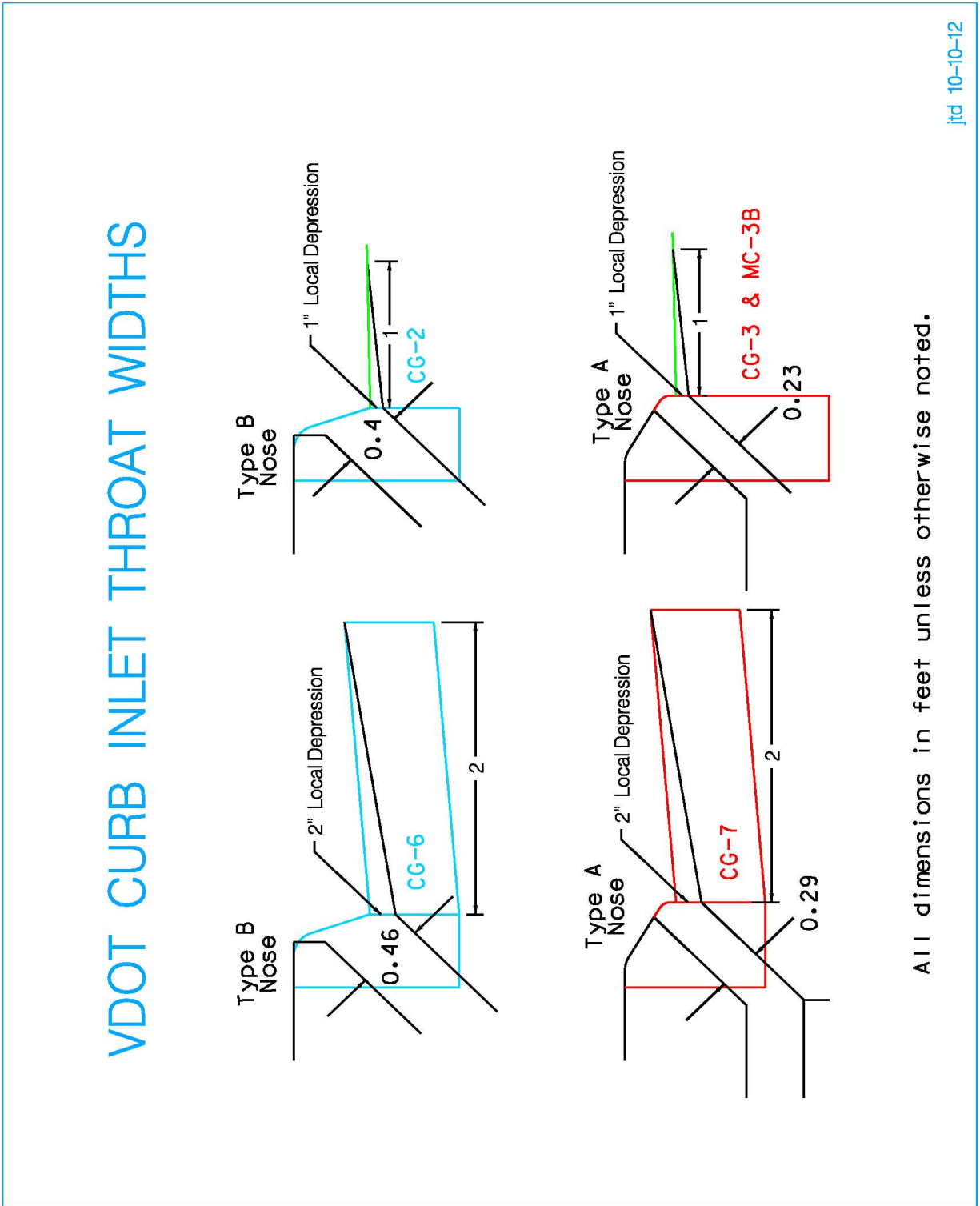


2" Depth over 2' Width



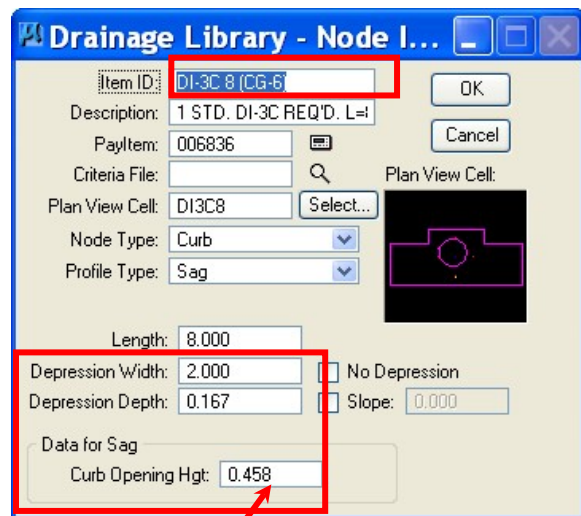
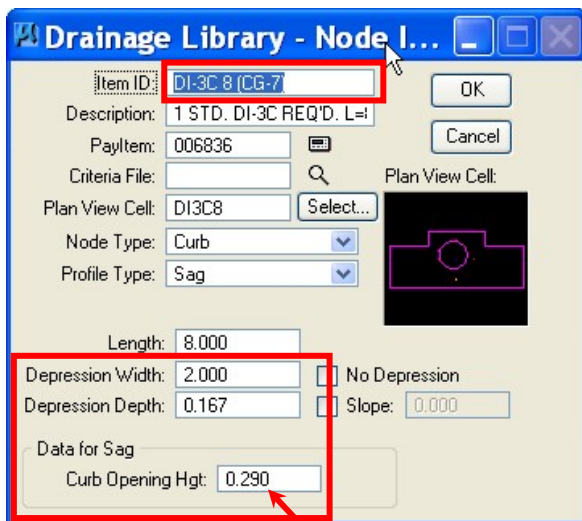
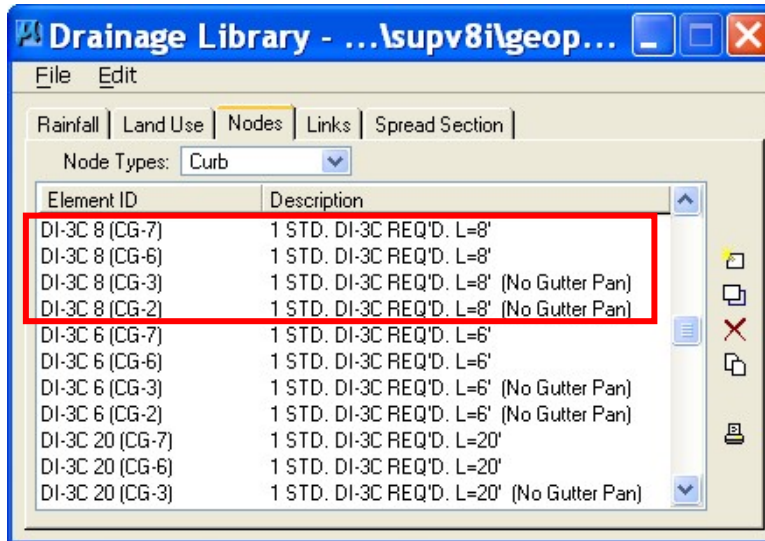
1" Depth over 1' Width

Figure 9-4 Curb Inlet Throat Widths



### 9.5.3.2 Sag Inlets (With and Without Gutter)

The situation is slightly more complicated for inlets located in a **Sag condition**, as the setting for **Curb Opening Height** (throat width) is included with the settings for **Depression Width** (width of local depression) and **Depression Depth** (amount of local depression). Once again, these settings are fixed within the **Node Library Item** (see illustration below); therefore, four (4) separate **Library Items** are needed to represent the different throat width and gutter/no gutter combinations available for **Sag inlets**.



Note the different  
**Throat Width** dimensions

**Drainage Library - Node I...**

Item ID: **DI-3C 8 (CG-3)** OK  
Description: 1 STD. DI-3C REQ'D. L=1 Cancel  
PayItem: 006836  
Criteria File: Search Plan View Cell:  
Plan View Cell: DI3C8MED Select...  
Node Type: Curb  
Profile Type: Sag  
Length: 8.000  
Depression Width: 1.000  No Depression  
Depression Depth: 0.083  Slope: 0.000  
Data for Sag  
Curb Opening Hgt: 0.230

**Drainage Library - Node I...**

Item ID: **DI-3C 8 (CG-2)** OK  
Description: 1 STD. DI-3C REQ'D. L=1 Cancel  
PayItem: 006836  
Criteria File: Search Plan View Cell:  
Plan View Cell: DI3C8MED Select...  
Node Type: Curb  
Profile Type: Sag  
Length: 8.000  
Depression Width: 1.000  No Depression  
Depression Depth: 0.083  Slope: 0.000  
Data for Sag  
Curb Opening Hgt: 0.390

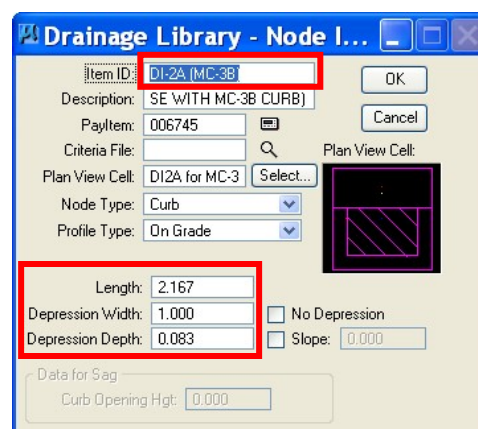
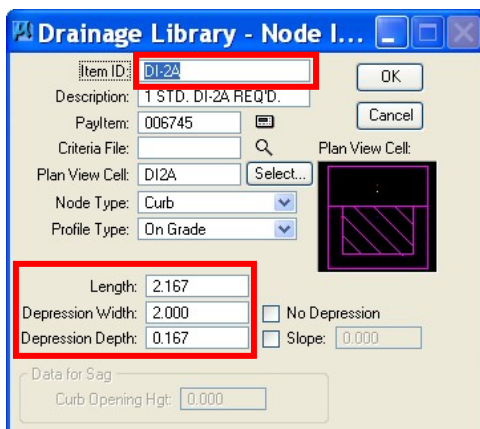
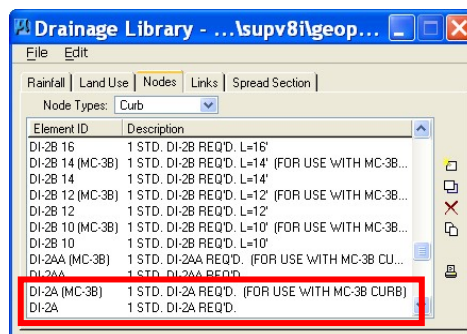
Note the different  
**Throat Width** dimensions

## 9.5.4 Special Use Inlets (DI-2 Series Inlets used in lieu of DI-13 Shoulder Slot Inlets)

As per **Chapter 15** of the [VDOT Drainage Manual](#), if a structure is needed to both intercept the water collected along the bituminous curbing under a guardrail system, and to accommodate pipe sizes or locations other than those shown in the Standard DI-13 details; a Standard DI-2 structure may be considered for use. The structure should utilize a Type A Nose Detail (in order to match the Standard MC-3B curb configuration) and the concrete gutter and grate should employ one inch of additional (local) depression (in lieu of the standard 2 inches) below the normal shoulder elevation. In order to satisfy the guardrail alignment and block out requirements in the areas where the DI-2's are utilized, a cast-in-place only structure must be specified. No DI-2's should be placed within 25 feet of a bridge terminal wall in order to avoid conflict with the **Guardrail Fixed Object Attachment**.

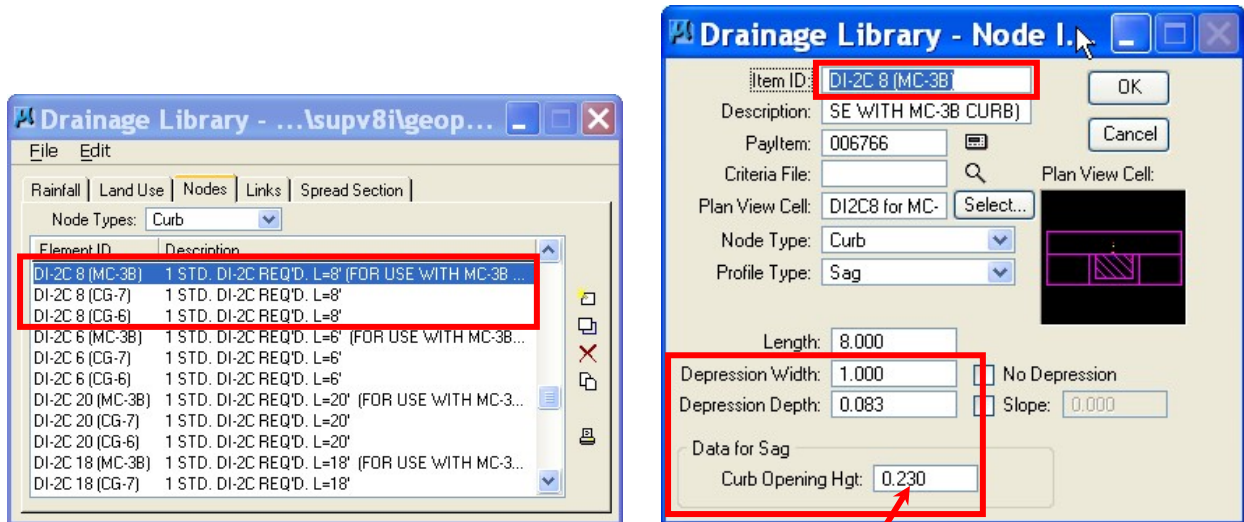
### 9.5.4.1 On-Grade Inlet Applications

Use of the DI-2 in lieu of the DI-13 Shoulder Slot inlet is the only situation where the DI-2 Series Inlet may be utilized without a gutter pan. Once again, the settings for **Depression Width** (width of local depression) and **Depression Depth** (amount of local depression) are fixed within the **Node Library Item** (see illustration below); therefore, for on-grade applications two separate **Node Library Items** will be needed to represent the available options, a standard on-grade inlet and an inlet configured for use with MC-3B Asphalt Curbing (the same configuration as for CG-3 curbing), see illustrations below:

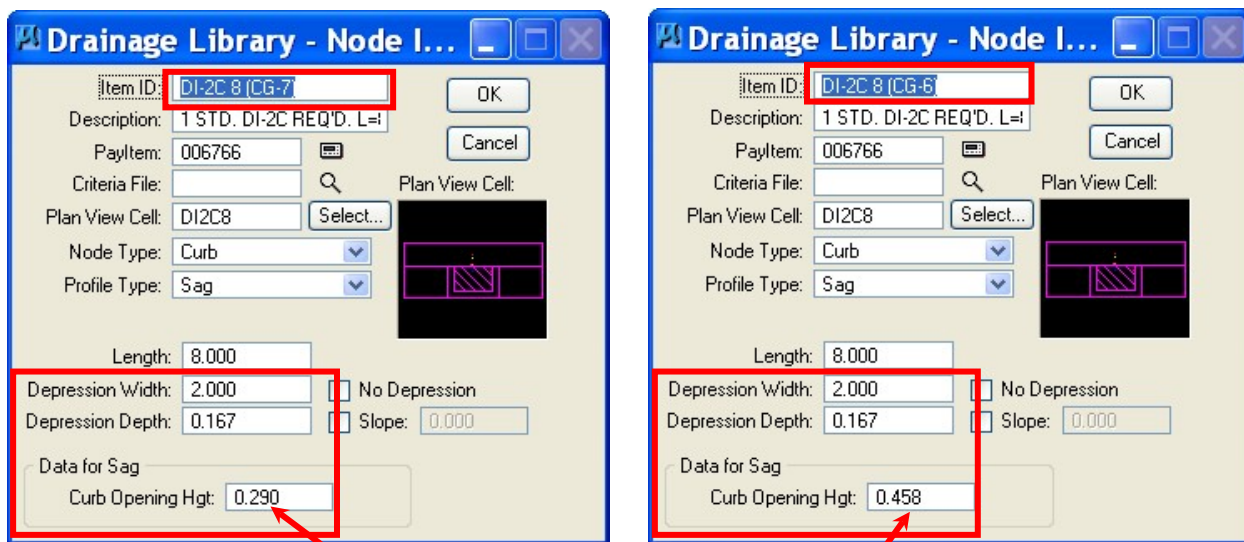


### 9.5.4.2 Sag Inlet Applications

The situation is slightly more complicated for inlets located in a Sag condition, as the setting for **Curb Opening Height** (throat width) is included with the settings for **Depression Width** (width of local depression) and **Depression Depth** (amount of local depression). Once again, these settings are fixed within the **Node Library Item** (see illustration below). Use of the DI-2 in lieu of the DI-13 Shoulder Slot inlet is the only situation where the DI-2 Series Inlet may be utilized without a gutter pan; therefore, three (3) separate **Library Items** are needed to represent the different throat width and gutter/no gutter combinations available for **Sag inlets**.



Note the different Throat Width dimensions



Note the different Throat Width dimensions



## 9.5.5 Drainage Input VBA

### 9.5.5.1 Purpose

- To provide supplemental instructions on the usage of the GEOPAK Drainage Input VBA application not found in either the [2011 GEOPAK Drainage VDOT Training Manual](#) or the Bentley VBA instructions document (see link below).

### 9.5.5.2 Bentley VBA Instructions

- Please fully read this set of instructions first, and then refer to the supplemental instructions on the VBA provided within this document.

See [Section 9.4](#) for **Bentley Drainage Input VBA Instructions**.

### 9.5.5.3 Inputting/Importing Data in the Applications Dialog Box

- Note:
  - Open the **\*.prj file**, in **Road Project Manager**, prior to importing the Ensoft data. This enables the available Alignments to populate the pull-down menu in the VBA.
- Ensoft Data
  - Items that require user input on the **Drainage Input Form** (when importing Ensoft data):

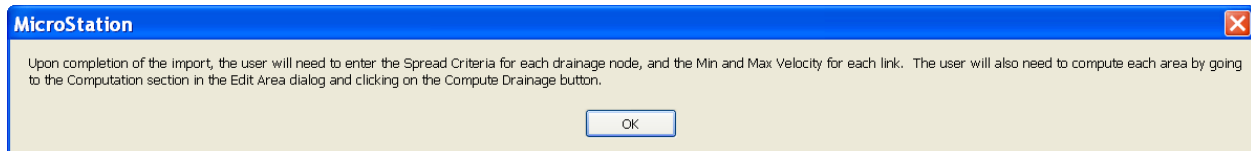
Link Design Constraints		
	Minimum	Maximum
Rise:	1.0	6.0
Slope:	0.4	10
Velocity	2	10

Node Design Maximums	
Pond Depth:	0.5
Pond Width:	8.0

- Preferences
  - Minimum & Maximum Link Velocities
  - Maximum Ponded Depth & Width for Nodes
    - The items will still need to be manually entered inside the program for each Node and Link until the next release of the software.
- Offset Distance
- Structure Name (for outlet structures only)
- Longitudinal & Cross Slope data (should be corrected in the next release of the software)
  - Roadway Cross Slope & Width may always require manual entry
  - The section is entered with the outermost point of the section (at the Inlet) first, followed toward the edge of the section away from the Inlet.
- Pipe Material
- Pipe Type (if applicable)
- Node Elevation

#### 9.5.5.4 Inputting/Manipulating Data in the GEOPAK Drainage Program

Items that require used input/manipulation in the GEOPAK Drainage program (when using imported Ensoft data). The following message will be displayed upon writing the data from the **Input VBA Form** to the **GEOPAK Drainage file**, at least until the next release of the software.



##### 9.5.5.4.1 Areas

- **Computation:**
  - As indicated in the pop-up screen shown above, the user will need to go in and manually calculate each **Drainage Area** associated with the proposed network. This can be accomplished by going to the **Computation section** in the **Edit Area dialog** for each area, and clicking on the **Compute Drainage button**. Click the **Apply button** before closing the dialog window.

##### 9.5.5.4.2 Nodes

- **Location:**
  - The user will need to manipulate the node into its correct position utilizing the software, not MicroStation.
- **Spread Criteria:**
  - The user will need to manually enter the **Longitudinal & Cross Slope data** for each node. (Note: should be corrected in the next release of the software, but **Roadway Cross Slope & Width** may always require manual entry)
    - An alternative option is to change the option on the **Spread Source** to **Reference TIN** and allow the program to compute this information. If this method is used, the user must set the location of the **Reference Surface: TIN File** in the **Elevations** section.
  - Pond Depth & Pond Width (this is your spread depth and width limits, typically set for 0.5' and 8') (Note: should be corrected in the next release of the software)

#### 9.5.5.4.3 Elevations

- **Elevation Source:** should be set to **User Supplied**, and an elevation entered for the node. (Note: for inlets this represents the top elevation of the structure)
- **Node Elevation Option:** should be set to **Same as Source**.
- **Minimum Depth:** normally set at 2.67' (this may be changed to reflect the selection of precast structures) during design; however, when utilizing the **Drainage Input VBA**, the user is simply inputting and analyzing a previously designed system; therefore, the value may remain at zero (0.000).
- **Maximum Depth:** normally set at 8.00' during design; however, when utilizing the **Drainage Input VBA**, the user is simply inputting and analyzing a previously designed system; therefore, the value may remain at zero (0.000).

The screenshot shows the 'Node Configuration - Elevations' dialog box. At the top, the 'Node ID' is set to '3-13'. There are checkboxes for 'Window Center' and 'Highlight', and an 'Apply' button. A 'Details' sidebar on the left lists 'Options', 'Properties', 'Location', 'Spread Criteria', 'Elevations' (selected), 'Junction Loss', 'Discharge Options', and 'Computations'. The main area contains the following settings:

Reference Surface:	TIN File	
Elevation Source:	User Supplied	2019.500
Node Elevation Option:	Same as Source	2019.500
Vertical Alignment:	Match Soffit	0.000
Minimum Depth:		0.000
Maximum Depth:		0.000
<input type="checkbox"/> Add Sump Depth:		0.000

#### 9.5.5.4.4 Computations

- Node Computations cannot be calculated until the user has completed the **Area Calculations** associated with each node. Assuming the user has already worked through the re-calculation of the areas, then simply clicking the **Apply button** should achieve the desired results; otherwise, an error message will appear indicating a task that has yet to be performed.

#### 9.5.5.4.5 Links

- **Definition**
  - Using the **Link Edit dialog**, the user will need to re-connect the ends of the links (pipes) to the appropriate **Node Connection Points**. Click the **Apply button** once this is done.
- **Constraints**
  - Using the **Link Edit dialog**, the user will also need to define the maximum and minimum velocity constraints for each link (pipe). Click the **Apply button** once this is done. (Note: these items will still need to be manually entered in the program until the next release of the software)

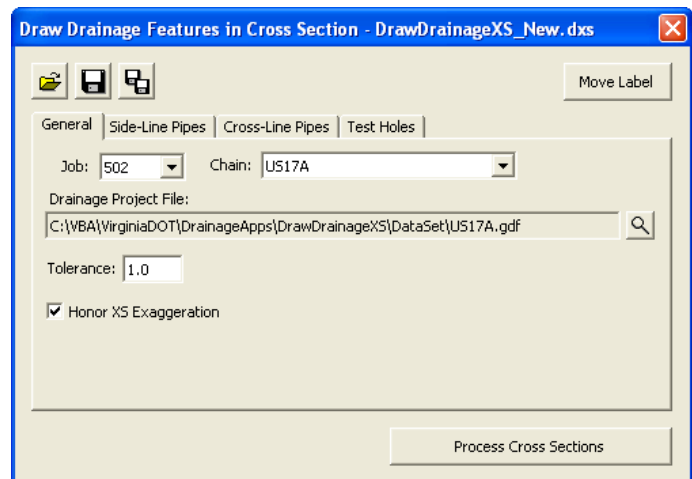
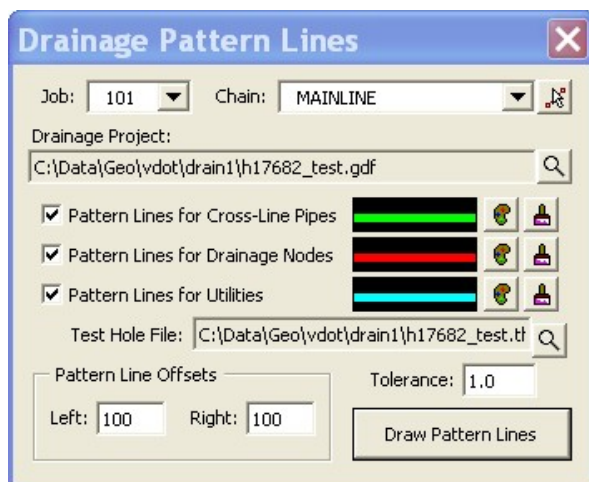
Now, the user must go through the process of creating a **Network** as outlined in Chapter 6 of the [2011 GEOPAK Drainage VDOT Training Manual](#).

- See [Section 9.4](#) for Bentley VBA Instructions.

### 9.5.6 Drainage Pattern Lines/Drainage XS VBA's

#### 9.5.6.1 Tolerances

Understanding the meaning and application of the tolerance settings on the dialog boxes for these two (2) VBAs is crucial to achieving the desired output. The cross-sectional output from these applications can be very misleading unless the user has a firm understanding of how the applications operate.



### 9.5.6.2 Drainage Pattern Lines VBA

- The **Tolerance field** defines the distance an object must be from one pattern line before it will be used to generate another pattern line. This helps eliminate pattern lines that are so close to each other they result in essentially the same cross-section.

### 9.5.6.3 Drainage XS VBA

- The **Tolerance field** indicates the distance within which a drainage object will be considered to fall on a cross-section. If a drainage object is farther away than this from the cross-section location (pattern line) it will not be drawn on the cross-section. Keep in mind that a cross-section must be cut at the pattern line location in order for drainage objects to be drawn on that cross-section. A drainage objects proximity to a pattern line in plan-view does not necessarily mean it will be drawn in cross-section unless a cross-section exists for that pattern line.
- The user should consider working with the roadway designer to have design cross-sections added at the locations of both utility test holes and crossing pipes (pipes that cross the alignment), if there not within close proximity to existing design cross-section locations (2' to 3' suggested).

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## 9.6 Ditch Design/Analysis in GEOPAK Drainage

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### 9.6.1 Introduction

The creation of a ditch system in GEOPAK Drainage is similar to the construction of a storm sewer system. The difference is that instead of specifying a pipe for the link connection between nodes, the user needs to select the ditch option.

Ditch systems can be created as **Individual Networks**, for independent design/analysis; or as part of **Combined Networks**, in combination with pipe and inlet systems.

GEOPAK Drainage allows the user to specify either a fixed ditch geometry or a ditch extracted from a reference surface.

### 9.6.2 Ditch Design - 2004 VDOT GEOPAK Drainage Training Manual

**Chapter 19 - Ditch Design** of the VDOT GEOPAK Drainage Training Manual, 2004 Edition, has been copied as [Appendix H](#) in this manual. This appendix will serve as the basic tutorial for the introduction and placement of ditch components (nodes and links) in GEOPAK Drainage.

It is highly recommended that the user read and thoroughly familiarize themselves with the information contained in this chapter prior to proceeding any further.

### 9.6.3 Types of Networks

#### 9.6.3.1 Individual Networks

An **Individual Network** is a network composed entirely of the same type of components (nodes and links), whether they are storm sewer or ditch.

