



# Designing Inlets and Gutters

*This course is for the **2023 Release 1** version of:*

OpenSite Designer CONNECT Edition

OpenRoads Designer CONNECT Edition

OpenRail Designer CONNECT Edition

## About this Practice Workbook...

- This workbook is designed for use in Live instructor-led training and for OnDemand self study. OnDemand videos for this course are available on the [LEARNserver](#).
- This PDF file includes bookmarks providing an overview of the document. Click on a bookmark to quickly jump to any section in the file.
- Both Imperial and Metric files are included in the dataset. Throughout this practice workbook Imperial values are specified first and the metric values second with the metric values enclosed in square brackets. For example: **12.0'** [3.4m].
- This course workbook uses the *Training and Examples* WorkSpace and the *Training-Imperial* or *Training-Metric* WorkSet delivered with the software.
- The terms “Left-click”, “Click”, “Select” and “Data” are used interchangeably to represent pressing the left mouse button. The terms “Right-click” and “Reset” are also used interchangeably to represent pressing the right mouse button. If your mouse buttons are assigned differently, such as for left-handed use, you will need to adjust accordingly.

## Have a Question? Need Help?

If you have questions while taking this course, you can submit questions to the [Civil Design Forum](#) on Bentley Communities where peers and Bentley subject matter experts are available to help.

## Designing Inlets and Gutters

This class will show you how to place inlets with catchment delineation and create gutters, to collect the runoff from a road surface. There will be two methods covered in this class, place inlets manually and place inlets automatically. When placing inlets automatically gutters and catchments are automatically created, but when using the manual method only catchments are generated.

You will learn how to check whether the inlet efficiencies, and the spread widths of the flows along the road edge, are acceptable, and adjust the design so that they are.

**Note:** Catch basins can also be called pits, gullies or inlets. In this class the term catch basins will be used to describe a drainage node that accepts surface runoff.

## Getting Started

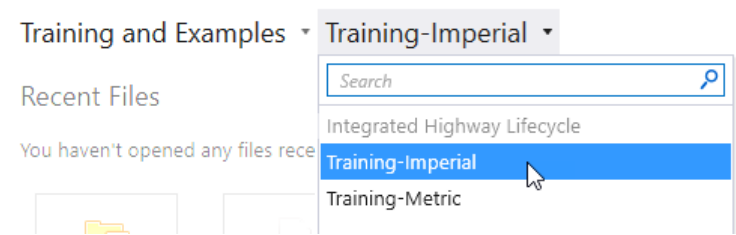
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1. Start the software.
2. Set the WorkSpace and WorkSet.

The WorkSpace and WorkSet define standards that are used by the software, and the ones used for this training are installed during the software installation.

Typically, the WorkSpace contains organizational standards and the WorkSet contains project standards.

- a. Select **Training and Examples** from the *WorkSpace* drop-down menu.
- b. Select **Training-Imperial** [*Training-Metric*] from the *WorkSet* drop-down menu.



3. Open an existing file.



- a. Select **Browse**.
- b. Browse to *C:\Bentley Training\Designing Inlets and Gutters* or other folder where you unzipped the dataset files.
- c. Select the file **Intersection-Drainage-Imperial.dgn** [*Intersection-Drainage.dgn*] and click **Open**.

**Note:** If you get a message stating “Incompatible Civil Data”, this is because the training files are “aligned” to OpenSite Designer. Clicking *Yes* will align the file to the software you are using (OpenRoads Designer or OpenRail Designer). This will have zero impact for the training courses. However, note that in production, upgrading the file will make the file read-only in OpenSite Designer. Full information is available at [Bentley Communities - Product Realignment](#).

