9.4.1 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. ***SUDA Drainage*** may be used 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.

9.4.2 Files

The following section describes several different types of files utilized by the SUDA Drainage software, these are standard files provided by VDOT.

9.4.2.1 Feature Definitions (.dgnlib)

This file contains all the information about the components of drainage systems such as inlet, junctions, and conduits (pipes).

9.4.2.2 Cell Library

This file contains the 2D and 3D information for displaying drainage elements from SUDA in Microstation.

9.4.2.3 File Types Utilized by SUDA Drainage

Unlike GEOPAK, SUDA stores all information relevant to the design within the associated MicroStation file.

9.4.3 Visual Basic Applications (VBAs)

Bentley & VDOT have collaborated to create four (4) new Visual Basic Applications (VBAs) to work in conjunction with the SUDA Drainage software. Several work processes using the GEOPAK VBAs have been replaced with alternate workflows due to differences between the SUDA and GEOPAK environments. These applications and functions will help to streamline and support, in SUDA Drainage, the workflow process essential to VDOT drainage design. The following sections provide a brief description of each of the four (4) applications and functions replacing existing GEOPAK VBAs.

9.4.3.1 Spread Analysis Tabulation Flex Table

This feature creates a formatted table ***Inlet Spread Tabulation Report***, similar in content to the **LD-204** form report, from the design and analysis information contained within the embedded SUDA design. This Flex Table replaces the GEOPAK Inlet Spread Analysis Tabulation VBA. The table can be printed or exported to **Excel** for

additional editing. See Section 9.5 for full usage instructions.

9.4.3.2 Storm Sewer Flex Table

This feature creates a formatted table ***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 embedded SUDA design. This Flex Table replaces the GEOPAK Storm Sewer VBA. The table can be printed or exported to **Excel** for additional editing. See Section 9.5 for full usage instructions.

9.4.3.3 Storm Sewer Tabulation Flex Table

This feature creates a formatted table ***Storm Sewer Tabulation Report***, similar in content to the **LD-347** form report with additional hydraulic grade-line (HGL) information, from the design and analysis information contained within the embedded SUDA design. This Flex Table replaces the GEOPAK Storm Sewer VBA. The table can be printed or exported to **Excel** for additional editing. See Section 9.5 for full usage instructions.

9.4.3.4 Utility Test-Hole VBA

The application imports user provided utility data to SUDA 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.

9.4.3.5 Drainage Profile Labeler VBA

The application reformates the symbology of the SUDA 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.

9.4.3.6 Drainage Descriptions VBA

This application reads the nodes and links from the embedded SUDA design information, 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 9.5 for full usage instructions.

9.4.3.7 Drainage Summary VBA

This application reads the embedded SUDA design information, 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 9.5 for full usage instructions.

9.4.3.8 Drainage Import Function

The purpose of this function is to provide a method for importing drainage designs, created utilizing GEOPAK, into SUDA Drainage. The application will read and accept information from the GEOPAK .gdf file and import it into the SUDA 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 ***SUDA design information*** are required. See Section 9.4 and Section 9.5 for full usage instructions.

9.4.4 Storm Sewer Profiles

The finished **Storm Sewer Profiles** will be a product of the SUDA 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.

9.4.4.1 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

DES_PLANSHEET_SSPROFILE and ***DES_PLANSHEET_SSPROFILE2***. The ***DES_PLANSHEET_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 ***DES_PLANSHEET_SSPROFILE2*** cell contains just the notes relative to the drainage system and is intended for use without the test hole data being place on the finished **Storm Sewer Profiles.** The cells are part of the MicroStation ***sheet2015 cell library*** located in \\coapp52\proj\supv8i\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 SUDA Drainage "design process" profiles, before running the ***Drainage Profile Labeler VBA*** and subsequent placement of the "finished" drainage profiles on the sheets.

9.4.4.2 Placement in the Project Plan Assembly

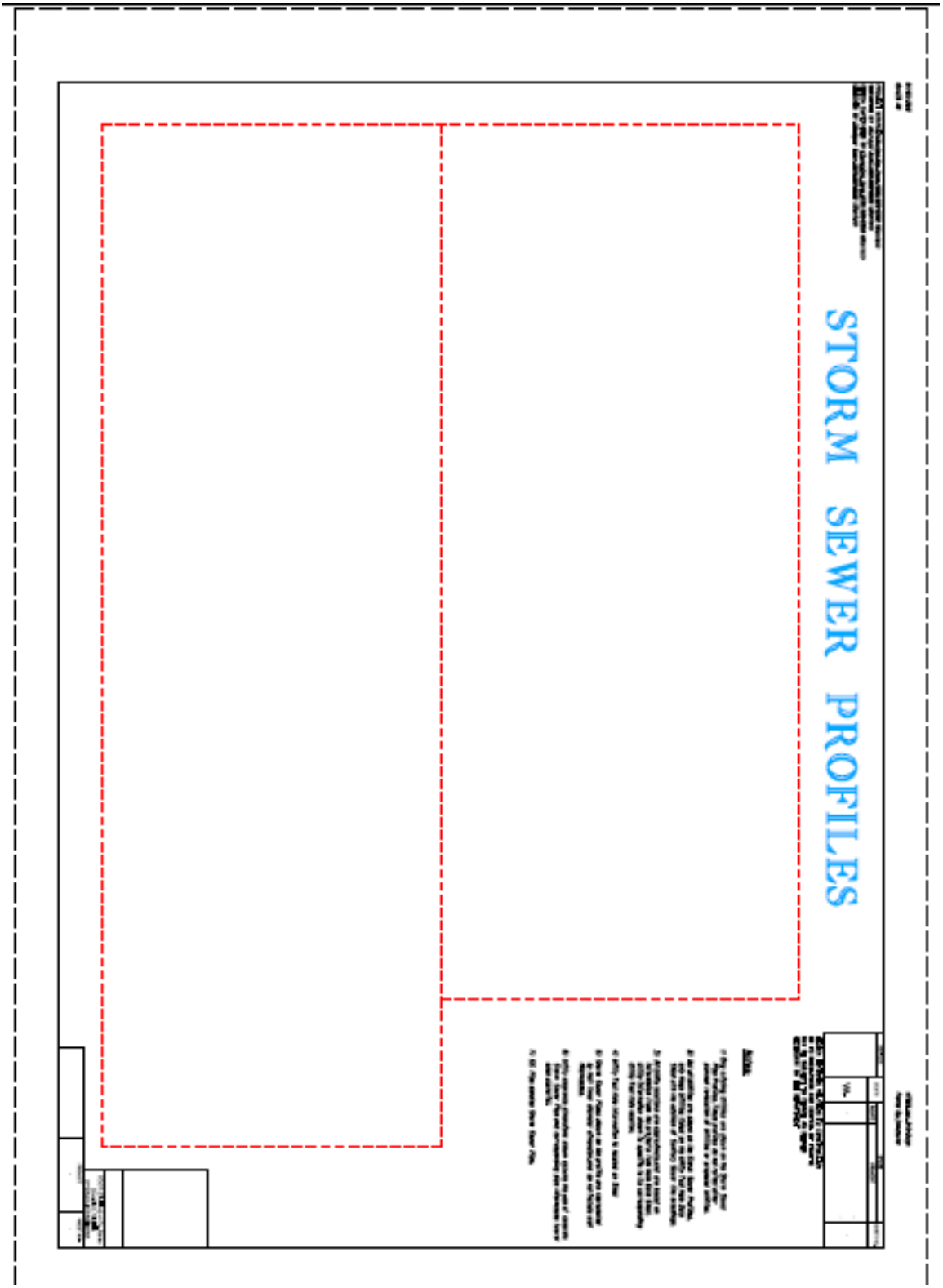
The project **Drainage Descriptions** and **Storm Sewer Profile Sheets** shall be grouped together and assigned their own sheet number. The sheet number following the last roadway profile sheet, or entrance profile sheet, whichever comes last shall be assigned to the **Drainage Descriptions** and **Storm 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 9-1 Description and Profile Sheet Numbering