An **Individual Ditch Network**; therefore, is defined as a network composed entirely of ditch components (nodes and links). See [Figure 9-5](#).

**Individual Ditch Networks** are the method for inputting stand-alone ditch design information into GEOPAK Drainage.

In an Individual Ditch Network, all of the nodes are ditch nodes (Node Type: Other) with the exception of the node at the downstream end. The node at the downstream end must be a ditch outlet node (Node Type: Outlet), as all networks must have an outlet. In [Figure 9-5](#), **D-6** is the outlet node.

#### 9.6.3.2 Combined Networks

A **Combined Network** is defined as a network composed of both ditch and storm sewer elements (nodes and links). See [Figure 9-6](#)

Several **Individual Networks** may be joined together to form a **Combined Network**. In a Combined Network, all of the different types of nodes can be present.

**Figure 9-5 Sample Individual Ditch Network**  
(w/ typical Ditch Components illustrated)

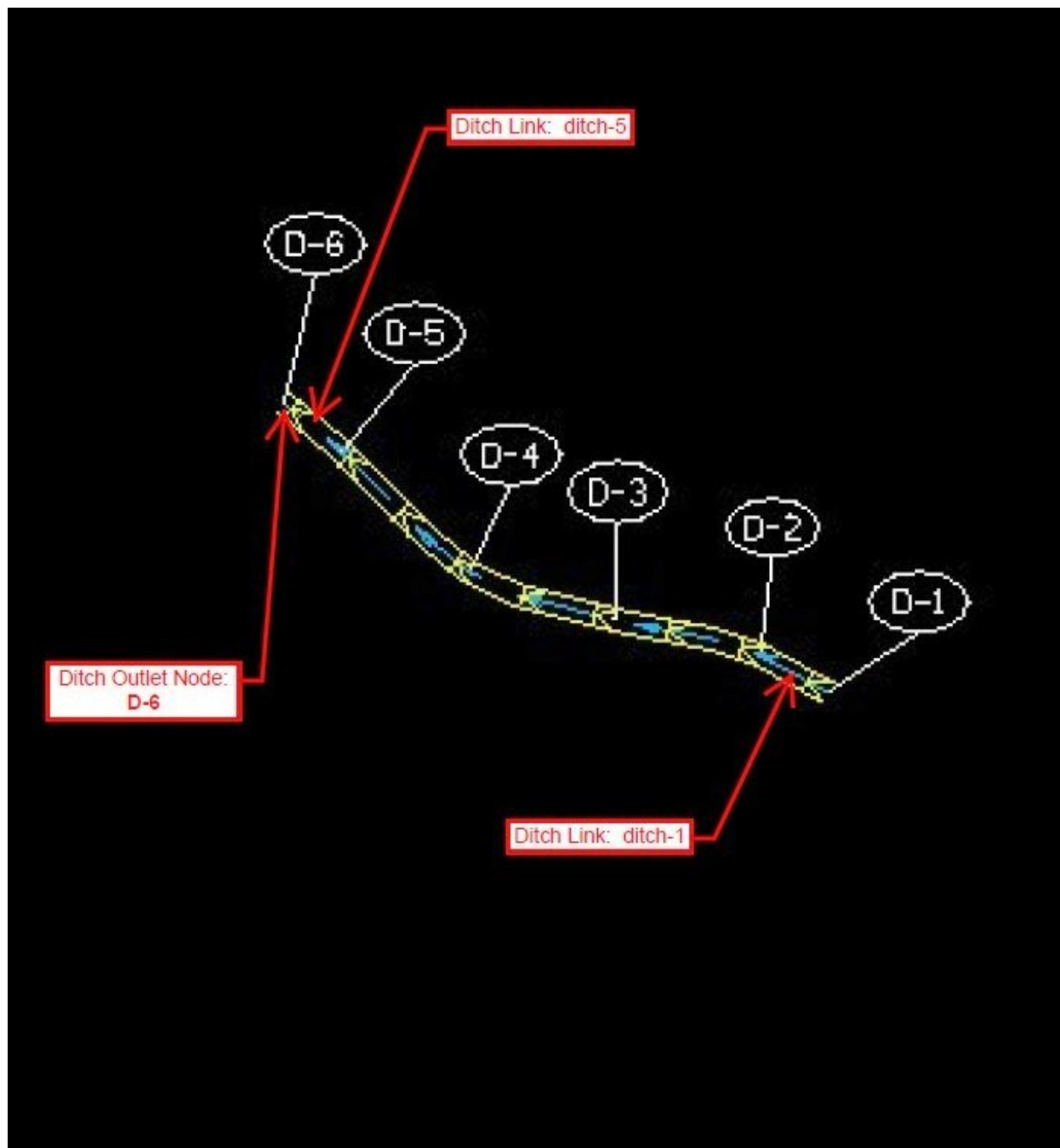
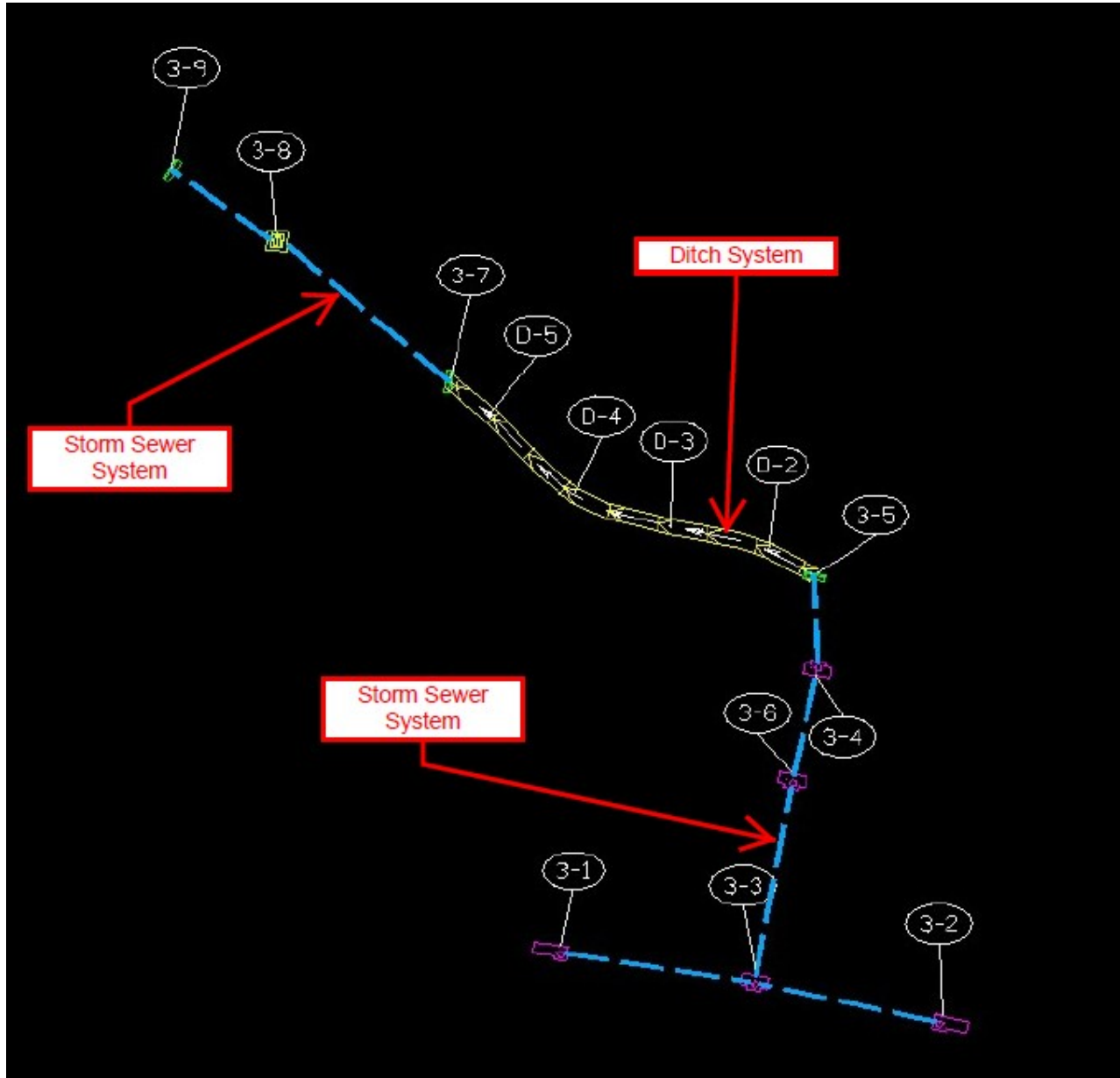


Figure 9-6 Sample Combined Network





### 9.6.3.3 Drawbacks/Limitations Associated with both Individual and Combined Networks

The particular drawbacks and limitations associated with the use of both **Individual** and **Combined Networks**, in terms of design, will be discussed in [Section 9.6.5](#).

## 9.6.4 VDOT Ditch Design/Analysis Procedures

### 9.6.4.1 Current Ditch Design Procedures

The current VDOT Ditch Design Procedure involves an analysis of both capacity (10-year frequency) and erosion resistance (2-year frequency).

As per **Section 7.5.2.2** of the [VDOT Drainage Manual](#), before the computational analysis can be performed, a soils report from the Materials Division is needed which specifies the type of soil that is found in the area of the ditch. The soil classification is then used with **Appendix 7D-2** to determine the maximum allowable velocity for the native soil. Native soil is assumed for new ditches and for ditches with vegetation established for less than two (2) years. When the maximum allowable velocity is exceeded, some type of ditch lining is needed.

For a given section of ditch, if the 2-year velocity is less than the allowable velocity, no ditch lining is needed for this section of ditch. If the 2-year velocity is greater than the allowable velocity for the appropriate soil type, a ditch lining is needed and the following steps should be followed.

**Step 1:** *The ditch under investigation is divided into convenient segments of length. The drainage area and runoff coefficient(s) for use in the Rational Method are determined for the first or farthest upstream segment of the ditch to be analyzed.*

**Step 2:** *Determine the time of concentration to the downstream end of the first segment of ditch. Using 2-year frequency rainfall intensity, determine the 2-year discharge by the Rational Method.*

**Step 3:** *Determine the average longitudinal grade for the ditch segment under consideration.*

**Step 4:** *Find the velocity for the 2-year frequency design discharge.*

**Step 5:** *If the velocity is less than the maximum allowable velocity, no ditch lining is needed. If the velocity is more than the allowable velocity, ditch lining should be required. The usual progression of types of ditch lining used as velocities increase would begin with VDOT Standard EC-2, then EC-3 Type A, EC-3 Type B, Rip-Rap and lastly concrete lining (Standard PG-2A).*

**Step 6:** *Determine the depth of flow for the 10-year frequency discharge to insure that the hydraulic capacity has not been exceeded.*

**Step 7:** Repeat the above steps for the next downstream segment of ditch. To calculate the discharge, add or accumulate the Rational Method CA values for each segment of the ditch contributing to the point of study.

The procedure outlined above can also be performed utilizing the **LD-268 Ditch Computation Spreadsheet**, available from the Central Office Hydraulics & Utilities Program.

#### 9.6.4.2 Future Ditch Design Procedures

VDOT will eventually transition to a **Shear Stress** based methodology for the design of ditches and channels. This methodology will be based on FHWA HEC-15 (Design of Roadside Channels with Flexible Linings, 3<sup>rd</sup> Edition). **The LD-268 Ditch Computation Spreadsheet** will be modified to incorporate the shear stress based methodology.

The purpose of this transition will be to comply with Section **713 – Roadside Improvement Materials** of the Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects.

Once the shear stress method of design becomes operational, ditches will still be able to be utilized in GEOPAK Drainage as components of a network; however, since the program does not incorporate a shear stress analysis in its design/analysis of ditches, the actual design will need to be performed outside of the program.

#### 9.6.4.3 Instructions Specific to GEOPAK Drainage

As per VDOT ditch design requirements, the 10-year discharge must be checked to ensure capacity, and the 2-year velocity for lining requirements. The design storm frequency can be changed under the settings for **Project Preferences > Frequency Options**. Each time the setting is changed, the network analysis must be re-run to reflect the changes.

### 9.6.5 Methods for Incorporating Ditch Design into the GEOPAK Drainage Workflow Process

There are two basic methods for incorporating ditches into the GEOPAK Drainage workflow process. One method makes use of **Combined Networks**, the other **Individual Networks**. Both methods are very similar to each other, however, each has its own advantages and disadvantages. **Combined Networks** are the preferred method because of their connectivity. When employed, the effects of changing single components can be observed across the entire network.

### 9.6.5.1 Leapfrogging through a Combined Network

When it comes to **Combined Networks**, the best way to design them is piece by piece in a downstream direction towards the ultimate outlet (outfall). This allows the user to isolate each section as they move along the network. For instance, in the case of our **Sample Combined Network** illustrated in [Figure 9-6](#), the ultimate network is constructed/created in three (3) phases. **Phase I** contains the storm sewer system from 3-1 to 3-5, **Phase II** contains the ditch system from 3-5 to 3-7, and **Phase III** contains the storm sewer system from 3-7 to 3-9. Thus, the network is created in this “leapfrog” fashion. If the goal is simply to analyze a design, then the phased approach may be skipped and the entire network constructed sequentially.

Detailed phased instructions for the construction of the **Sample Combined Network** are illustrated in the following figures:

#### Phase I – [Figure 9-7](#)

- Construction of the storm sewer system from 3-1 to 3-5
- Detailed instructions on the use of the **Drainage Labeler** for extracting outlet data for a given network are presented in [Section 9.6.7](#).