## Exercise 1: Place Catch Basins with Catchment Delineation

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### Description

In this exercise, you will place catch basins individually with catchment delineation using Snaps and Civil AccuDraw methods of placement

### Skills Taught

- Use the Place Node tool to place several Catch Basins
- Use Snaps and Civil AccuDraw
- Review the 2D and 3D graphics, placement position, and orientation.
- Review the Catch Basin properties

## Checking Project Reference Files

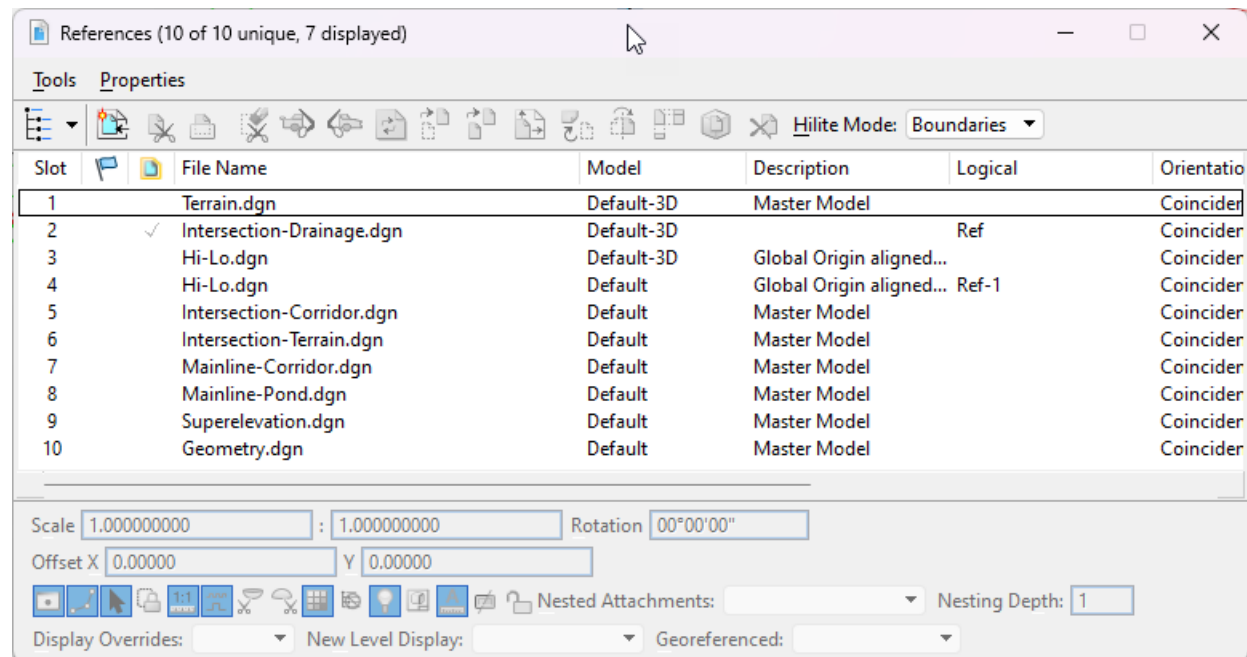
In this section you will open the Reference file manager and review the reference files attached.

1. On the *Home* ribbon, click *Primary* > *Attach Tools* > *References*.

**Note:** References have already been attached and some have the *Display* icon clicked to turn off the display of the model.