Sheet Number	Description
Plan Sheet 3	(1st roadway plan sheet)
Plan Sheet 4	(2nd roadway plan sheet)
Plan Sheet 5	(3rd 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)
Plan Sheet 6D	(Environmental Commitment plan for Plan Sheet 6)
Plan Sheet 7(1)	**(1st sheet of Drainage Descriptions)**
Plan Sheet 7(2)	**(2nd sheet of Drainage Descriptions)**
Plan Sheet 8(1)	**(1st sheet of Storm Sewer Profiles)**
Plan Sheet 8(2)	**(2nd sheet of Storm Sewer Profiles)**
Plan Sheet 8(3)	**(3rd sheet of Storm Sewer Profiles)**
Plan Sheet 9	(1st sheet of Sign Plans, if applicable)

Figure 9-1 Storm Sewer Profile Sheet



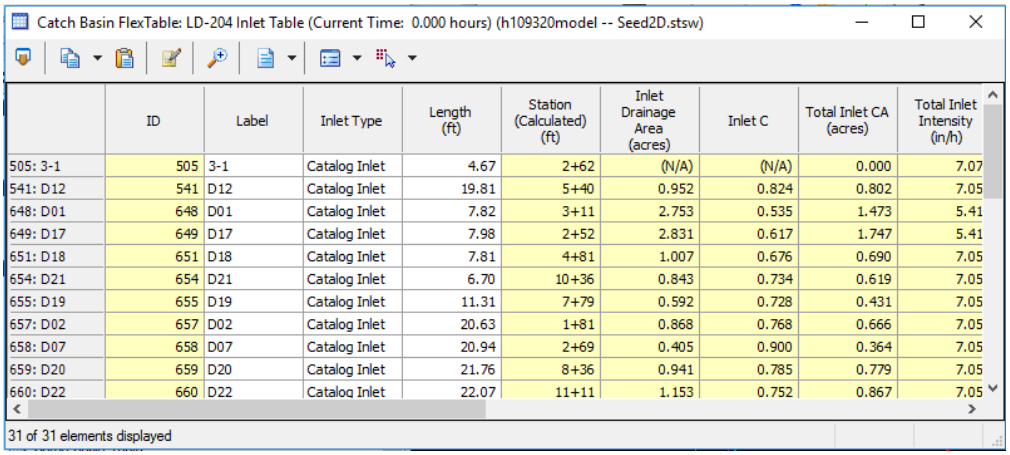
9.5 Bentley Instructions for SUDA Drainage VBA's

9.5.1 VDOT Spread Analysis Flex Table

The Spread Analysis Flex Table will read a **SUDA Drainage file** and populate the ***Spread Analysis table*** similar to the VDOT LD-204 form in a format that can be printed directly or exported to an **Excel** format.

Prior to processing the ***LD-204 Inlet Table*** flex table the user must have the SUDA drainage design developed with at least one drainage network completed and analyzed. By default the table will display results for all active inlet in the design file. If multiple networks are created in the drainage file, the table can be created for the desired network or group of inlet can be created by manually selecting the inlets in the file or through the use of ***Selection Sets***.

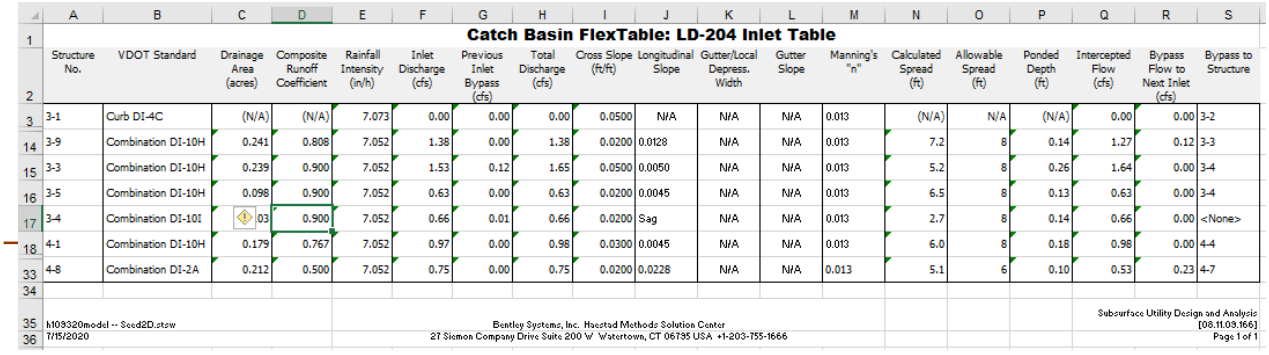
The table is accessed through the menu ***Subsurface Utility > View > Flex Tables***. Under the ***Hydraulic Analysis > Tables – Project*** heading under flex tables the LD-204 Inlet Table flex table can be opened. This will display the calculated results for the selected inlets.


Catch Basin FlexTable: LD-204 Inlet Table (Current Time: 0.000 hours) (h109320model -- Seed2D.stsw)

	ID	Label	Inlet Type	Length (ft)	Station (Calculated) (ft)	Inlet Drainage Area (acres)	Inlet C	Total Inlet CA (acres)	Total Inlet Intensity (in/h)
505: 3-1	505	3-1	Catalog Inlet	4.67	2+62	(N/A)	(N/A)	0.000	7.07
541: D12	541	D12	Catalog Inlet	19.81	5+40	0.952	0.824	0.802	7.05
648: D01	648	D01	Catalog Inlet	7.82	3+11	2.753	0.535	1.473	5.41
649: D17	649	D17	Catalog Inlet	7.98	2+52	2.831	0.617	1.747	5.41
651: D18	651	D18	Catalog Inlet	7.81	4+81	1.007	0.676	0.690	7.05
654: D21	654	D21	Catalog Inlet	6.70	10+36	0.843	0.734	0.619	7.05
655: D19	655	D19	Catalog Inlet	11.31	7+79	0.592	0.728	0.431	7.05
657: D02	657	D02	Catalog Inlet	20.63	1+81	0.868	0.768	0.666	7.05
658: D07	658	D07	Catalog Inlet	20.94	2+69	0.405	0.900	0.364	7.05
659: D20	659	D20	Catalog Inlet	21.76	8+36	0.941	0.785	0.779	7.05
660: D22	660	D22	Catalog Inlet	22.07	11+11	1.153	0.752	0.867	7.05

31 of 31 elements displayed

From the menu the user should select ***Report > Report in Current Time Step*** to generate a preview of the report for printing or exporting. From the report preview view the user can use the File menu to select printing or the option to export the report to various formats including PDF, text, or Excel.


Catch Basin FlexTable: LD-204 Inlet Table

Structure No.	VDOT Standard	Drainage Area (acres)	Composite Runoff Coefficient	Rainfall Intensity (in/h)	Inlet Discharge (cfs)	Previous Inlet Bypass (cfs)	Total Discharge (cfs)	Cross Slope (ft/ft)	Longitudinal Slope	Gutter/Local Depress. Width	Gutter Slope	Manning's "n"	Calculated Spread (ft)	Allowable Spread (ft)	Ponded Depth (ft)	Intercepted Flow (cfs)	Bypass Flow to Next Inlet (cfs)	Bypass to Structure
3-1	Curb DI-4C	(N/A)	(N/A)	7.073	0.00	0.00	0.00	0.0500	N/A	N/A	N/A	0.013	(N/A)	N/A	(N/A)	0.00	0.00	3-2
3-9	Combination DI-10H	0.241	0.808	7.052	1.38	0.00	1.38	0.0200	0.0128	N/A	N/A	0.013	7.2	8	0.14	1.27	0.12	3-3
3-3	Combination DI-10H	0.239	0.900	7.052	1.53	0.12	1.65	0.0500	0.0050	N/A	N/A	0.013	5.2	8	0.26	1.64	0.00	3-4
3-5	Combination DI-10H	0.098	0.900	7.052	0.63	0.00	0.63	0.0200	0.0045	N/A	N/A	0.013	6.5	8	0.13	0.63	0.00	3-4
3-4	Combination DI-10I	03	0.900	7.052	0.66	0.01	0.66	0.0200	Sag	N/A	N/A	0.013	2.7	8	0.14	0.66	0.00	<None>
4-1	Combination DI-10H	0.179	0.767	7.052	0.97	0.00	0.98	0.0300	0.0045	N/A	N/A	0.013	6.0	8	0.18	0.98	0.00	4-4
4-8	Combination DI-2A	0.212	0.500	7.052	0.75	0.00	0.75	0.0200	0.0228	N/A	N/A	0.013	5.1	6	0.10	0.53	0.23	4-7