#### Phase II – [Figure 9-8](#)

- Delete **Network 3-5** by using the **Network > Delete** commands. Remember to only delete the network and not all of its components (the program will prompt the user with this question).
- Construction of the ditch system from 3-5 to D-6
- Node D-6 ultimately is eliminated in Phase III, and only exists to aid in the design of the ditch section in this Phase.
- Drainage Reports for the Ditch System in this Phase as shown in [Table 9-9](#). These **Excel** Files were created from tab and comma delimited field data (\*.sum files). This data can also be viewed in the **Dialog Box** for ditch link under the **Computations** option; however, the tabulated data in **Excel** spreadsheet format is highly preferable.

#### Phase III – [Figure 9-10](#)

- Delete **Network D-6** by using the **Network > Delete** commands. Remember to only delete the network and not all of its components (the program will prompt the user with this question).
- Construction of the storm sewer system from 3-7 to 3-9

- Finalized **Storm Sewer Tabulation Report**. This report will need to be hand modified to remove the rows containing the ditch links. The **Inlet Spread Analysis Tabulation Report** can also be run at this time.

#### 9.6.5.2 Important Items to Remember

- A complete network, including outlet, is required to perform link (pipe and/or ditch) calculations.
- As per VDOT ditch design requirements, the 10-year discharge must be checked to ensure capacity, and the 2-year velocity for lining requirements. The design storm frequency can be changed under the settings for **Project Preferences > Frequency Options**. Each time the setting is changed, the network analysis must be re-run to reflect the changes.
- Nodes (including ditch nodes), in addition to their computed discharges, can have an additional **Discharge** or **Drainage Area** defined or linked to them. This allows more than one drainage area to be associated to a given node.

#### 9.6.5.3 Drawback or Limitations Associated with this Method

- This method is more time consuming than using independent networks, particularly when designing in GEOPAK Drainage.
- The complexity of the larger networks associated with this method can lead to more problems when trying to validate the network and run calculations.

Figure 9-7 Phase I - Leapfrogging through a Combined Network

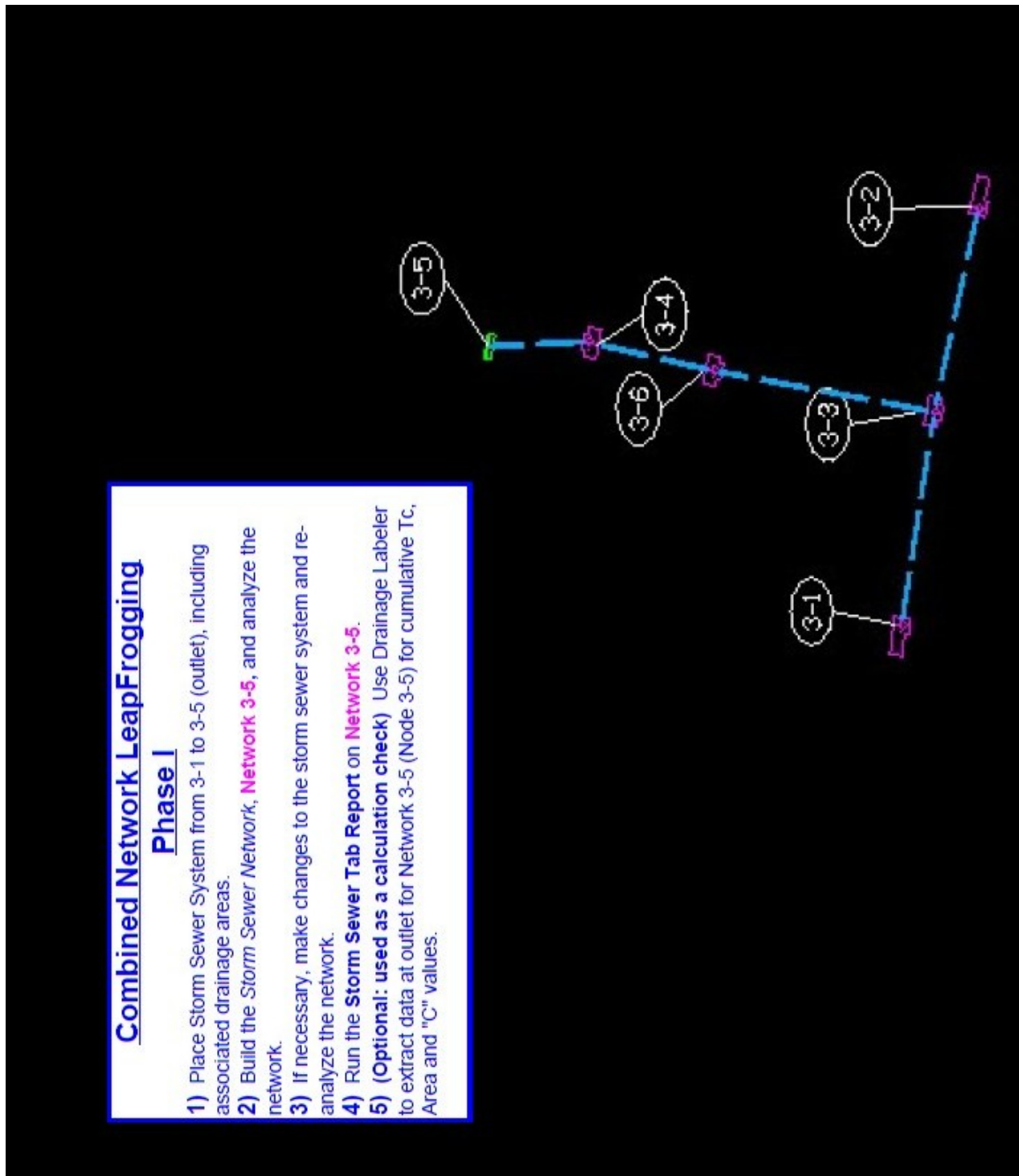
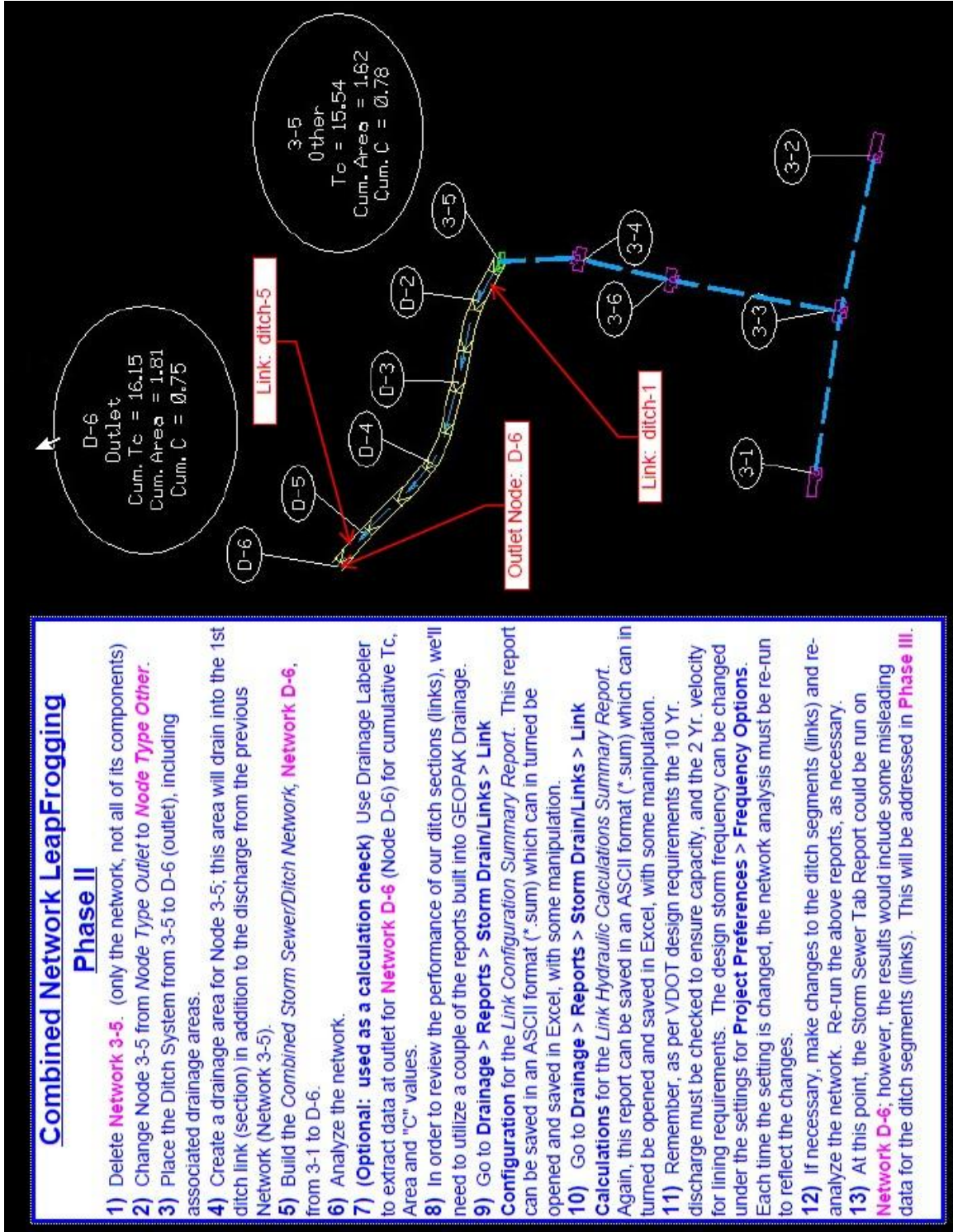


Figure 9-8 Phase II - Leapfrogging through a Combined Network



### Combined Network Leapfrogging

#### Phase II

- 1) Delete **Network 3-5**. (only the network, not all of its components)
- 2) Change Node 3-5 from Node Type **Outlet** to **Node Type Other**.
- 3) Place the Ditch System from 3-5 to D-6 (outlet), including associated drainage areas.
- 4) Create a drainage area for Node 3-5; this area will drain into the 1st ditch link (section) in addition to the discharge from the previous Network (Network 3-5).
- 5) Build the **Combined Storm Sewer/Ditch Network, Network D-6**, from 3-1 to D-6.
- 6) Analyze the network.
- 7) **(Optional: used as a calculation check)** Use Drainage Labeler to extract data at outlet for **Network D-6** (Node D-6) for cumulative Tc, Area and "C" values.
- 8) In order to review the performance of our ditch sections (links), we'll need to utilize a couple of the reports built into GEOPAK Drainage.
- 9) Go to **Drainage > Reports > Storm Drain/Links > Link Configuration** for the **Link Configuration Summary Report**. This report can be saved in an ASCII format (\*.sum) which can in turned be opened and saved in Excel, with some manipulation.
- 10) Go to **Drainage > Reports > Storm Drain/Links > Link Calculations** for the **Link Hydraulic Calculations Summary Report**. Again, this report can be saved in an ASCII format (\*.sum) which can in turned be opened and saved in Excel, with some manipulation.
- 11) Remember, as per VDOT design requirements the 10 Yr. discharge must be checked to ensure capacity, and the 2 Yr. velocity for lining requirements. The design storm frequency can be changed under the settings for **Project Preferences > Frequency Options**. Each time the setting is changed, the network analysis must be re-run to reflect the changes.
- 12) If necessary, make changes to the ditch segments (links) and re-analyze the network. Re-run the above reports, as necessary.
- 13) At this point, the Storm Sewer Tab Report could be run on **Network D-6**; however, the results would include some misleading data for the ditch segments (links). This will be addressed in **Phase III**.

**Table 9-9 Link Configuration & Calculation Report – Ditch System (Phase II)**

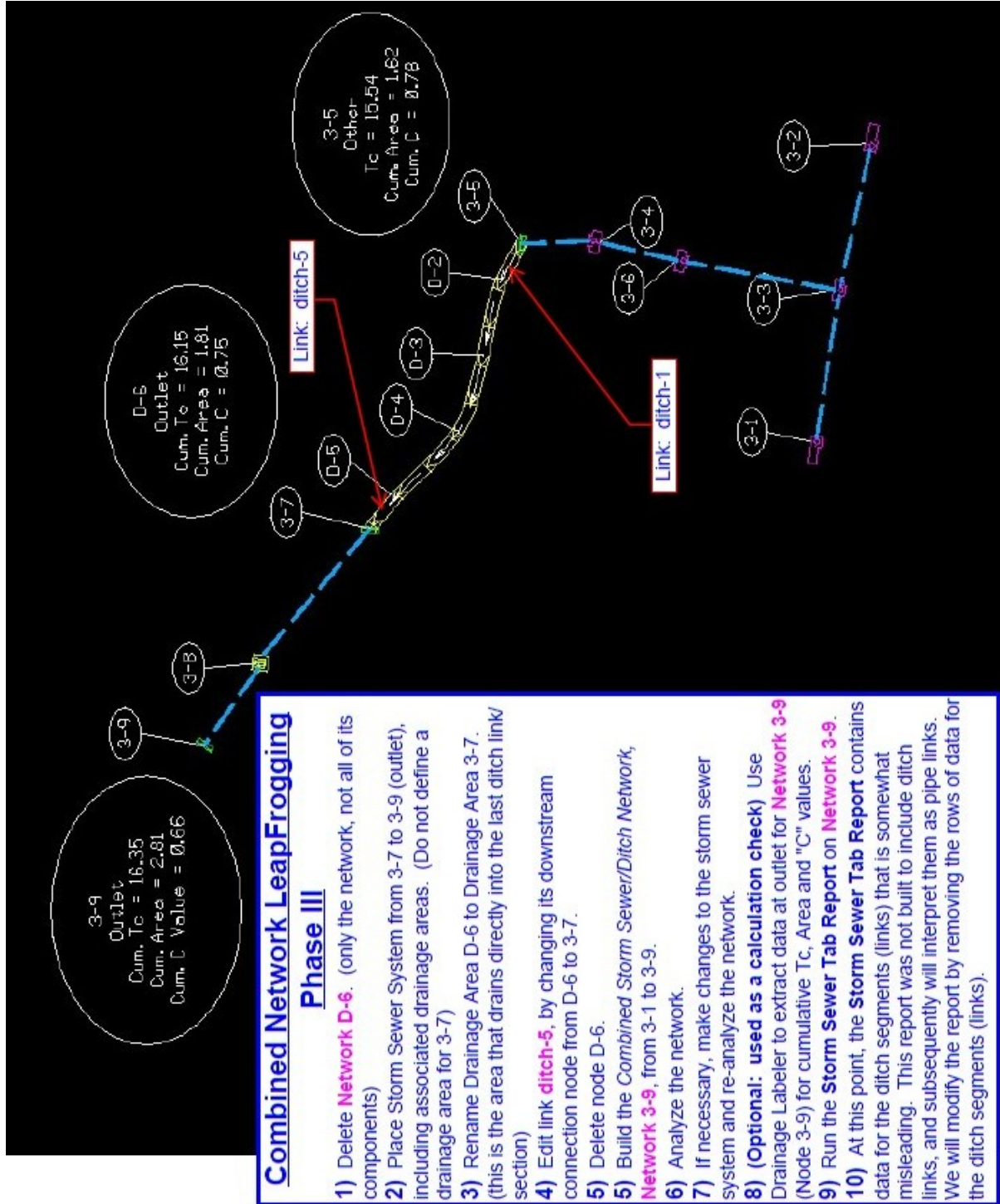
Link Configuration Summary Report (2 Yr. w/ Bare Earth "n" = 0.03)												
ID	ID	ID	Discharge	Length	Shape	#	Rise	Span	n	Slope	Invert	Invert
ditch-1	3-5	D-2	4.149	13.868	Ditch	n/a	1.5	0	0.03	3.605	258	257.5
ditch-2	D-2	D-3	4.18	26.961	Ditch	n/a	1.5	0	0.03	4.451	257.5	256.3
ditch-3	D-3	D-4	4.227	27.499	Ditch	n/a	1.5	0	0.03	9.819	256.3	253.6
ditch-4	D-4	D-5	4.307	31.475	Ditch	n/a	1.5	0	0.03	1.112	253.6	253.25
ditch-5	D-5	3-7	4.397	13.724	Ditch	n/a	1.5	0	0.03	4.736	253.25	252.6