2. Put focus on to *View 1*, by clicking on its title bar.

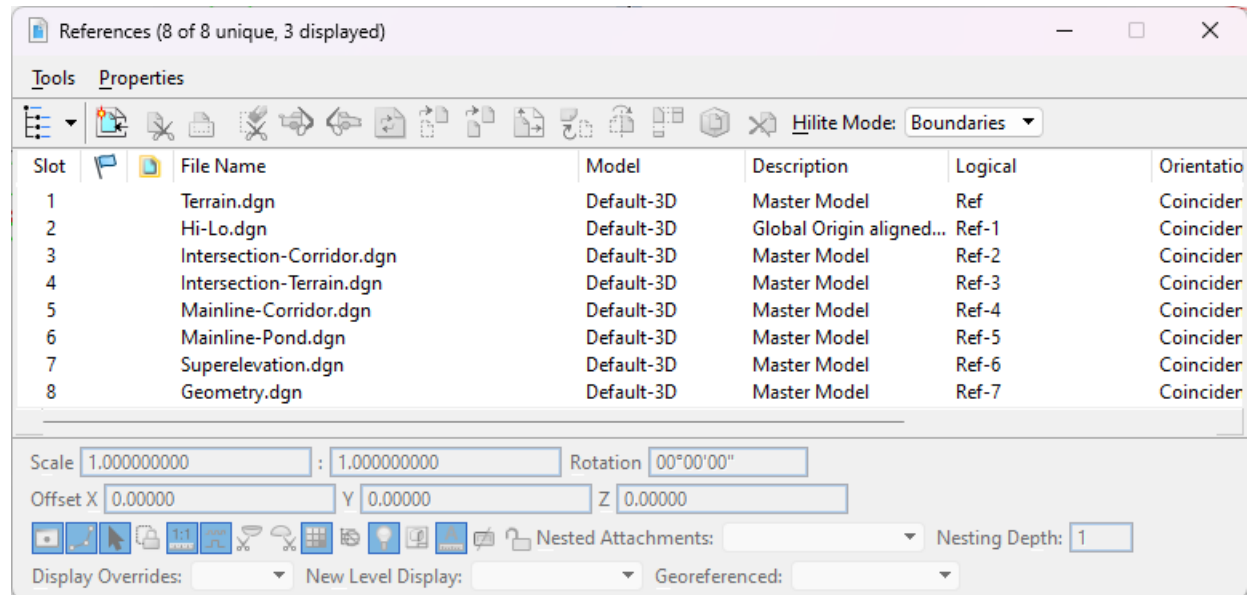
The *Default* model References are shown below.



A reference file that contains a terrain model for the surface of the intersection – Intersection-Terrain - is displayed in the Default-3D model. This will be used when placing the inlets and catchments.

3. Check the *Default-3D* model References as well.

The *Default-3D* model References are shown below.



- a. Close the *References* dialog.

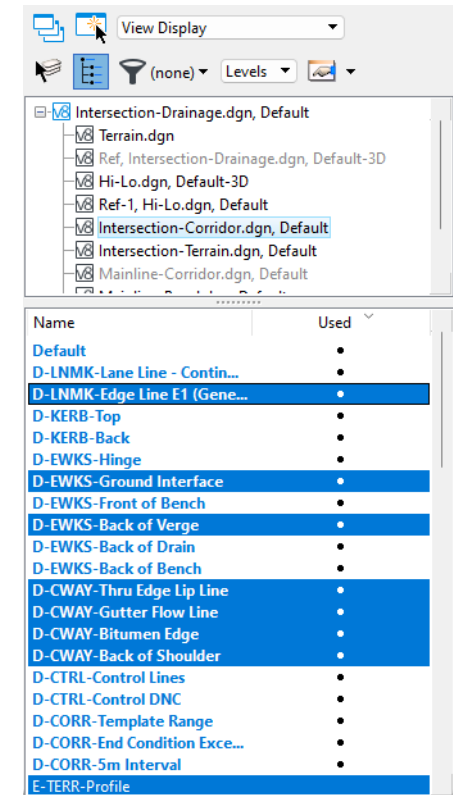
4. Review the corridor levels.



- a. Make sure focus is on to **View 1**, by clicking on its title bar.
- b. On the **Home** ribbon, click **Primary** > **Level Display**.
- c. Select the **Intersection-Corridor-Imperial** [*Intersection-Corridor.dgn*]

**Note:** Some of the Corridor Levels have already been turned off. This will help when placing the catch basins.

- d. Close the **Level Display** dialog.



## Set the Default Design Constraints

1. Click on title bar of **View 1, Default** to make it active.
2. Select, **Drainage and Utilities** workflow
3. Select, **Analysis > Analysis Tools > Default Design Constraints**
  - a. Select, **Inlet** and check the **Maximum Spread > 4.92' (1.5m)**
  - b. **Maximum Gutter Depth > 0.41' (0.13m)**
  - c. **Select > Close.**



Default Design Constraints

Gravity Pipe Node Inlet

Maximum Spread: 4.921 ft

Maximum Gutter Depth: 0.41 ft

Default On Grade Inlet Design Constraints

Minimum Efficiency on Grade: 50.0 %

Close Search Help

The reason we are setting these values is that these are maximum spread and depth of flow we require for our design. These values will be used at a later date to check our design.