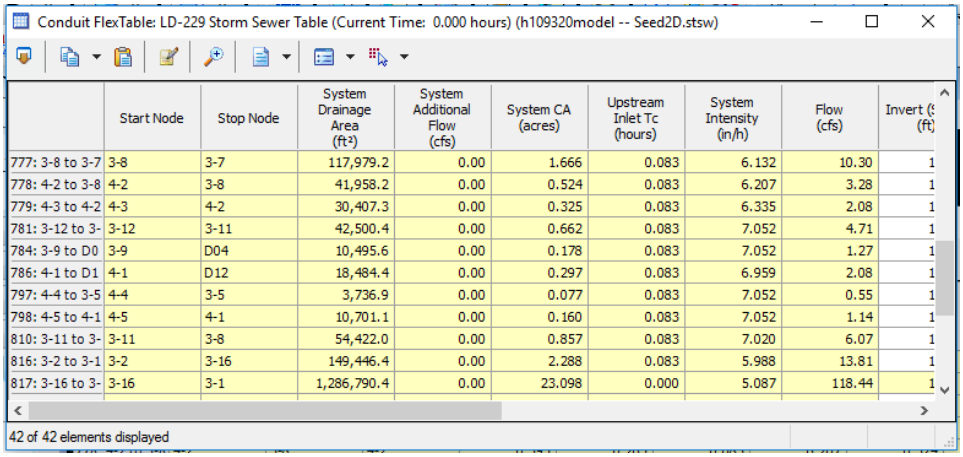
h109320model -- Seed2D.stsw
7/15/2020
Bentley Systems, Inc. Haestad Methods Solution Center
27 Siemon Company Drive Suite 200 W Watertown, CT 06795 USA +1-203-755-1666
Subsurface Utility Design and Analysis [08.11.03.166]
Page 1 of 1

9.5.2 VDOT Storm Sewer Tabulation Flex Tables

The Storm Sewer and Storm Sewer Tabulation Flex Tables will read a **SUDA Drainage file** and populate the ***Storm Sewer table*** and ***Storm Sewer Tabulation table*** similar to the VDOT LD-229 and LD-347 forms in a format that can be printed directly or exported to an **Excel** format.

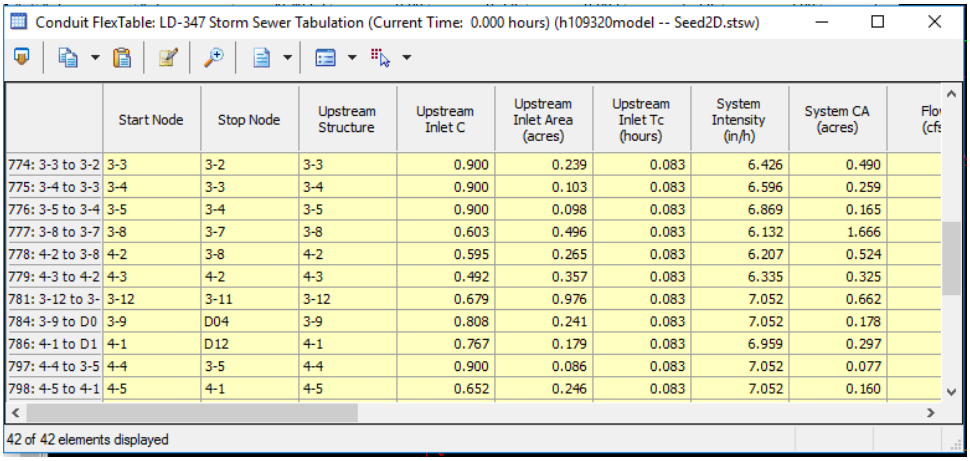
Prior to processing the ***LD-229 Storm Sewer Table*** and ***LD-347 Storm Sewer Tabulation*** flex tables the user must have the SUDA drainage design developed with at least one drainage network completed and analyzed. By default the table will display results for all active inlet in the design file. If multiple networks are created in the drainage file, the table can be created for the desired network or group of inlet can be created by manually selecting the inlets in the file or through the use of ***Selection Sets***.

The table is accessed through the menu ***Subsurface Utility > View > Flex Tables***. Under the ***Hydraulic Analysis > Tables – Project*** heading under flex tables the LD-229 Storm Sewer Table and LD-347 Storm Sewer Tabulation flex tables can be opened. This will display the calculated results for the selected inlets.



	Start Node	Stop Node	System Drainage Area (ft²)	System Additional Flow (cfs)	System CA (acres)	Upstream Inlet Tc (hours)	System Intensity (in/h)	Flow (cfs)	Invert (ft)
777: 3-8 to 3-7	3-8	3-7	117,979.2	0.00	1.666	0.083	6.132	10.30	1
778: 4-2 to 3-8	4-2	3-8	41,958.2	0.00	0.524	0.083	6.207	3.28	1
779: 4-3 to 4-2	4-3	4-2	30,407.3	0.00	0.325	0.083	6.335	2.08	1
781: 3-12 to 3-	3-12	3-11	42,500.4	0.00	0.662	0.083	7.052	4.71	1
784: 3-9 to D0	3-9	D04	10,495.6	0.00	0.178	0.083	7.052	1.27	1
786: 4-1 to D1	4-1	D12	18,484.4	0.00	0.297	0.083	6.959	2.08	1
797: 4-4 to 3-5	4-4	3-5	3,736.9	0.00	0.077	0.083	7.052	0.55	1
798: 4-5 to 4-1	4-5	4-1	10,701.1	0.00	0.160	0.083	7.052	1.14	1
810: 3-11 to 3-	3-11	3-8	54,422.0	0.00	0.857	0.083	7.020	6.07	1
816: 3-2 to 3-1	3-2	3-16	149,446.4	0.00	2.288	0.083	5.988	13.81	1
817: 3-16 to 3-	3-16	3-1	1,286,790.4	0.00	23.098	0.000	5.087	118.44	1

42 of 42 elements displayed



	Start Node	Stop Node	Upstream Structure	Upstream Inlet C	Upstream Inlet Area (acres)	Upstream Inlet Tc (hours)	System Intensity (in/h)	System CA (acres)	Flo (cfs
774: 3-3 to 3-2	3-3	3-2	3-3	0.900	0.239	0.083	6.426	0.490	
775: 3-4 to 3-3	3-4	3-3	3-4	0.900	0.103	0.083	6.596	0.259	
776: 3-5 to 3-4	3-5	3-4	3-5	0.900	0.098	0.083	6.869	0.165	
777: 3-8 to 3-7	3-8	3-7	3-8	0.603	0.496	0.083	6.132	1.666	
778: 4-2 to 3-8	4-2	3-8	4-2	0.595	0.265	0.083	6.207	0.524	
779: 4-3 to 4-2	4-3	4-2	4-3	0.492	0.357	0.083	6.335	0.325	
781: 3-12 to 3-	3-12	3-11	3-12	0.679	0.976	0.083	7.052	0.662	
784: 3-9 to D0	3-9	D04	3-9	0.808	0.241	0.083	7.052	0.178	
786: 4-1 to D1	4-1	D12	4-1	0.767	0.179	0.083	6.959	0.297	
797: 4-4 to 3-5	4-4	3-5	4-4	0.900	0.086	0.083	7.052	0.077	
798: 4-5 to 4-1	4-5	4-1	4-5	0.652	0.246	0.083	7.052	0.160	

42 of 42 elements displayed

From the menu the user should select ***Report > Report in Current Time Step*** to generate a preview of the report for printing or exporting. From the report preview view the user can use the File menu to select printing or the option to export the report to

various formats including PDF, text, or Excel.