Link Calculations Summary Report (2 Yr. w/ Bare Earth "n" = 0.03)												
ID	ID	ID	HGL	HGL	Discharge	Capacity	Slope	Loss	Velocity	Depth	Velocity	Depth
ditch-1	3-5	D-2	258.768	258.194	4.149	32.433	3.61	0	4.312	0.694	4.304	0.694
ditch-2	D-2	D-3	258.27	256.969	4.18	36.036	4.451	0	4.674	0.669	4.674	0.669
ditch-3	D-3	D-4	257.074	254.179	4.227	53.523	9.815	0	6.304	0.579	6.301	0.579
ditch-4	D-4	D-5	254.476	254.036	4.307	18.012	1.12	0	2.806	0.876	3.481	0.786
ditch-5	D-5	3-7	254.036	253.274	4.397	37.174	4.731	0	4.842	0.674	4.833	0.674

Link Configuration Summary Report (10 Yr. w/ Lining "n" = 0.05)												
ID	ID	ID	Discharge	Length	Shape	#	Rise	Span	n	Slope	Invert	Invert
ditch-1	3-5	D-2	5.632	13.868	Ditch	n/a	1.5	0	0.05	3.605	258	257.5
ditch-2	D-2	D-3	5.671	26.961	Ditch	n/a	1.5	0	0.05	4.451	257.5	256.3
ditch-3	D-3	D-4	5.729	27.499	Ditch	n/a	1.5	0	0.05	9.819	256.3	253.6
ditch-4	D-4	D-5	5.833	31.475	Ditch	n/a	1.5	0	0.05	1.112	253.6	253.25
ditch-5	D-5	D-6	5.945	12.859	Ditch	n/a	1.5	0	0.05	5.055	253.25	252.6

Link Calculations Summary Report (10 Yr. w/ Lining "n" = 0.05)												
ID	ID	ID	HGL	HGL	Discharge	Capacity	Slope	Loss	Velocity	Depth	Velocity	Depth
ditch-1	3-5	D-2	258.942	258.408	5.632	19.46	3.613	0	3.174	0.942	3.414	0.908
ditch-2	D-2	D-3	258.408	257.174	5.671	21.622	4.447	0	3.437	0.908	3.71	0.874
ditch-3	D-3	D-4	257.174	254.386	5.729	32.114	9.817	0	4.638	0.786	4.638	0.786
ditch-4	D-4	D-5	254.775	254.152	5.833	10.807	1.116	0	2.062	1.189	3.582	0.902
ditch-5	D-5	D-6	254.152	253.487	5.945	23.042	5.06	0	3.651	0.902	3.778	0.887

Figure 9-10 Phase III - Leapfrogging through a Combined Network





## 9.6.6 Using Equivalent Drainage Areas with Individual Networks

The method of utilizing **Individual Networks** is simply that, using Individual Networks “linked” together by succeeding equivalent drainage areas. Although it may sound confusing, it is actually easier than building a Combined Network. Like the **Leapfrogging Method**, the user is able to isolate each section (in this case each network) for design/analysis. The difference is that here the sections remain as unconnected separate networks.

Much like the **Sample Combined Network**, our **Sample Individual Network System** illustrated in [Figure 9-11](#), is constructed/designed in three (3) phases. **Phase I** contains the storm sewer system from 3-1 to 3-5, **Phase II** contains the ditch system from D-1 to D-6, and **Phase III** contains the storm sewer system from 3-7 to 3-9. At the end of each Phase, the discharge associated with the current network’s outlet is equated to its:

**Cumulative Time of Concentration ( $T_c$ )**

**Cumulative Drainage Area**

**Cumulative Weighted “C” Value**

In this fashion, each **Individual Network** “feeds” the subsequent (next downstream) network.

Detailed instructions on the use of the **Drainage Labeler** for extracting outlet data for a given network are presented in [Section 9.6.7](#).

Detailed phased instructions for the construction of the **Sample Individual Network System** are illustrated in the following figures:

### Phase I – [Figure 9-12](#)

- Construction of the storm sewer network from 3-1 to 3-5
- **Storm Sewer Tabulation & Inlet Spread Analysis Tabulation Reports** can be run for this network.
- Use the **Drainage Labeler** to determine the **Equivalent Drainage Area** info for **Network 3-5** at the outlet point, **Node 3-5**.

### Phase II – [Figure 9-13](#)

- Construction of the ditch network from D-1 to D-6
- Drainage Reports for the Ditch System in this Phase as the same as those shown in [Table 9-9](#). These **Excel** Files were created from tab and comma delimited field data (\*.sum files). This data can also be viewed in the **Dialog Box** for ditch link under the **Computations** option; however, the tabulated data in Excel spreadsheet format is highly preferable.

- Use the **Drainage Labeler** to determine the **Equivalent Drainage Area** info for **Network D-6** at the outlet point, **Node D-6**.

### Phase III – [Figure 9-14](#)

- Construction of the storm sewer system from 3-7 to 3-9
- **Storm Sewer Tabulation & Inlet Spread Analysis Tabulation Reports** can be run for this network.
- Use the **Drainage Labeler** to determine the **Equivalent Drainage Area** info for **Network 3-9** at the outlet point, **Node 3-9**. The user should make a habit of determining this info for the last network, in case it needs to be added to at a later date.

#### 9.6.6.1 Important Items to Remember

- Although they can be very close, **Independent Networks** cannot physically touch each other.
- A complete network, including outlet, is required to perform link (pipe and/or ditch) calculations.
- Nodes (including ditch nodes), in addition to their computed discharges, can have an additional **Discharge** or **Drainage Area** defined or linked to them. This allows more than one drainage area to be associated to a given node.

#### 9.6.6.2 Drawback or Limitations Associated with this Method

- The major drawback associated with this method is that it lacks the connectivity of the **Combined Method**. It is easy to forget to update downstream networks due to upstream network changes. Often small changes in the time of concentration ( $T_c$ ) in an upstream network can have significant impacts to the **Equivalent Area** discharges entering downstream networks, particularly if there are a lot networks in the system being modeled.
- This method also often requires manual entry for the **Equivalent Drainage Areas** on which it is based.