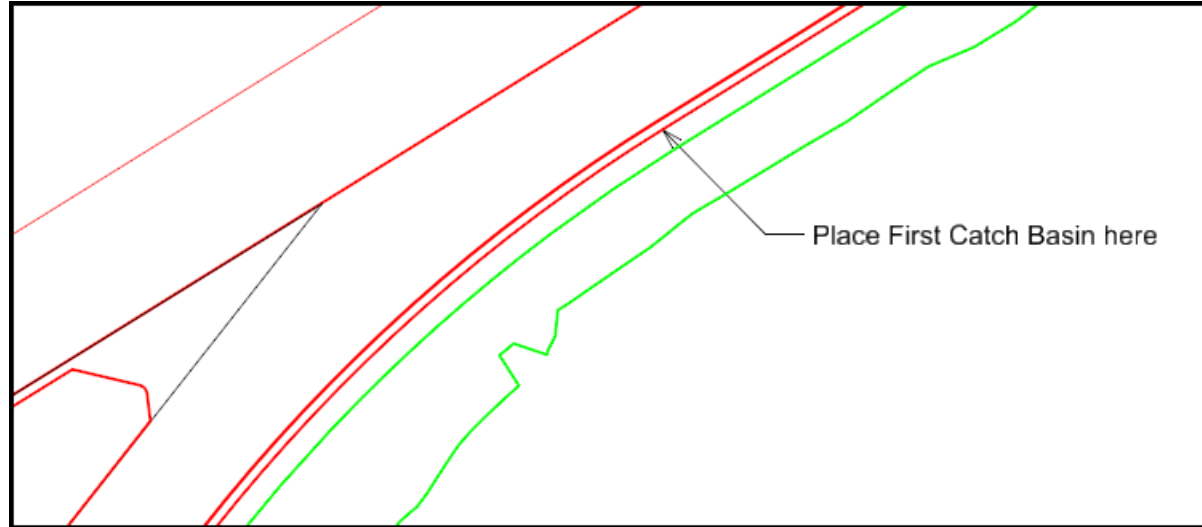
## Placing Catch Basins and Catchments using AccuSnap

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1. Window to the area shown opposite.



2. On the **Layout** ribbon, Select > **Place Node**

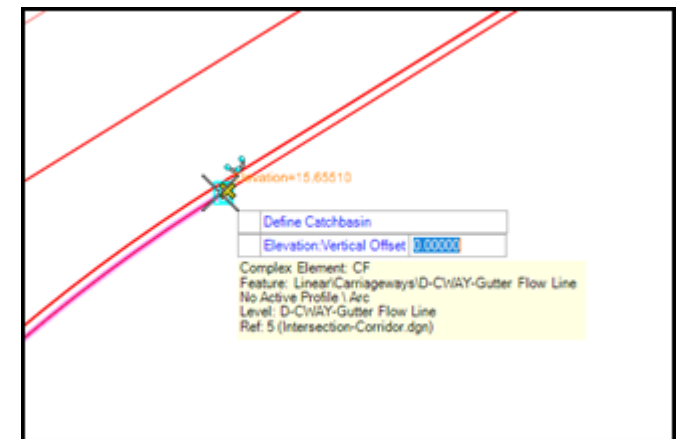


- a. On the *Place Node* dialog set the following:
- b. Set the *Feature Definition* > *Node* > *StormWaterNode* > *Inlets* > **Training Combination Inlet**
- c. Check **Vertical Offset**, set value to **0**
- d. Select *Rotation Mode* > **Relative to alignment**
- e. **Check Catchment** > **Catchment Delineation**

- f. Set the *Catchment Feature Definition* to *Drainage Area > Catchment > Pavement*
3. Following the *Heads-up prompts*, set the following:
  - a. At the *Select Reference Element for Node Elevation. <Reset> to Type Elevation* prompt, select the **D-Terrain-Intersection** Terrain model from *View 2*.
  - b. Select any contour.
  - c. At the *Define Catch basin* prompt, data point on the **D-CWAY-Gutter Flow Line** feature opposite the catch basin on the intersection approach in View 1