Conduit FlexTable: LD-229 Storm Sewer Table

Label	From Point Reference	To Point Reference	Drain Area "A" (acres)	Runoff Coeff. "C"	CA Accumulated (acres)	Inlet Time (min)	Rainfall (in/h)	Runoff Q (cfs)	Invert Elevation Upper End (ft)	Invert Elevation Lower End (ft)	Length of Pipe (ft)	Slope (ft/ft)	Size	Capacity (cfs)	Velocity (ft/s)	Flow Time (hours)
3-6 to 3-2	3-6	3-2	0.031	0.681	1.706	8.486	6.048	10.40	122.10	121.85	50.0	0.0050	Circle - 24.0 in	16.00	3.31	0.004
3-7 to 3-6	3-7	3-6	0.028	0.700	1.681	8.343	6.083	10.31	122.75	122.20	50.0	0.0110	Circle - 18.0 in	11.01	5.83	0.002
3-3 to 3-2	3-3	3-2	0.239	0.900	0.490	7.017	6.426	3.17	122.10	121.85	29.8	0.0084	Circle - 15.0 in	5.92	2.59	0.003
3-4 to 3-3	3-4	3-3	0.103	0.900	0.259	6.422	6.596	1.72	122.50	122.20	50.1	0.0060	Circle - 15.0 in	5.00	1.40	0.010
4-1 to D12	4-1	D12	0.179	0.767	0.297	5.258	6.959	2.08	121.21	119.37	60.1	0.0306	Circle - 15.0 in	11.30	1.70	0.010
4-4 to 3-5	4-4	3-5	0.086	0.900	0.077	4.980	7.052	0.55	123.84	123.00	100.1	0.0084	Circle - 15.0 in	5.92	3.02	0.009
3-10 to 3-15	3-10	3-15	(N/A)	(N/A)	20.172	13.232	5.110	103.90	132.00	130.90	52.4	0.0210	Circle - 48.0 in	208.02	16.55	0.001
3E-1 to 3-17	3E-1	3-17	0.478	0.794	0.380	4.980	7.052	2.70	139.50	138.10	169.1	0.0083	Circle - 48.0 in	130.70	4.16	0.011
3-17 to 3-13	3-17	3-13	(N/A)	(N/A)	0.380	5.658	6.829	2.61	138.00	137.75	55.9	0.0045	Circle - 48.0 in	96.06	3.32	0.005
3-18 to 3-15	3-18	3-15	(N/A)	(N/A)	0.638	5.996	6.723	4.32	135.00	134.75	15.4	0.0162	Circle - 15.0 in	8.23	6.79	0.001
3-13 to 3-18	3-13	3-18	0.416	0.687	0.638	5.938	6.741	4.33	137.65	137.60	12.8	0.0039	Circle - 48.0 in	89.91	3.69	0.001
4-6 to 4-3	4-6	4-3	0.050	0.500	0.163	6.586	6.548	1.07	126.39	124.69	176.7	0.0096	Circle - 15.0 in	6.34	3.84	0.013
4-7 to 4-6	4-7	4-6	0.080	0.500	0.129	5.541	6.866	0.89	127.50	126.49	186.3	0.0054	Circle - 15.0 in	4.76	2.97	0.017
4-8 to 4-7	4-8	4-7	0.212	0.500	0.074	4.980	7.052	0.53	129.50	127.60	124.0	0.0153	Circle - 15.0 in	8.00	3.69	0.009

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Bentley Systems, Inc. Haestad Methods Solution Center
27 Siemon Company Drive Suite 200 W Watertown, CT 06795 USA +1-203-755-1666
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Conduit FlexTable: LD-347 Storm Sewer Tabulation

Label	Structure No. Upper	Structure No. Lower	Composite C Value	Area (acres)	Cumulative Time of Concentration (min)	Intensity (in/h)	Total Accumulated (CA) (acres)	Total Runoff Q (cfs)	Inlet Throat or Manhole Top Elevation (ft)	HGL Clearance	HGL Elevation Upper End (ft)	Crown Elevation Upper End (ft)	Flowline Elevation Upper End (ft)	HGL Elevation Lower End (ft)	Crown Elevation Lower End (ft)	Flowline Elevation Lower End (ft)	Fall	Pipe Length (ft)	Size	Number of Barrels	Friction Slope (ft/ft)	Pipe Slope (ft/ft)	Flow Velocity (ft/s)	Pipe Capacity (cfs)	Time of Flow in Section (hours)	Manning's n
4-3 to 4-2	4-3	4-2	0.492	0.357	7.353	6.333	0.323	2.08	128.39	2.40	126.19	126.00	124.39	126.14	125.61	124.20	0.39	49.8	Circle - 15.0 in	1	0.0010	0.0078	1.69	3.72	0.008	0.013
3-12 to 3-11	3-12	3-11	0.679	0.976	4.980	7.052	0.662	4.71	148.00	9.12	138.88	139.41	138.00	136.39	137.27	135.86	2.14	54.4	Circle - 15.0 in	1	0.0274	0.0393	9.64	12.81	0.002	0.013
3-9 to D04	3-9	D04	0.808	0.241	4.980	7.052	0.178	1.27	128.88	7.54	121.34	123.16	120.93	119.57	120.51	118.30	2.45	55.8	Circle - 24.0 in	1	0.0341	0.0472	6.70	49.30	0.002	0.013
4-1 to D12	4-1	D12	0.767	0.179	5.258	6.959	0.297	2.08	127.87	5.13	122.74	122.62	121.21	122.68	120.78	119.37	1.84	60.1	Circle - 15.0 in	1	0.0010	0.0306	1.70	11.30	0.010	0.013
4-4 to 3-5	4-4	3-5	0.900	0.086	4.980	7.052	0.077	0.55	127.84	2.96	124.88	125.23	123.84	124.87	124.41	123.00	0.84	100.1	Circle - 15.0 in	1	0.0001	0.0084	3.02	5.92	0.009	0.013
4-5 to 4-1	4-5	4-1	0.632	0.246	4.980	7.052	0.160	1.14	128.77	3.52	125.25	126.24	124.83	122.74	122.72	121.31	3.52	102.5	Circle - 15.0 in	1	0.0259	0.0343	6.14	11.97	0.003	0.013
3-11 to 3-8	3-11	3-8	0.631	0.274	5.074	7.020	0.857	6.07	139.26	8.26	131.00	131.41	130.00	126.01	126.30	124.89	5.11	149.9	Circle - 15.0 in	1	0.0339	0.0341	9.76	11.93	0.004	0.013
3-2 to 3-16	3-2	3-16	0.663	0.138	8.737	5.988	2.288	13.81	128.47	3.72	124.75	123.96	121.75	124.53	123.56	121.35	0.40	59.6	Circle - 24.0 in	1	0.0037	0.0067	4.40	18.34	0.004	0.013
3-16 to 3-1	3-16	3-1	(N/A)	(N/A)	13.371	5.087	23.098	118.44	129.02	4.49	124.53	125.58	121.25	123.26	125.01	120.68	0.57	9.0	Circle - 48.0 in	1	0.0099	0.0623	25.75	361.33	0.000	0.013
3-14 to 3-16	3-14	3-16	(N/A)	(N/A)	13.338	5.092	20.810	106.82	143.14	9.81	133.33	134.53	130.20	123.31	126.13	121.80	8.40	65.1	Circle - 48.0 in	1	0.0351	0.1291	32.38	516.09	0.001	0.013
3-15 to 3-14	3-15	3-14	(N/A)	(N/A)	13.284	5.101	20.810	107.00	143.76	9.83	133.93	135.13	130.80	132.99	134.63	130.30	0.50	42.5	Circle - 48.0 in	1	0.0079	0.0118	13.38	155.78	0.002	0.013
3-10 to 3-15	3-10	3-15	(N/A)	(N/A)	13.232	5.110	20.172	103.90	130.40	95.31	135.09	136.33	132.00	133.24	135.23	130.90	1.10	52.4	Circle - 48.0 in	1	0.0100	0.0210	16.33	208.02	0.001	0.013
3E-1 to 3-17	3E-1	3-17	0.794	0.478	4.980	7.052	0.380	2.70	151.83	11.88	139.97	143.83	139.50	138.30	142.43	138.10	1.40	169.1	Circle - 48.0 in	1	0.0081	0.0083	4.16	130.70	0.011	0.013
3-17 to 3-13	3-17	3-13	(N/A)	(N/A)	5.658	6.829	0.380	2.61	149.56	11.69	138.47	142.33	138.00	138.25	142.08	137.75	0.25	55.9	Circle - 48.0 in	1	0.0044	0.0045	3.32	96.06	0.005	0.013
3-18 to 3-15	3-18	3-15	(N/A)	(N/A)	5.996	6.723	0.638	4.32	144.94	9.10	135.84	136.41	135.00	135.44	136.16	134.75	0.25	15.4	Circle - 15.0 in	1	0.0111	0.0162	6.79	8.23	0.001	0.013
3-13 to 3-18	3-13	3-18	0.687	0.416	5.938	6.741	0.638	4.33	144.66	6.41	138.25	141.98	137.65	138.20	141.93	137.60	0.05	12.8	Circle - 48.0 in	1	0.0039	0.0039	3.69	89.91	0.001	0.013
4-6 to 4-3	4-6	4-3	0.500	0.050	6.586	6.548	0.163	1.07	130.39	3.59	126.80	127.65	126.39	126.19	125.93	124.69	1.70	176.7	Circle - 15.0 in	1	0.0042	0.0096	3.84	6.34	0.013	0.013
4-7 to 4-6	4-7	4-6	0.500	0.080	5.541	6.866	0.129	0.89	133.06	5.19	127.87	128.76	127.50	126.86	127.75	126.49	1.01	186.3	Circle - 15.0 in	1	0.0054	0.0054	2.97	4.76	0.017	0.013
4-8 to 4-7	4-8	4-7	0.500	0.212	4.980	7.052	0.074	0.53	135.81	6.03	129.78	130.76	129.50	127.82	128.86	127.60	1.90	124.0	Circle - 15.0 in	1	0.0150	0.0153	3.69	8.00	0.009	0.013