**Figure 9-11 Sample Individual Network System**  
(linked by Equivalent Drainage Areas)

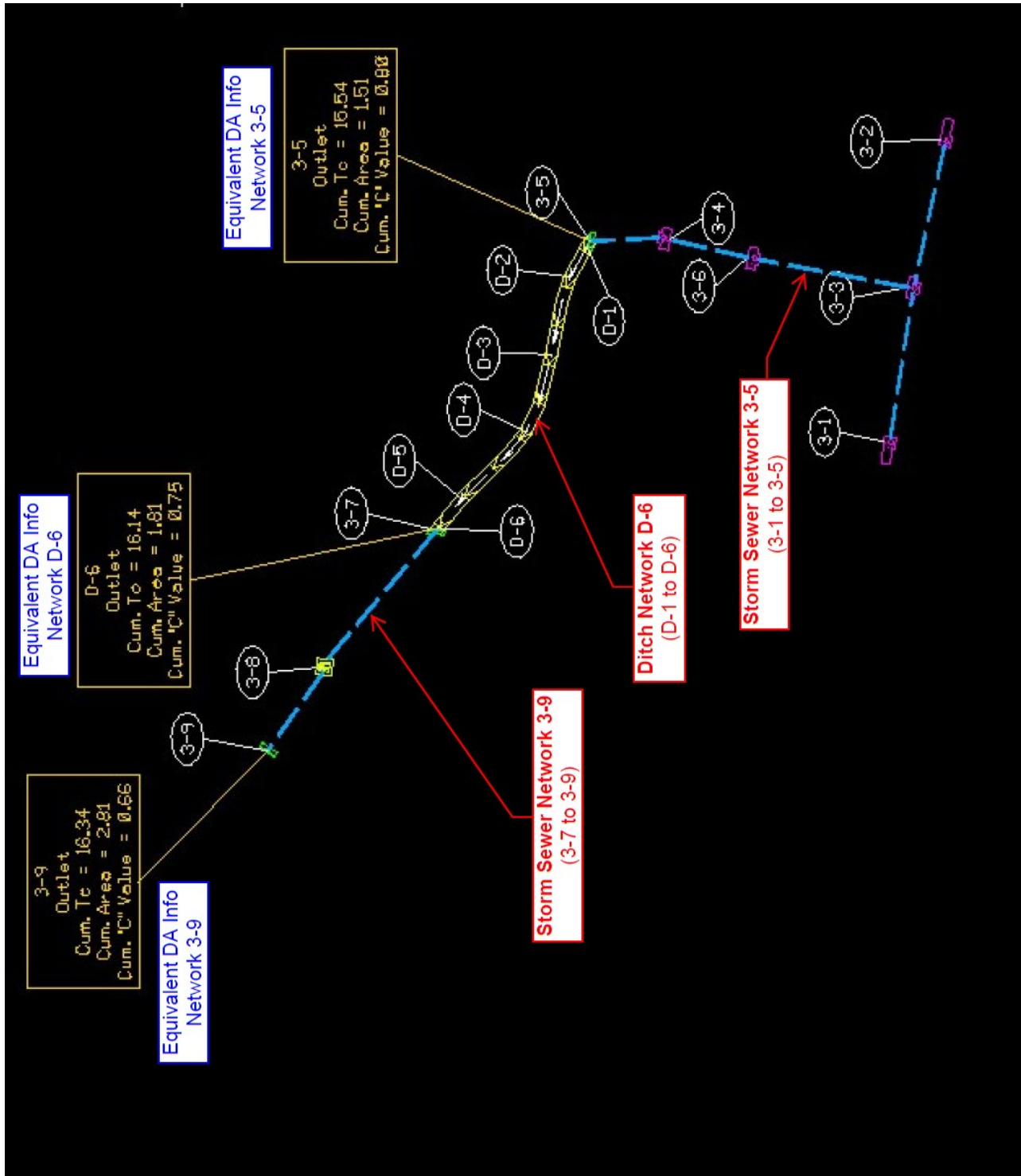


Figure 9-12 Phase I - Individual Networks with Equivalent Drainage Areas

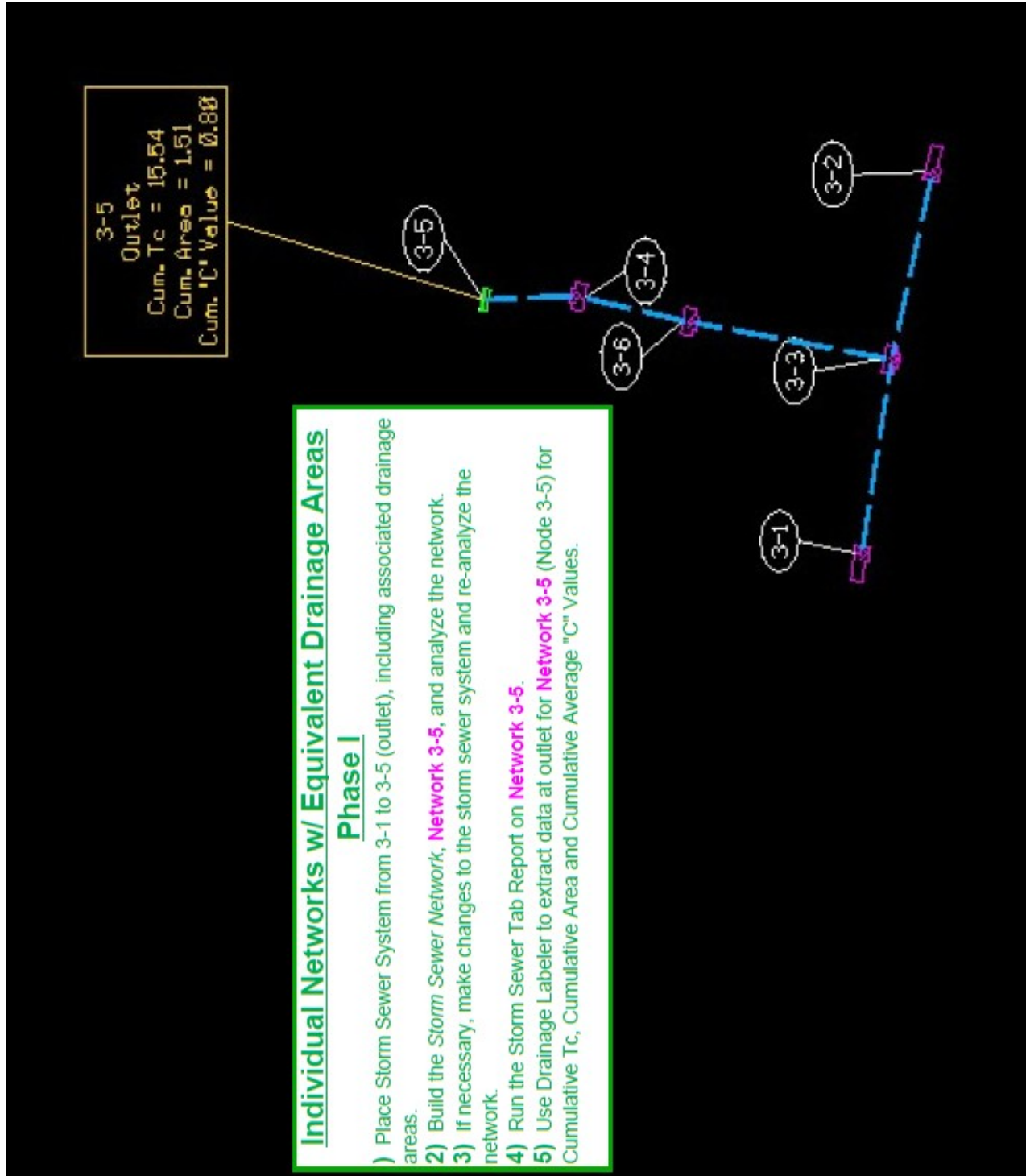
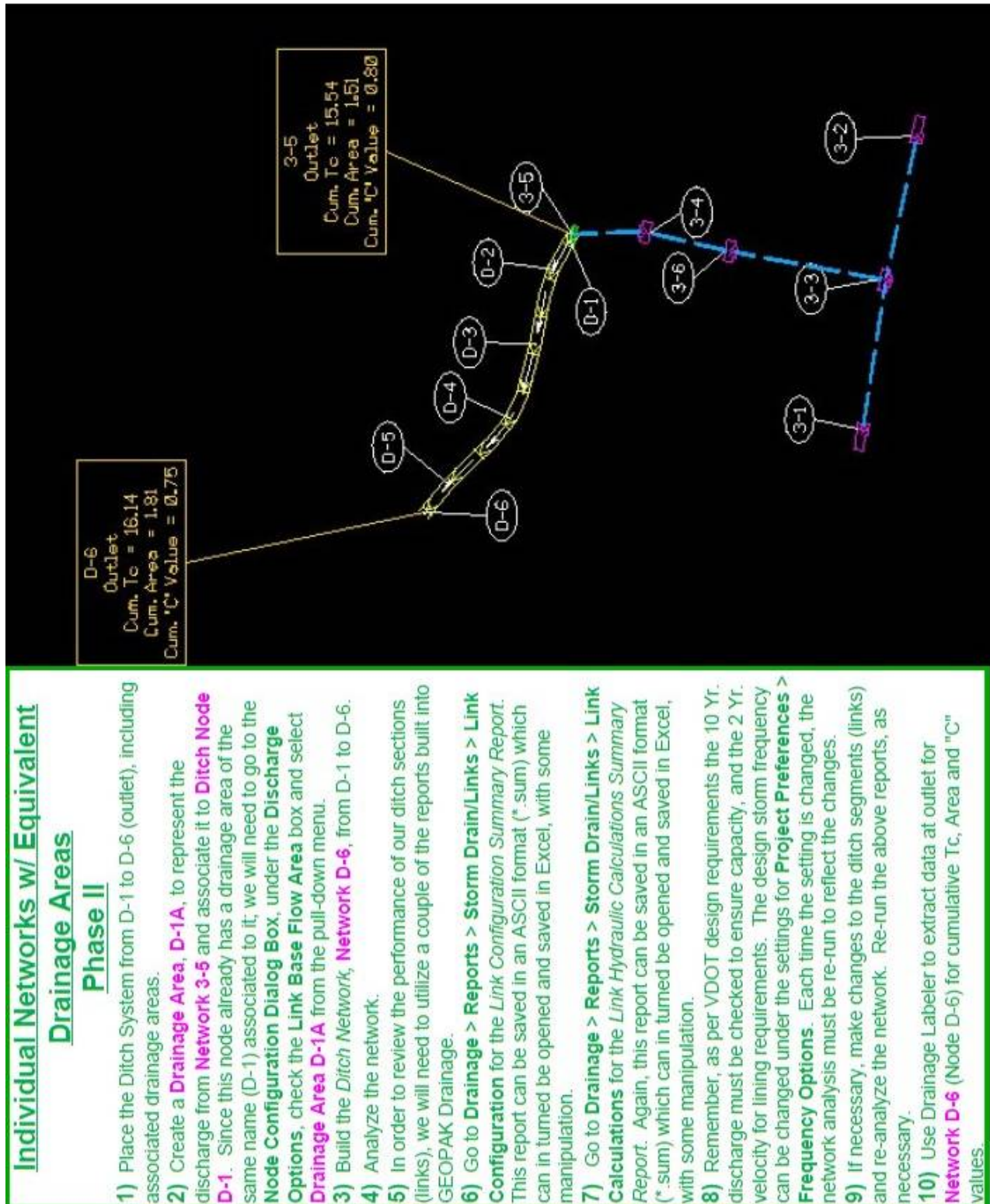


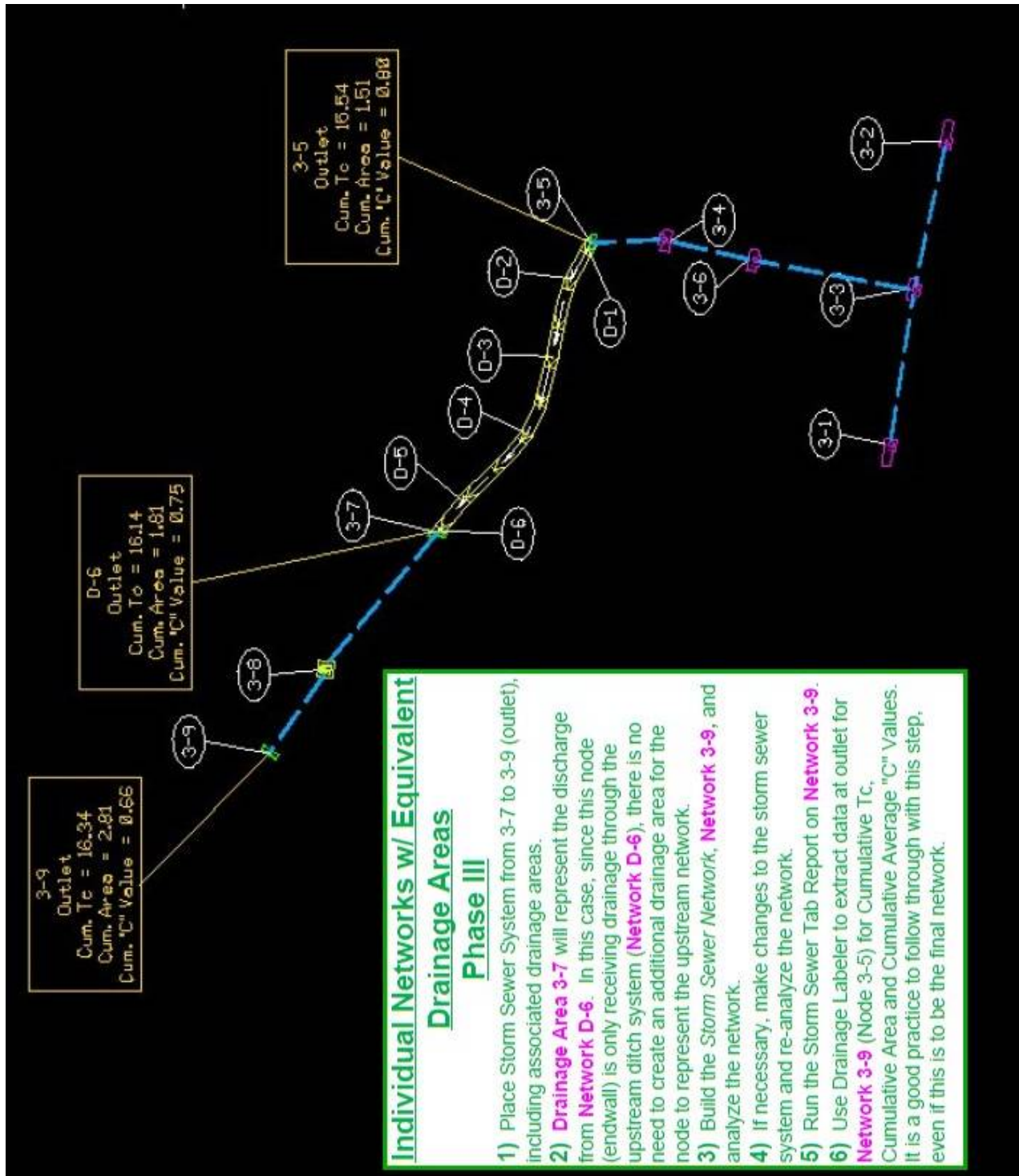
Figure 9-13 Phase II - Individual Networks with Equivalent Drainage Areas



## Individual Networks w/ Equivalent Drainage Areas Phase II

- 1) Place the Ditch System from D-1 to D-6 (outlet), including associated drainage areas.
- 2) Create a **Drainage Area, D-1A**, to represent the discharge from **Network 3-5** and associate it to **Ditch Node D-1**. Since this node already has a drainage area of the same name (D-1) associated to it, we will need to go to the **Node Configuration Dialog Box**, under the **Discharge Options**, check the **Link Base Flow Area** box and select **Drainage Area D-1A** from the pull-down menu.
- 3) Build the **Ditch Network, Network D-6**, from D-1 to D-6.
- 4) Analyze the network.
- 5) In order to review the performance of our ditch sections (links), we will need to utilize a couple of the reports built into GEOPAK Drainage.
- 6) Go to **Drainage > Reports > Storm Drain/Links > Link Configuration** for the **Link Configuration Summary Report**. This report can be saved in an ASCII format (\*.sum) which can in turned be opened and saved in Excel, with some manipulation.
- 7) Go to **Drainage > Reports > Storm Drain/Links > Link Calculations** for the **Link Hydraulic Calculations Summary Report**. Again, this report can be saved in an ASCII format (\*.sum) which can in turned be opened and saved in Excel, with some manipulation.
- 8) Remember, as per VDOT design requirements the 10 Yr. discharge must be checked to ensure capacity, and the 2 Yr. velocity for lining requirements. The design storm frequency can be changed under the settings for **Project Preferences > Frequency Options**. Each time the setting is changed, the network analysis must be re-run to reflect the changes.
- 9) If necessary, make changes to the ditch segments (links) and re-analyze the network. Re-run the above reports, as necessary.
- 10) Use **Drainage Labeler** to extract data at outlet for **Network D-6** (Node D-6) for cumulative Tc, Area and "C" values.