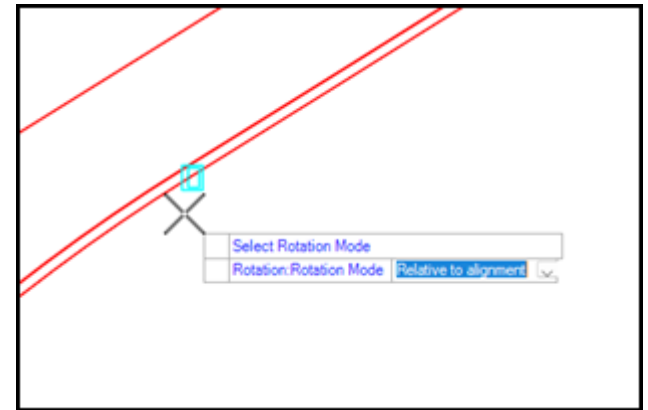
Place Node

<b>Feature</b>	
Feature Definition	Training Combination Inlet
Name Prefix	SA1-
<b>Elevation</b>	
Elevation is the Invert	<input type="checkbox"/>
<input checked="" type="checkbox"/> Vertical Offset	0.00000
<b>Baseline Reference</b>	
Baseline Reference	<input type="checkbox"/>
<b>Rotation</b>	
Rotation Mode	Relative to alignment
Locate Reference Element for Rotation	CF
<input checked="" type="checkbox"/> Rotation	90°00'00.0"
<b>Catchment</b>	
Catchment Delineation	<input checked="" type="checkbox"/>
Feature Definition	Pavement
Name Prefix	DR-

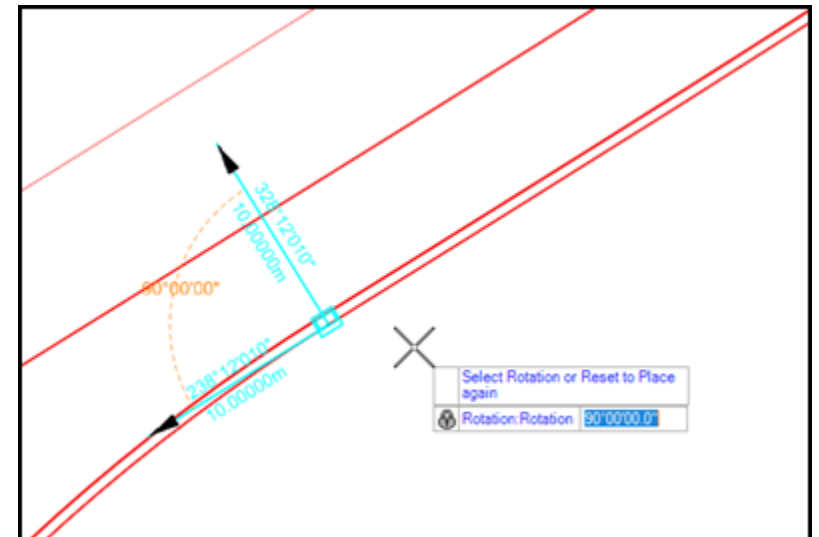


- d. **Data point** to accept the *Rotation Mode* > **Relative to alignment**
- e. At the *Locate Reference Element for Rotation* prompt, **Data point** on the **D-CWAY-Gutter Flow Line**

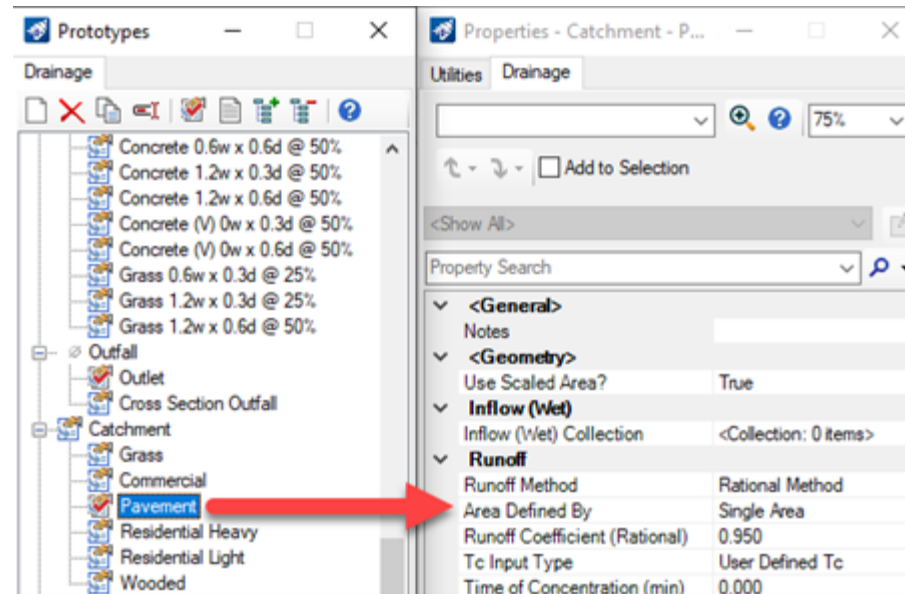
At this point the catch basin is placed.