h109320model -- Seed2D.stsw
7/15/2020
Bentley Systems, Inc. Haestad Methods Solution Center
27 Siemon Company Drive Suite 200 W Watertown, CT 06795 USA +1-203-755-1666
Subsurface Utility Design and Analysis
[08.11.09.166]
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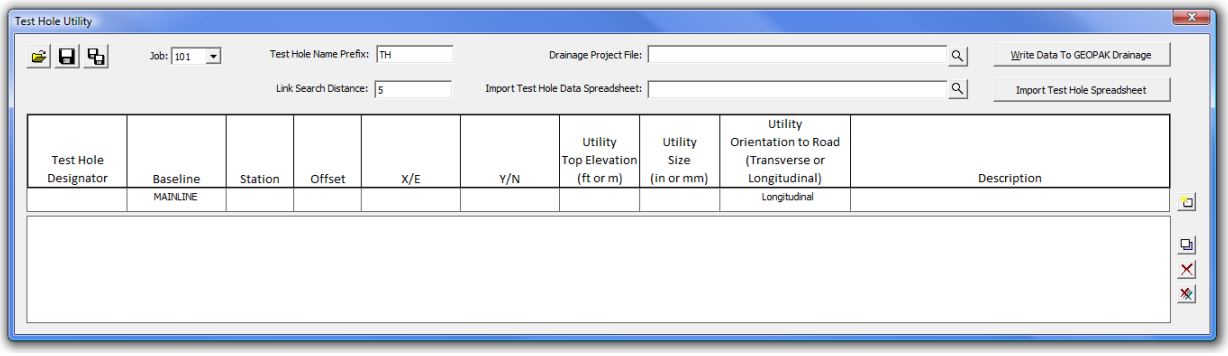
9.5.3 VDOT Test Hole Utility

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 it 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 if the data fields to add it to the list. Additional utilities can be added to the list as needed.

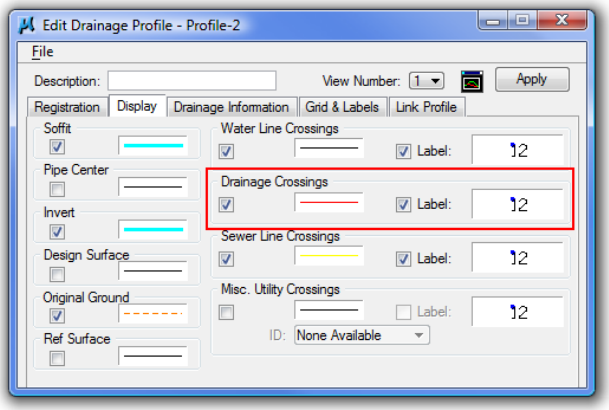
To modify an entry in the list, select the entry in the list. This displays the entry in the entry fields. Make the desired changes. Press the ***Modify button*** to make the changes in the list.

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.



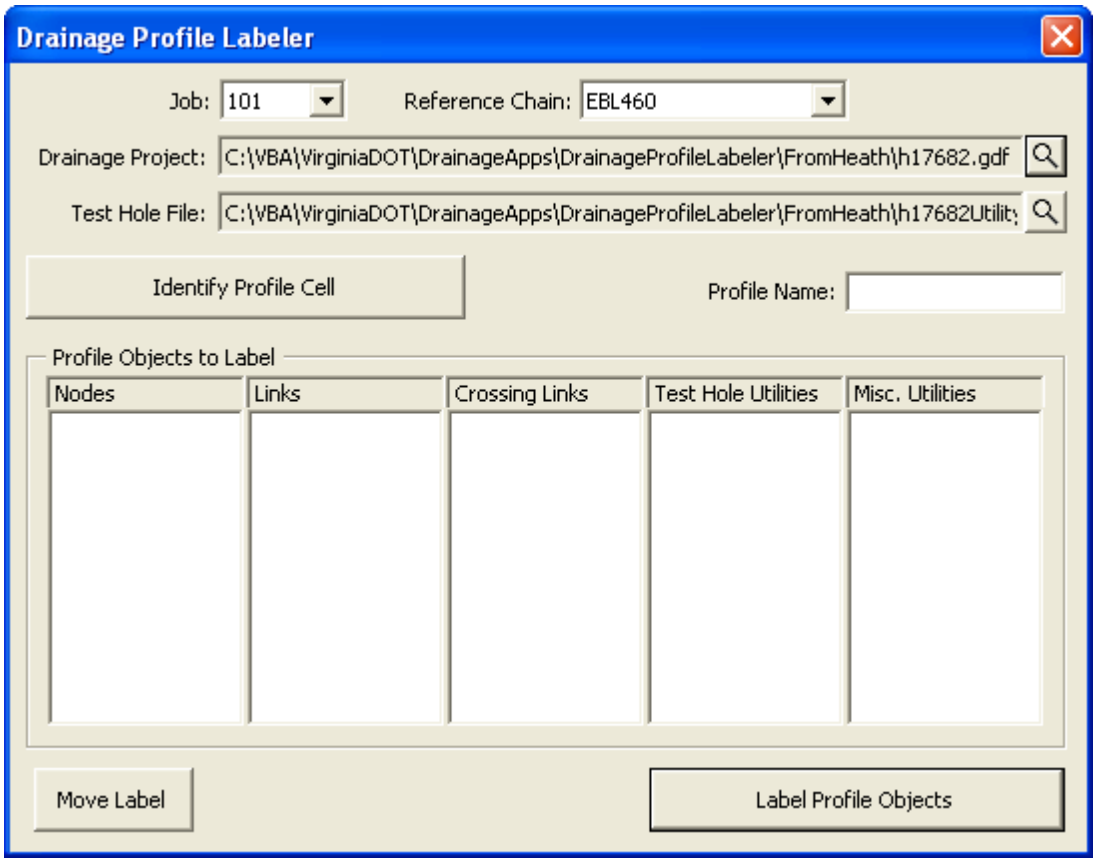
The user has the opportunity to save the dialog settings into a settings file. When the **Test Hole Utility application** is opened, it will search the current directory for the settings file. If a settings file is found, the dialog will be populated with the information from the first settings file 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.

9.5.4 VDOT 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 ***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.