Figure 9-14 Phase III - Individual Networks with Equivalent Drainage Areas



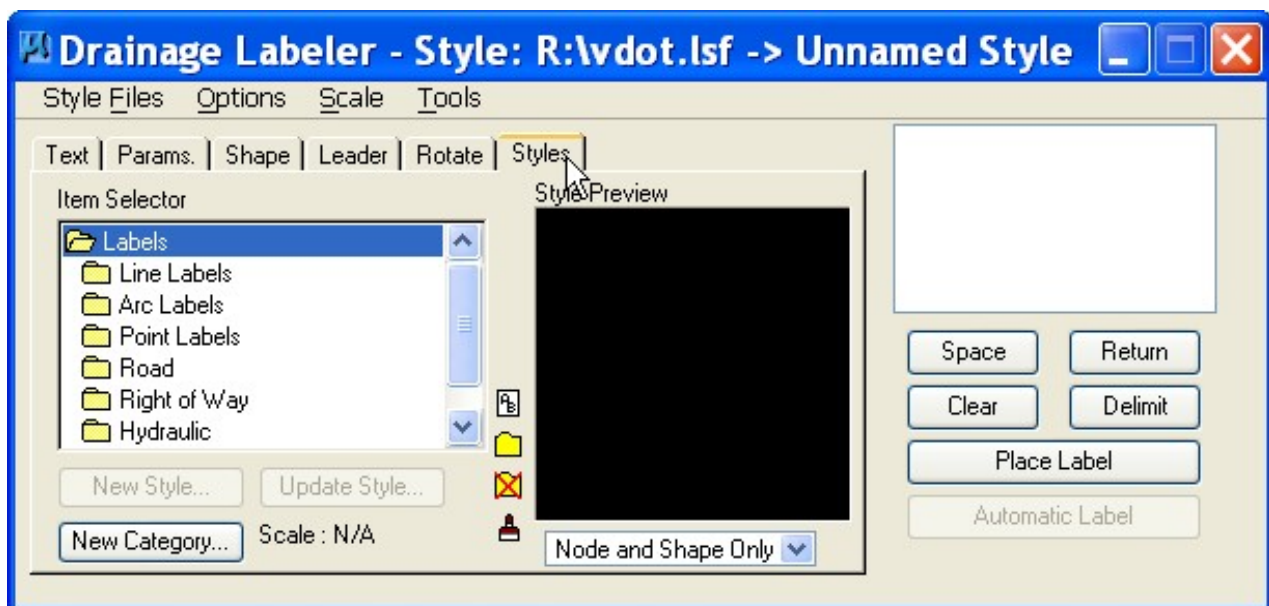
## 9.6.7 Drainage Labeler Instructions

### 9.6.7.1 Introduction

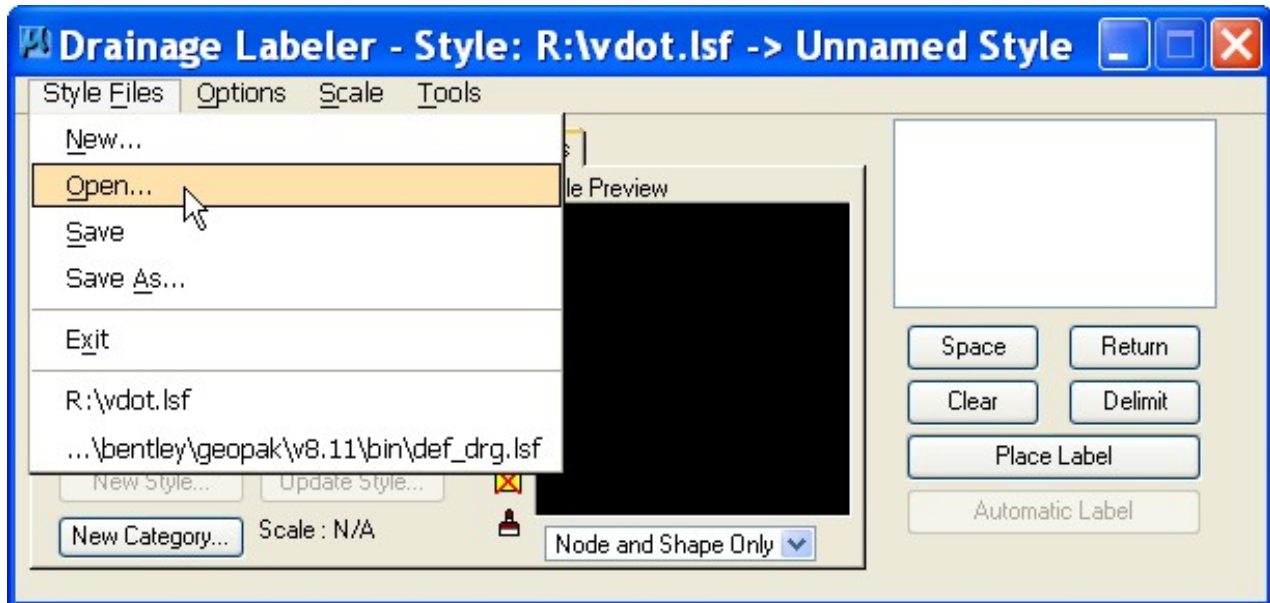
The **Drainage Labeler** is a very powerful tool that can help to automate the composition and placement of drainage associated labeling into the plans. The **Drainage Labeler** can do a lot more than just provide labeling for inlets, manholes, endwalls and pipes. The Labeler can also be utilized to display a multitude of pre-computed text inserts containing data for nodes, links and drainage areas. VDOT has created a few such labels specific to hydraulic design and plan labeling.

### 9.6.7.2 Detailed Instructions

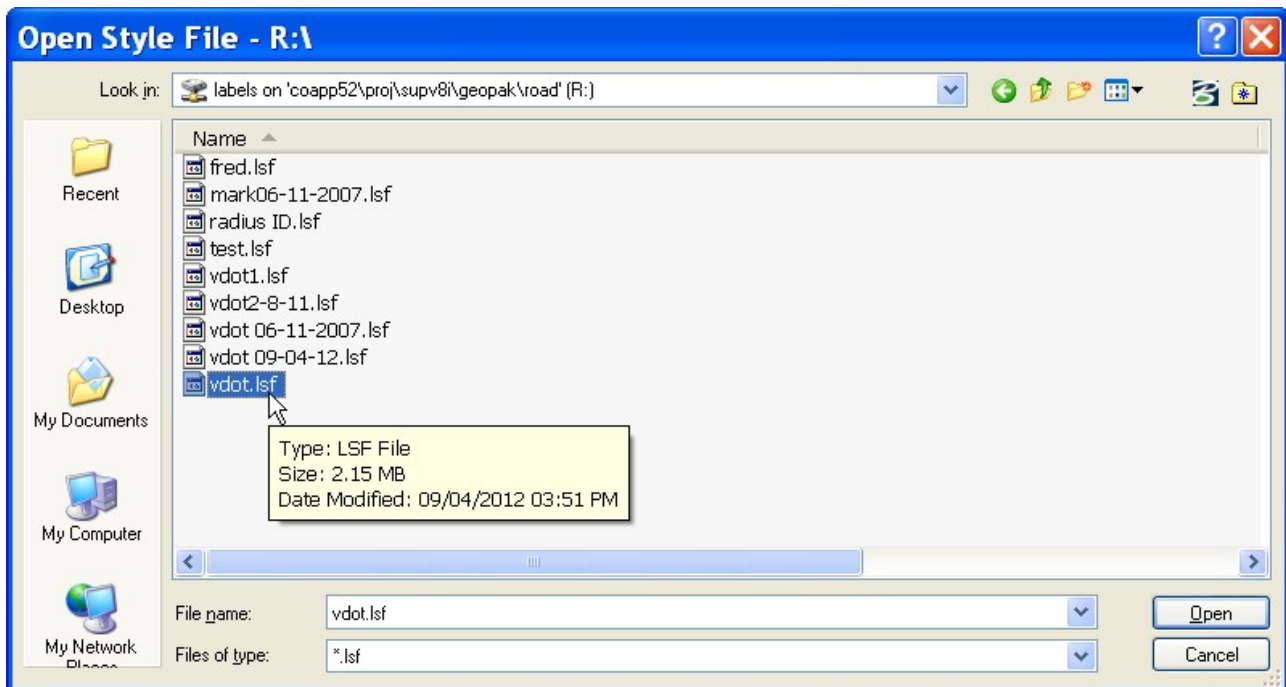
- Open the Drainage Labeler. **Utilities > Labeler**
- **Load/Open the VDOT Style File (vdot.lsf)**, located at this link:  
\\coapp52\proj\supv8i\geopak\road\labels
- Select the **Styles Tab**



- **Style Files > Open**



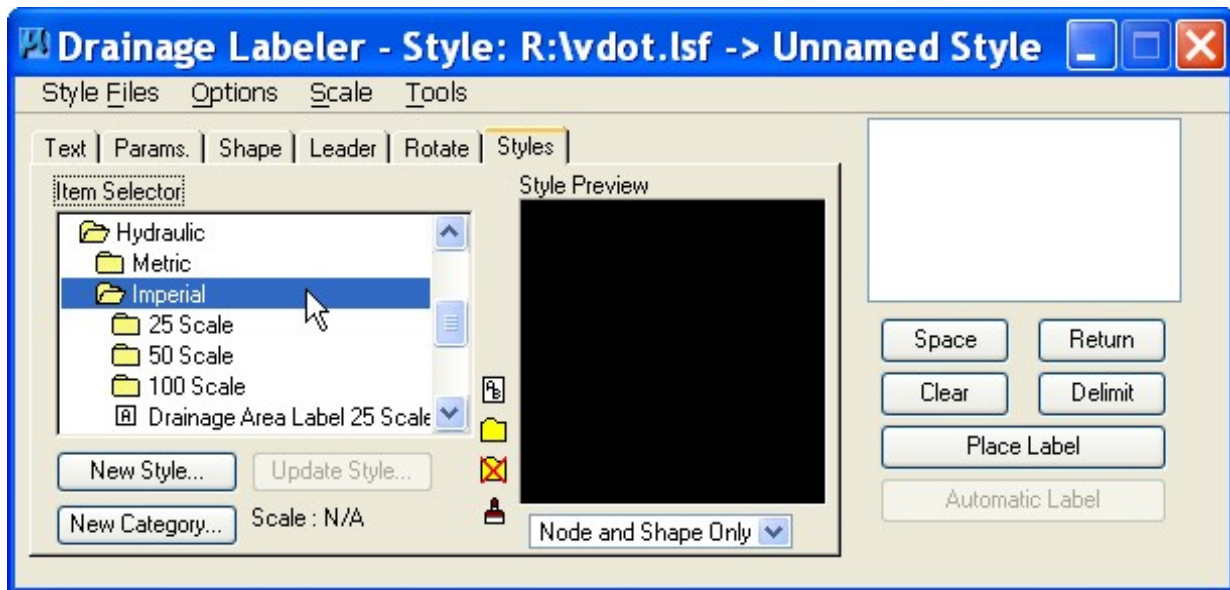
- Select the appropriate **Line Style File**



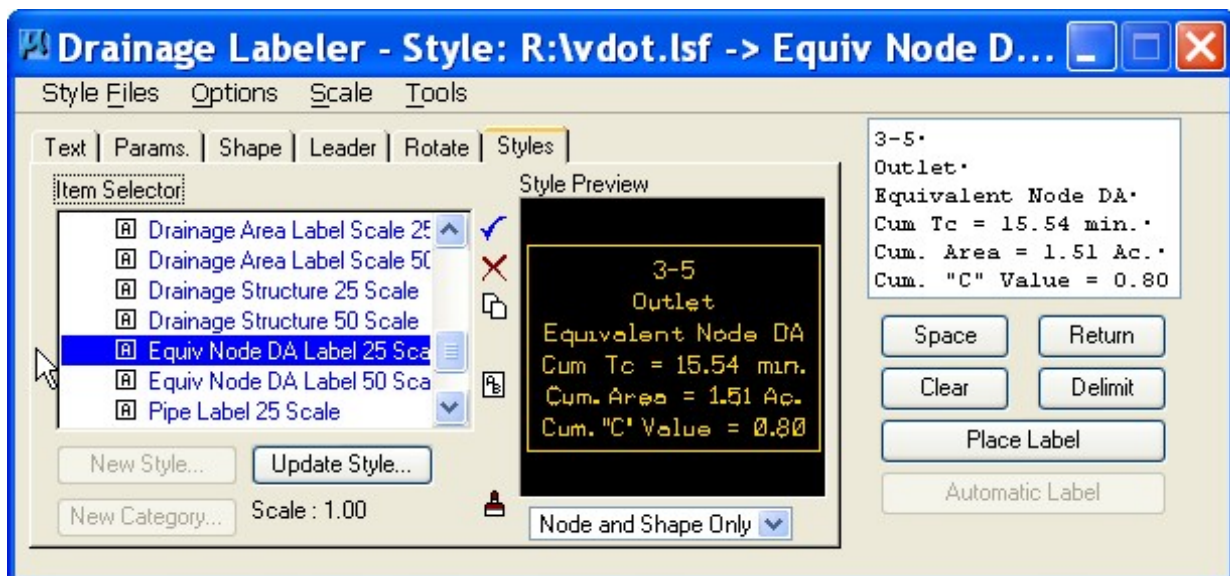


The **Drainage Labeler** should reappear with the **Styles Tab** selected.

- In the **Item Selector** window, scroll down to the **Hydraulic** folder.
- Double click the **Hydraulic** folder, to open it.
- Double click the **Imperial** folder inside the **Hydraulic** folder, to open it.



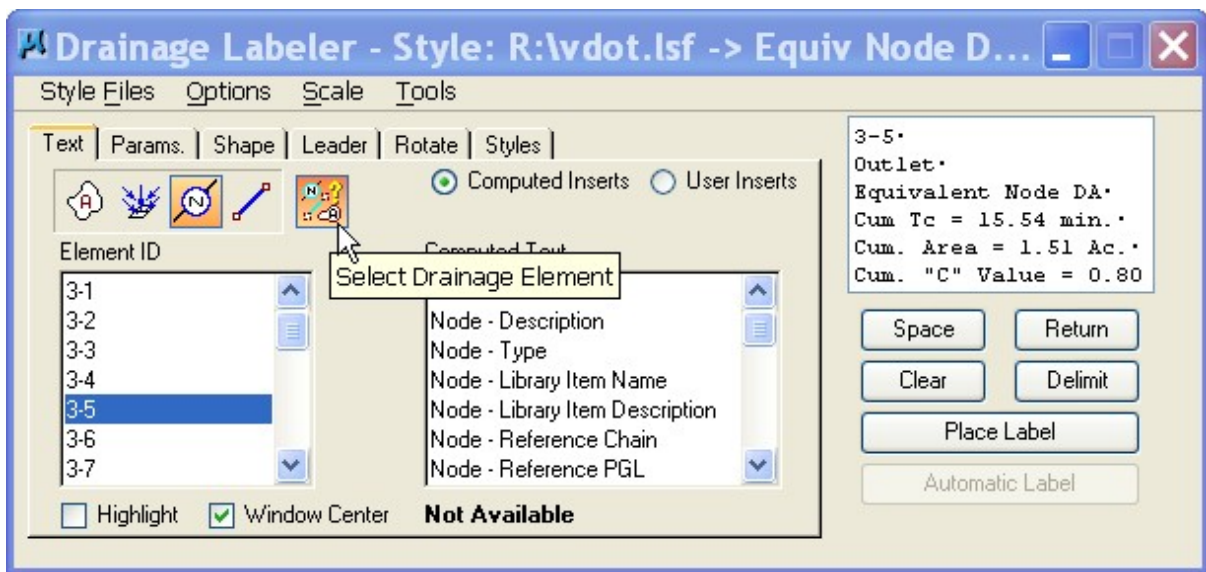
- Once in the **Imperial** folder, scroll down to the individual style formats shown below, and double click on the style format entitled **Equiv Node DA Label 25 Scale**.