- f. Type **90** for the *Rotation* and *Enter*, then **Data point** to accept the rotation.
- g. **Esc** to exit command.

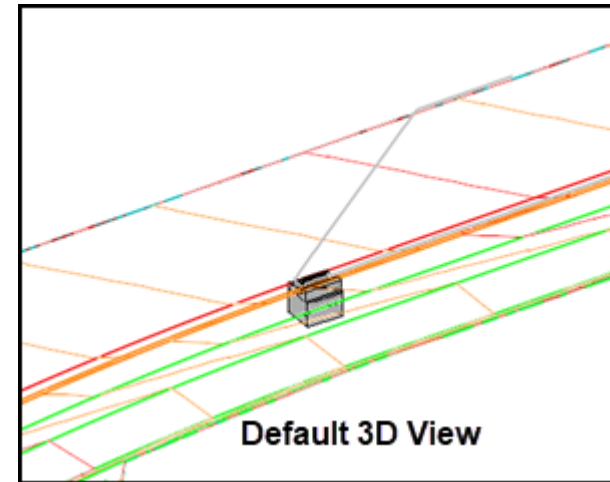
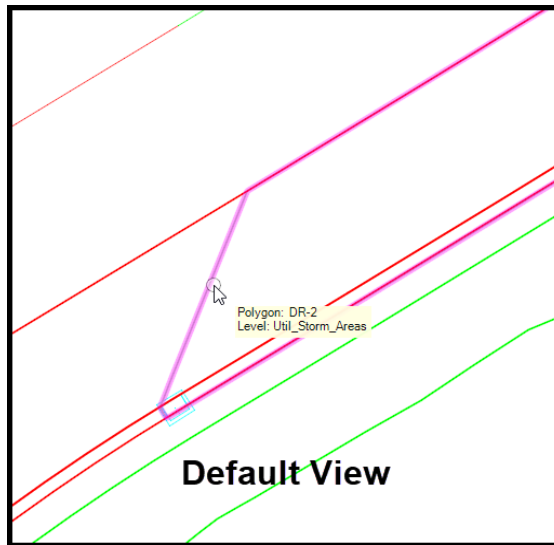


The Hydraulic Properties of the Catchment will be populated from the Hydraulic Prototype. One of these properties is the **Runoff Coefficient** for the catchment. One of the properties of a Feature Definition is the Hydraulic Prototype, which defines the default properties to be used when the catchment is created.



Prototypes can be viewed and edited using the *Components > Catalog > Prototypes* tool or viewed and selected through *Home > Explorer > OpenRoads Standards > Active File > Feature Definitions > Drainage Area > Catchment > Pavement > Hydraulic > Prototype*.

The placed catch basin and the catchment area can now be seen in both the *Default* and *Default-3D* views.



4. Review the catch basin properties.

a. Select the catch basin and from the *Context Sensitive toolbar* Select > **Properties**.

**Note:** The design intent – it is ruled to the gutter flow line feature both for position and rotation. The catch basin will be updated if the element is subsequently modified. The Elevation Reference is the terrain.