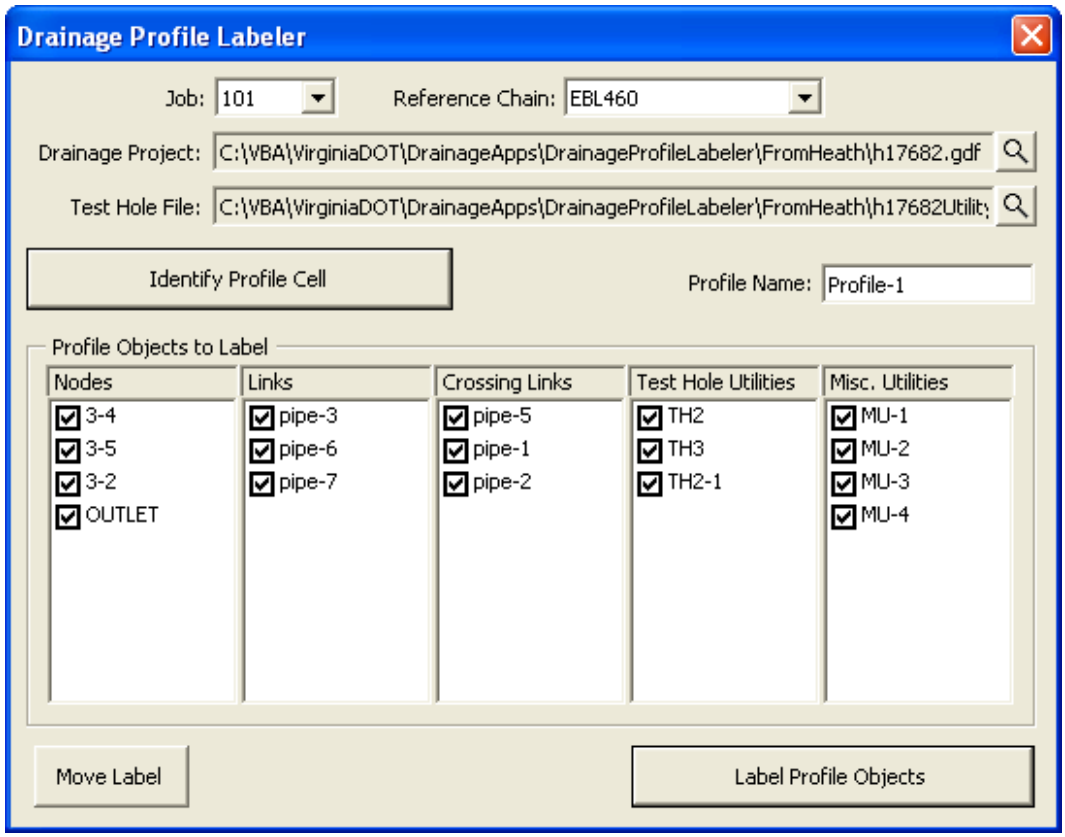
The user will first select the ***COGO job*** that contains the chain they wish to reference stationing from, and then select the reference chain itself. These may already be selected by default but the user should check to make sure.

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:



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

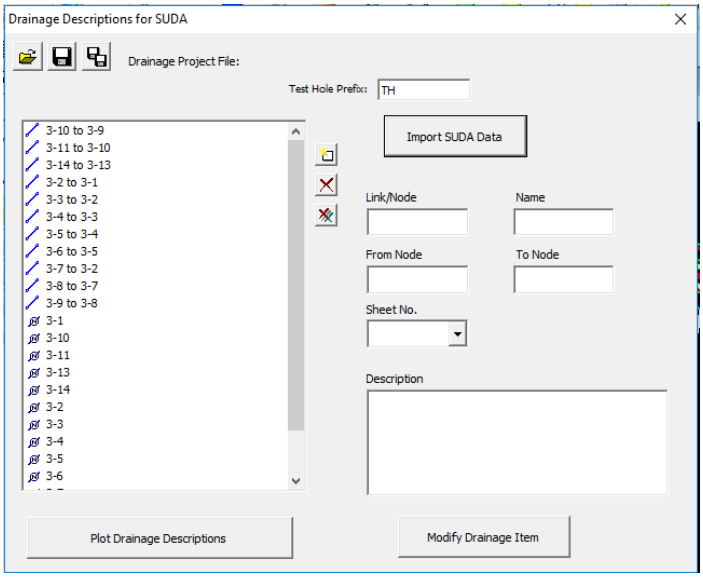
Once the user has reviewed those objects found within the profile to be labeled they will click the ***Label Profile Objects button*** which will commence the labeling process.

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.

9.5.5 VDOT Drainage Descriptions

The ***Drainage Description application*** will import the nodes and links from a **SUDA 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.



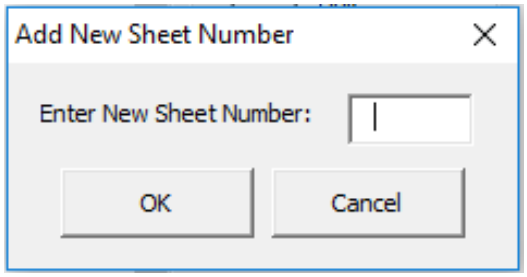
The user must first import the Drainage information by pressing the ***Import SUDA Data button***. The drainage nodes and links will be placed in tree on the left side of the dialog. If any items are added to the drainage file, the file can be re-imported. Only the new items will be added to the drainage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

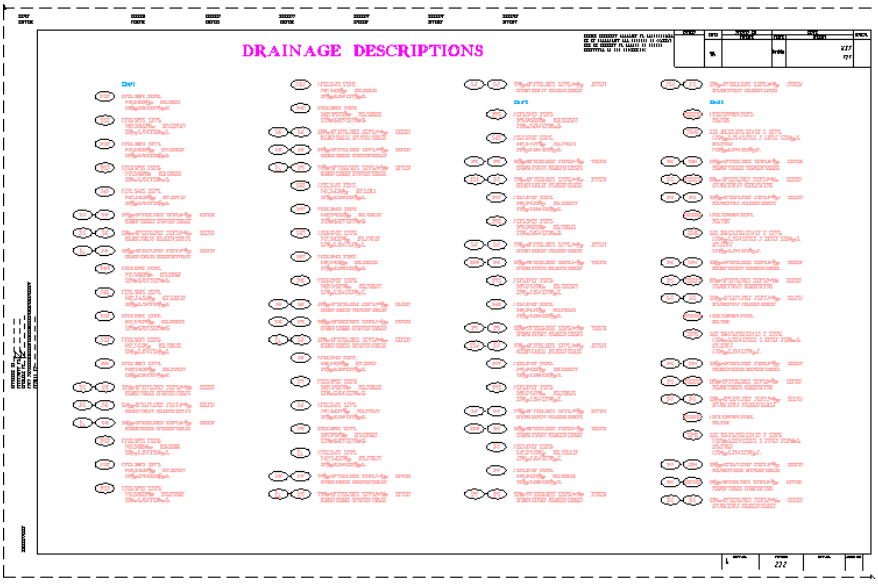
Drainage items can also be arranged into sheets using the tree view. Once the sheet has been created, drag the drainage items into the desired sheet. The order of the sheets or drainage items can also be changed by dragging the item to the desired location. The item being moved will be placed after the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

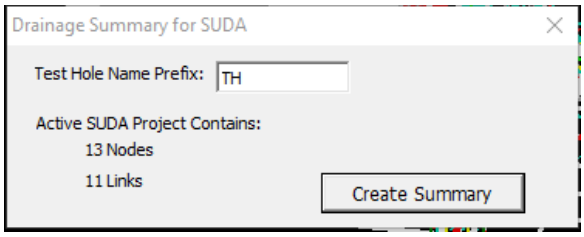
Once the drainage items and sheets are set, the descriptions can be plotted into the active **.dgn file** by pressing the ***Plot Drainage Descriptions button***. This will delete any existing sheets in the **.dgn file**, and plot the new description sheets into the **.dgn file**.



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.

9.5.6 VDOT Drainage Summary

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



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

Structure	Cover	Pipe			Concrete Pipe				EndSections			End Wall		Height of Drop Inlet	lets - Length, Type, and M		Manhole	Remarks
			Elliptical/Arch					Elliptical/Arch	ES-1 or 2	ES-3					DI-2 SERIES	DI-3 SEIRES		
		15"	38" x 57"	85" x 116"	15"	18"	21"	42" x 27"	18"	28"x20"	42"x29"	EW-1: 36" Conc. Pipe	EW-2: 1.5:1 48" Conc. Pipe		DI-2A	DI-3B, L= 8'	MH-1 or 2	
		FT	FT	FT	FT	FT	FT	FT	EA	EA	EA	CY	CY	FT	EA	EA	EA	
3-1														4.25	1			
3-2											1							
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	

9.5.7 VDOT Drainage Import

The ***Drainage Import application*** will allow storm sewer design from legacy GEOPAK projects to imported into SUDA. From the menu the user will select ***Susurface Utility > Project > Import > Bentley GEOPAK***. The used will then select the appropriate GEOPAK .gdf file.