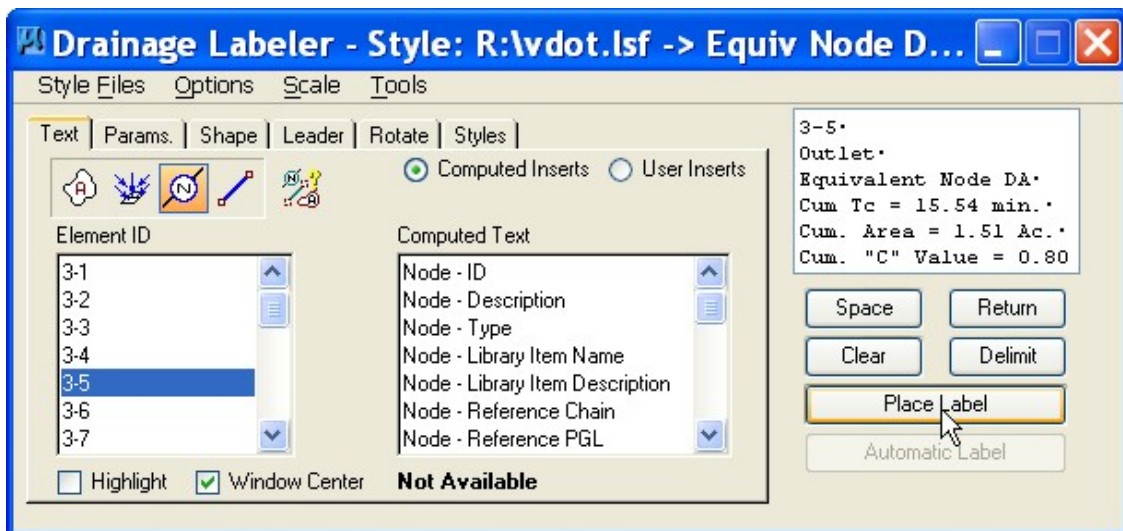
- In this example case, the pre-defined information for Node 3-5 appears in the **Style Preview window**, as shown below. **\*\*Note:** Understand that this style format has been created to display the **Equivalent Drainage Area** information for a selected **node**, and will not work with actual drainage area components defined in GEOPAK

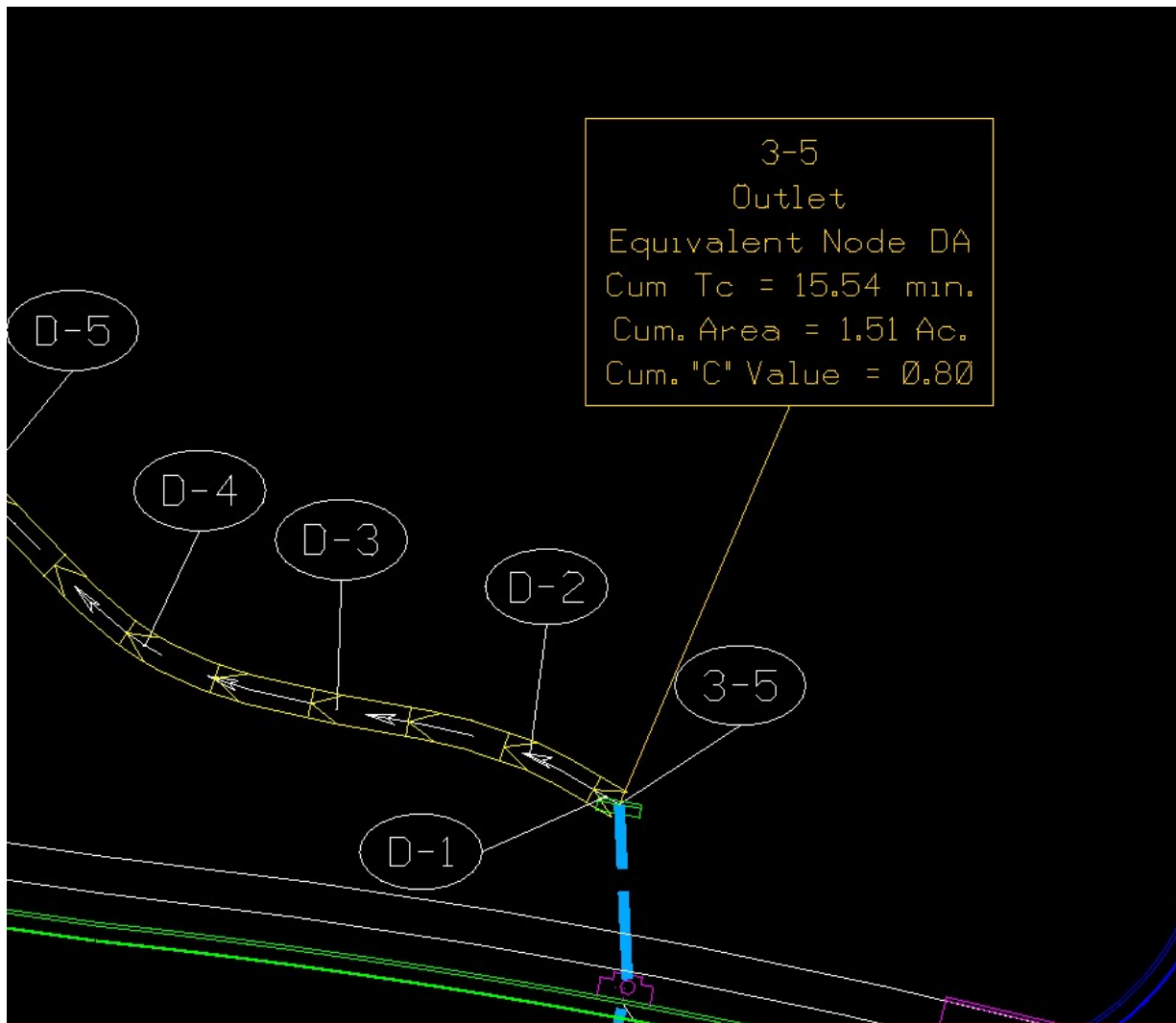
Drainage; two other styles entitled **Drainage Area Label Scale 25** and **Drainage Area Label Scale 50** have been created to work with **Drainage Areas**. Additional styles have also been created in the **Imperial folder** for labeling drainage structures and pipes, although the labeling for pipes will need to be manually edited to remove the material description.

- Under normal circumstances, the user will need to return to the **Text Tab** and select a node before the information for that node will be displayed in the **Style Preview Window**. First, the element to be selected is identified as a **node** (by clicking on the **node button**). Then, the user may either select the appropriate node from the **Element ID window**, or by clicking on the **Select Drainage Element button** and then clicking on the graphical element in the MicroStation design file.



- The labeling can then be placed into the Microstation design file by clicking on the **Place Label button**.





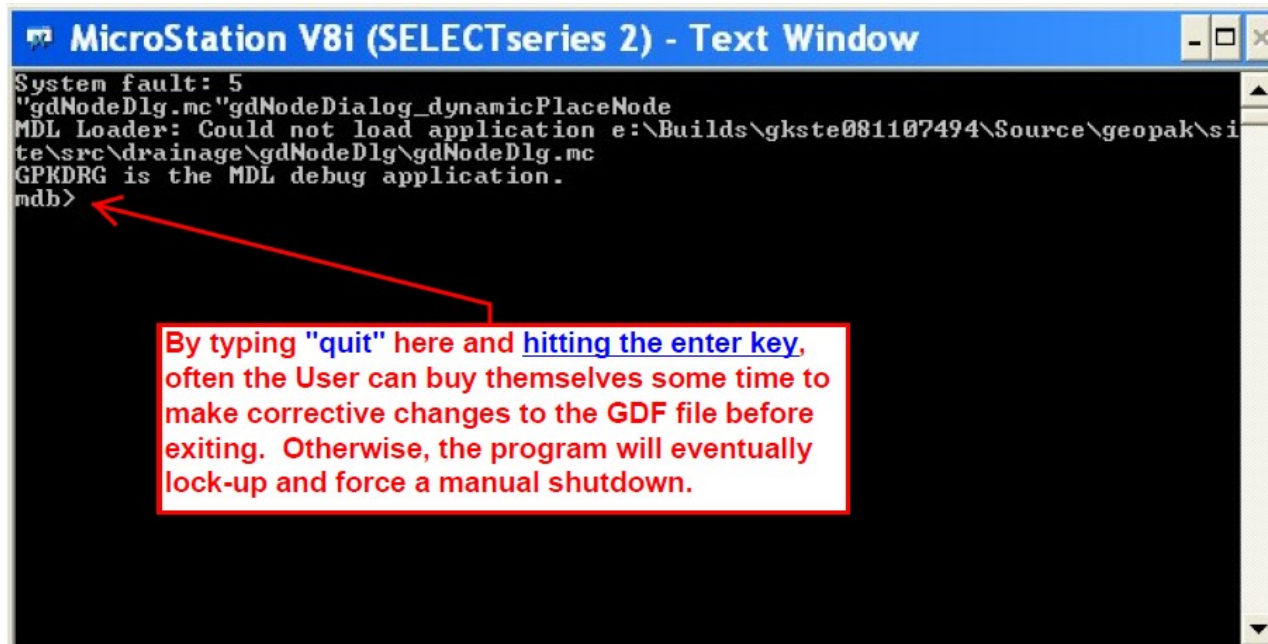
## 9.6.8 Potential Problems, Errors & Lock-ups

This section has been included in an attempt to further discuss some of the common errors/problems encountered when using GEOPAK Drainage, in hopes that helping users to avoid these errors and subsequent program lock-ups. Some of the more commonly encountered problems are as follows:

### 9.6.8.1 Changes to Outlet Nodes after Building a Network

Many program crashes will occur from manipulation of a network's **Outlet Node** after the network has been built. For example, attempting to change a node, that is defined as the outlet of a built network, to a **Node Type: Other** node will almost assuredly cause a program crash. This creates a situation where the program searches for the outlet of the defined network, but can never find it. This can lead to the appearance of the window shown below. This is a common mistake made during **Phases II & III** of **Combined Network** creation outlined in [Section 9.6.5.1](#), where outlet nodes either are modified to be non-outlet nodes or deleted altogether. It is essential to delete the associated network first, before attempting those actions (delete the network, but not its components).

As noted in the window shown below, the user, by typing "quit" where shown and hitting the enter key, can often buy themselves some time to make corrective changes to the GDF file before exiting. Otherwise, the program will eventually lock-up and force a manual shutdown.



```
MicroStation V8i (SELECTseries 2) - Text Window
System fault: 5
"gdNodeDlg.mc"gdNodeDialog_dynamicPlaceNode
MDL Loader: Could not load application e:\Builds\gkste081107494\Source\geopak\si
te\src\drainage\gdNodeDlg\gdNodeDlg.mc
GPKDRG is the MDL debug application.
mdb>
```

By typing "quit" here and hitting the enter key, often the User can buy themselves some time to make corrective changes to the GDF file before exiting. Otherwise, the program will eventually lock-up and force a manual shutdown.

### 9.6.8.2 DRGLOC (Drainage Lock) File

Whenever the user opens a **GDF file**, a **\*.drgLoc (Drainage Lock) file** is created in the project folder, on the GEOPAK Server where the project resides. The purpose of this file is to prevent two (2) users from opening the **GDF file** at the same time. Usually, this file is automatically deleted when the user exits the program under normal circumstances. However, if the program lock-up and/or shuts down under abnormal circumstances, this file can remain. This file will need to be located and deleted before the user can open the GDF again. If this situation occurs, a message informing the user that the **GDF file** has been locked will appear when trying to open the file.

### 9.6.8.3 Re-running VBAs after an Initial Failure

*If at once you don't succeed...try...try again.*

This means exactly what it implies. Occasionally, VBAs will fail to run correctly when initiated. In some cases, closing and re-opening **GEOPAK**, **GEOPAK Drainage** and **Microstation**, then re-initiating the VBA, can solve this. This seems to be particularly true with the **Utility Test Hole VBA**. For unknown reasons, it often fails to run correctly on the first attempt. Under these circumstances, the user should first delete any **Test Hole nodes and links** that were partially created in the unsuccessful run. These **Test Hole node and link names** have a TH prefix, if utilizing the standard nomenclature. Then, follow the procedure previously described in this paragraph by closing and re-opening GEOPAK, GEOPAK Drainage and MicroStation, then re-initiating the VBA.

#### 9.6.8.4 Excel Running in the Background Unseen

On occasion, users may encounter this issue when running a VBA that produces output in the form of an **Excel** spreadsheet. In these situations, the VBA will fail to run to completion. This can be recognized by the VBA failing to inform the user that the output file was created, or failing to ask the user if they would like to open the output file). On a re-run of the VBA, the user will be prompted with a message indicating that the output file is already open in **Excel**, and possibly also that it has been locked by the user. To resolve this problem, the user will need to initiate the **Windows Task Manager** (pressing Ctrl-Alt-Del simultaneously), go to the **Processes Tab**, scroll down the list until **excel.exe** is located, selecting it, and then hitting the **End Process button**. The user should then locate the output file that was created and delete it, then re-run the VBA from the beginning.

#### 9.6.8.5 The Importance of Reference Files in Maintaining Network Topology

**Topology** refers to the spatial location and physical arrangement of the various components (nodes, links, etc.) of a network. The user should always have the roadway design file referenced and displayed when attempting to validate or build a network. Otherwise, the network components may lose their topology, particularly in regards to nodes that are placed tangent on or tangent to elements (curb-lines, EPs, etc.) in the roadway design file.

#### 9.6.8.6 Security Updates

On rare occasions, security updates from Microsoft will have effects on the script (command language) that VBAs are written in. An indication that this problem is present will be an error message such as the following:

*VBA Interface error: unable to run macro - 0x80004003*

Users should contact CADD Support or Hydraulics upon encountering this type of message.