Feature Definition	Training Combination Inlet
Feature Name	SA1-3
Description	
Spread / Top Width	3.609'
Flow (Captured)	1.213cfs
Flow (Total Bypassed)	0.134cfs
> Point	1683912.809',21829542.7
X	1683912.809'
Y	21829542.776'
Rotation	N21°47'50.0"W
Rotation Offset	N90°00'00.0"E
Rotation Reference	CF
Absolute Angle	False
PositionType	Key Point

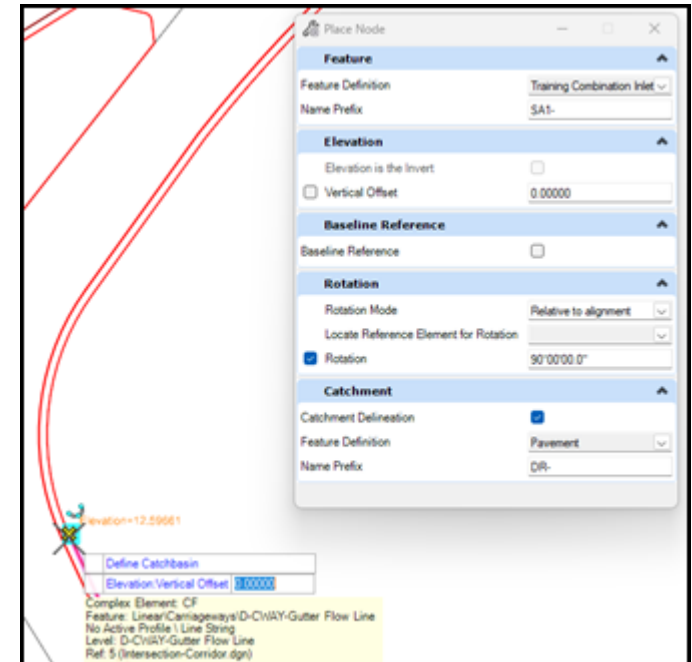


5. Place another catch basin, moving in a southerly (downstream) direction and snapping to the same gutter feature.

a. On the **Layout** ribbon, Select > **Place Node**

b. On the **Place Node** dialog check the following:

- Check the *Vertical Offset* value is **0**
- Check the *Rotation Mode* is **Relative to alignment**
- Check the Feature Definition, *Node* > *StormWaterNode* > *Inlets* > **Training Combination Inlet**
- Check the Catchment Feature Definition > *Drainage Area* > *Catchment* > **Pavement**
- From the *Heads-up prompts* set the following: -
- Select *Reference Element for Node Elevation. Reset to Type Elevation* prompt, select the **D-Terrain-Intersection** Terrain model from *View 2*



c. At the Define *Catch basin* prompt, **Data point** on the **D-CWAY-Gutter Flow Line** feature opposite the catch basin on the intersection approach in *View 1*.

d. **Data point** to accept the Rotation Mode > **Relative to alignment**

e. At the Locate Reference Element for Rotation prompt, **Data point** on the **D-CWAY-Gutter Flow Line**.

At this point the catch basin is placed.

f. Check the Rotation is **90** and *Enter*, then **Data point** to accept the rotation

g. **<Esc>** to exit command

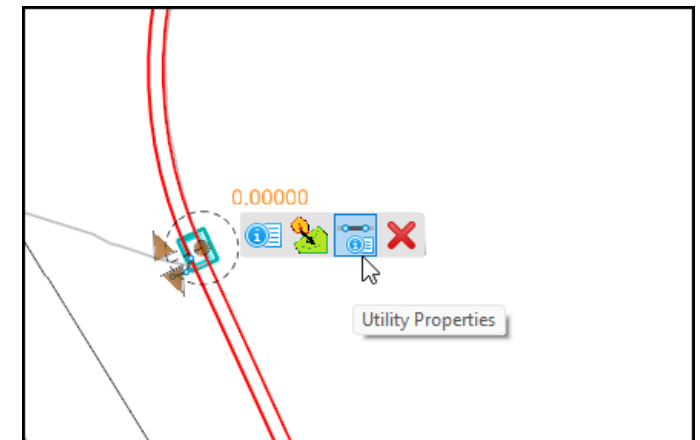
**Note:** Notice how the area for the new catchment has stopped at the edge of the previous area.