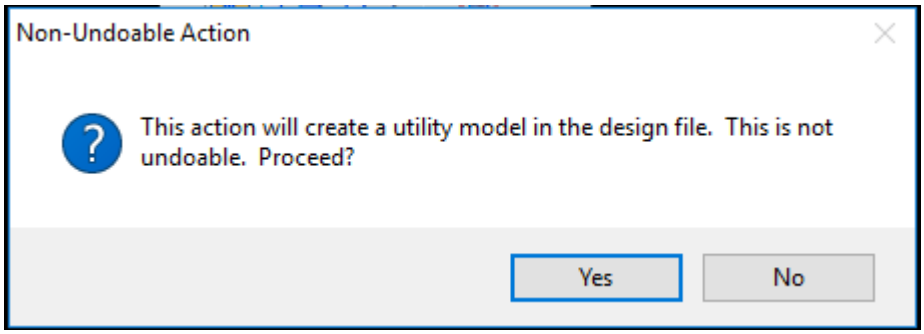
It is important to note this will carry over many aspects of the existing drainage model such as pipe sizes, network geometry, inverts, etc., but some features such as longitudinal slopes, roadway sections for spread calculations, and inlet rotation will be lost and must be reset to the correct values manually for each inlet as these reference the Geopak roadway model

9.6 Supplemental Instructions on SUDA Project Setup & VBA's

9.6.1 Project Setup

9.6.1.1 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*. To begin a new SUDA drainage design the designer can select and option under the ***Subsurface Utility*** menu. The user will receive a prompt "This action will create a utility model in the design file. This is not undoable. Proceed?" Select "Yes" to create the SUDA design.



9.6.1.2 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.

9.6.1.3 Create Scenarios

- Create a new base ***Scenario*** for the design storm and primary design layout and any child scenarios as needed for alternate storms and layouts.

9.6.1.4 Rainfall Parameters

- Open the ***Properties*** for the based Scenario. Under ***Alternatives > Rainfall Runoff*** select "New" and enter a name for the base rainfall. Open ***Global Storm Events*** under the Subsurface Utility > Components > Global Storm Events… From the Global Storm Event drop down select the appropriate Location/Return Period storm from the IDF curve library. The user must manually select the NOAA station closest to where the project is located. This represents the Rational Method rainfall source.

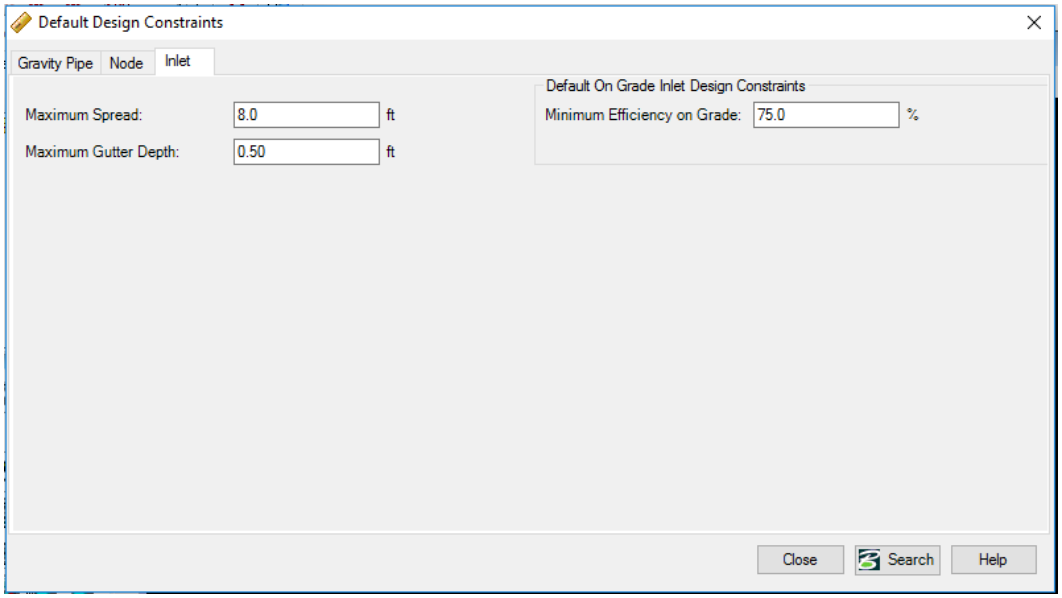
9.6.1.5 Intensity Option

- The **Absolute Intensity** is preset to the actual rainfall intensity based on location, **Time of Concentration** (**Tc**), and design storm. However, the user should recognize that there are situations where roadway classification and design speed will dictate that an **Absolute Intensity** setting of **4 in/hr** is preferred for Inlet Spread

Calculations. (Refer to Table 9-1 in Chapter 9 of the VDOT Drainage Manual, for further guidance.) In these situations, **Time-Intensity** curve under **Storm Data**, and set the intensity to 4in/hr. The user will next create a new Global Storm Event selecting the 4in/hr Time-Intensity curve. Then the user will create a new Child Scenario with a new Rainfall Runoff selecting the 4in/hr Global Strom Event.

9.6.1.6 Inlet Options

- The **Default Design Constraints** will not have constraints for inlet design populated. To Analyze a design the **Maximum Spread, Maximum Gutter Depth,** and **Minimum Efficiency on Grade** must be filled out as appropriate for the project under Subsurface Utility > Project > Default Design Constraints under the Inlet tab.



9.6.1.7 Plan Symbology

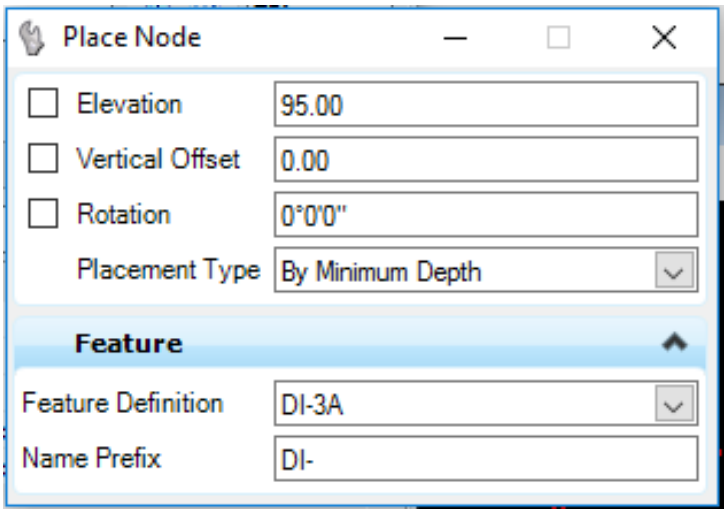
- When placing **Nodes** (inlets, junctions, and outlets) and **Conduits** (pipes) using the Layout under Subsurface Utility the elements will be placed using the correct VDOT symbology including cells, line styles, level, color, and line weight. However, when an element is changed in subsurface utility , such as pipe size or material, or inlet type, the corresponding plan symbology will not automatically update. The element symbology must be updated manually by selecting the element, selecting **Properties**, and picking the correct new **Feature Definition** from the drop down list.

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**.

9.6.2 Additional Topics

9.6.2.1 Node Configuration (Elevations)

- The **Elevation Reference** 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 SUDA VDOT curb drop inlets is located at the bottom of curb point. Therefore, it is important to select the bottom of curb as the **Elevation Refernece**,to automatically determine the top of curb elevation for a respective curb drop inlet from the selected ***Open Roads model*****.**
- The **Vertical Offset** option is simply a way to adjust the **Elevation Reference** data, if needed. If we utilize the proposed ***Open Roads model*****,** as expected, no adjustment should be needed**.**



9.6.3 VDOT Inlet Configurations in SUDA Drainage

9.6.3.1 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**. Therefore, an adjustment within the inlet Properties are needed to represent the standard inlet with gutter pan and one without (such as a median inlet). The default setting is an inlet without a gutter pan, the information for a gutter pan if applicable is set under the **Physical** setting under the inlet properties.

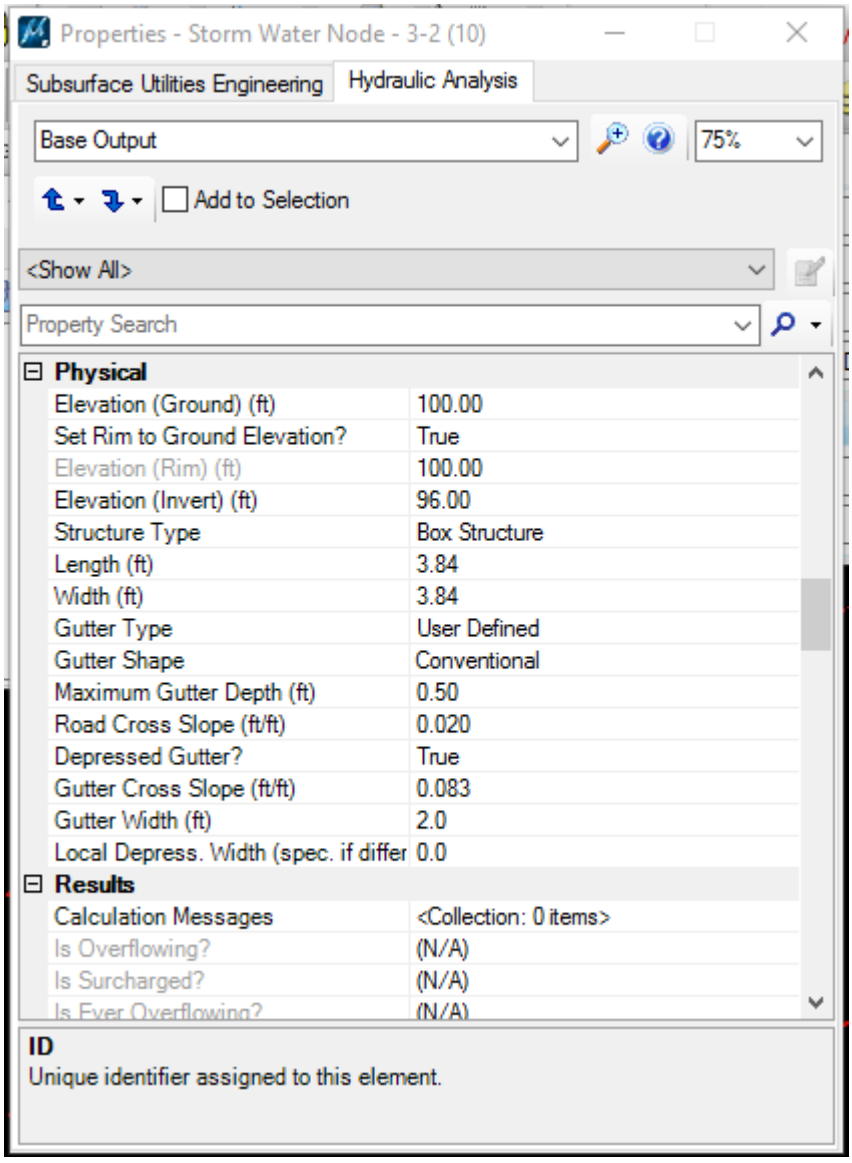
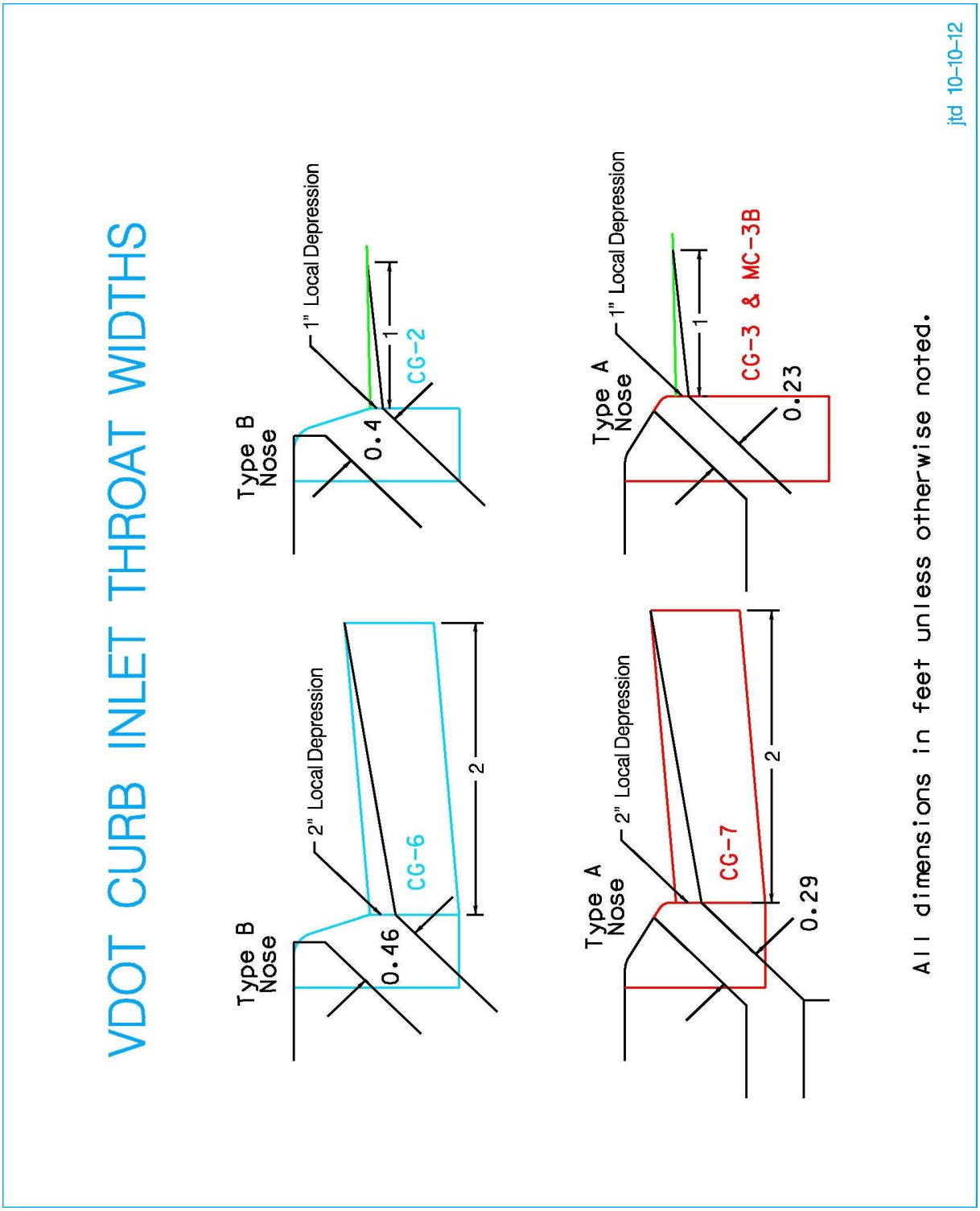


Figure 9-2 Curb Inlet Throat Widths



9.6.3.2 Sag Inlets (With and Without Gutter)

The situation is similar 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, the inlet gutter condition (cross slope, width, local depression) must be manually set by the user for **Sag inlets**.

9.6.4 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**.

9.6.4.1 On-Grade and Sag 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 user defined in the Node Physical Properties.

9.6.5 GEOPAK Drainage Import

9.6.5.1 Purpose

- To provide supplemental instructions on the importation of GEOPAK Drainage project from legacy GEOPAK projects into SUDA

9.6.5.2 Importation Instructions

- From the menu the user will select Susurface Utility > Project > Import > Bentley GEOPAK. The used will then select the appropriate GEOPAK .gdf file.

9.6.5.3 Inputting/Manipulating Data in the SUDA Drainage Program

Items that require user input/manipulation in the SUDA Drainage program (when using imported GEOPAK data). This is in addition to the initial setup step of all SUDA Drainge project such as setting the Global Storm and defining Inlet setting in the Default Design Constraints.

9.6.5.4.1 Areas

- **Display:**
  - The delineation of drainage areas will not be displayed upon import
- **Sub-Areas:**
  - Any sub-areas used in computing a composite ‘c’ value for a drainage area will not be included. The given ‘c’ value or composite ‘c’ value if used in GEOPAK will be applied to the total drainage area.

9.6.5.4.2 Nodes

- **Rotation:**
  - The user will need to manipulate the node into its correct rotation utilizing the software, not MicroStation.
- **Feature Definition:**
  - The user will need to use the node properties for each inlet and outlet to reset the feature definition to set the correct drainage cell.

9.6.5.4.3 Elevations

- ***Elevation Reference:*** The structure elevation from GEOPAK will be transferred with the import but will continue to reference the poroject .tin surface or manually entered elevation. To reference the Open Roads Model elevation the Elevation Reference for each node must be manually set from the node Properties menu. (Note: for curb inlets this represents the bottom of curb elevation of the structure)

9.6.5.4.4 Links

- **Feature Definition:**
  - The user will need to use the node properties for each inlet and outlet to reset the feature definition to set the correct pipe type and size.