6. On the *Layout* ribbon, click the **Element Selection** icon.

7. Select the catchment just placed and from the *Context Sensitive toolbar*, Select > **Utility Properties**.

You will see a line is also displayed from the centroid of the catchment to the *Outflow Element*



The **Utility Properties** show information such as the *Outflow Element* the catchment flows to, and *Runoff* properties such as *Runoff Method* and *Runoff Coefficient*.

There are numerous properties with values of N/A. This is because you have not computed the system yet.

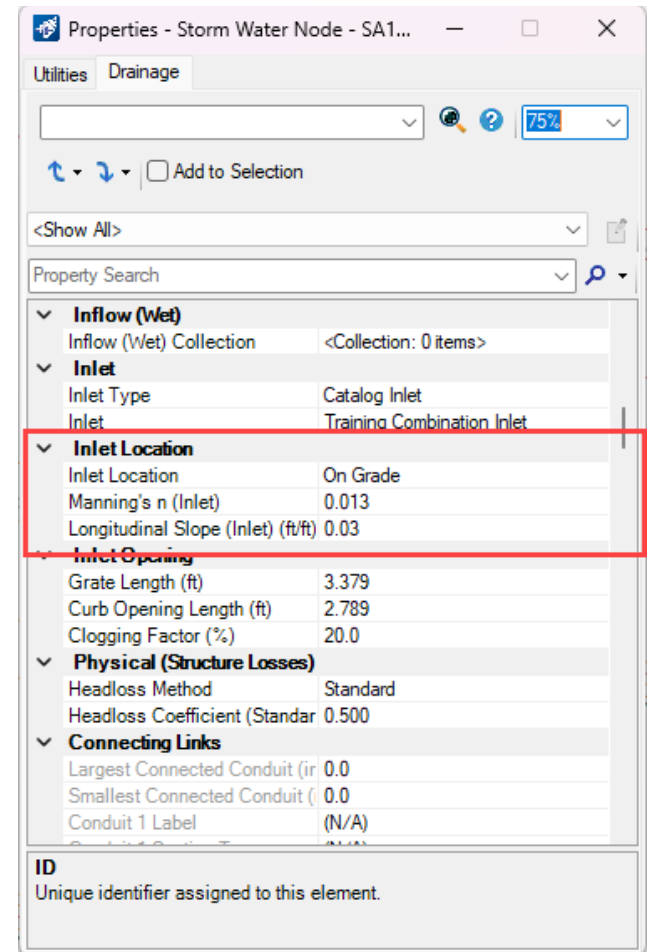
- a. As an example of what properties you can check find the **Inlet Location** property and check *Longitudinal Slope Value*

This value is the slope of the gutter read from the gutter flow line where the inlet was placed.

**Note:** Nodes have been created along with their associated catchment delineation and gutters. If you are placing a catch basin, and you select a terrain model, mesh, or linear element with a profile as the elevation reference, then the value for the Longitudinal Slope in the Drainage properties is set automatically, and is updated when the elevation reference changes or the catch basin is moved.

However, there are some occasions when you might not want to use this value - perhaps because you want to see if a change to the slope would mean a better drainage layout, by increasing the hydraulic efficiency of the inlet.

In this case, you can set Use Longitudinal Slope in the Civil properties to False, and then type in the slope that you want to use in the Drainage properties. This slope will not be affected by any changes to the elevation reference.





## Placing Catch Basins and Catchments using Civil AccuDraw

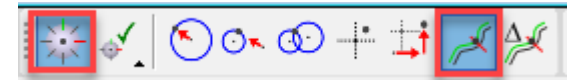
Civil AccuDraw is used for precision input and will be used here to place catch basins that are ruled to civil geometry by station and offset. The feature we are going to offset the Catch Basins from is the Gutter Flow Line.



1. Select *Layout* > *Toggles* > **Civil AccuDraw** to display the *Civil AccuDraw* toggle bar.



2. Dock the toggle bar next to the *AccuSnap* tools at bottom of the screen.



- a. Select the **Toggle Civil AccuDraw** icon on the toggle bar.
- b. Select > **Station-Offset** icon on the toggle bar.



The next catch basin you will place is near the pond. The levels that the pond features are displayed on are turned off in the *Default* view.

3. Make sure focus is on to *View 1*, by clicking on its title bar.



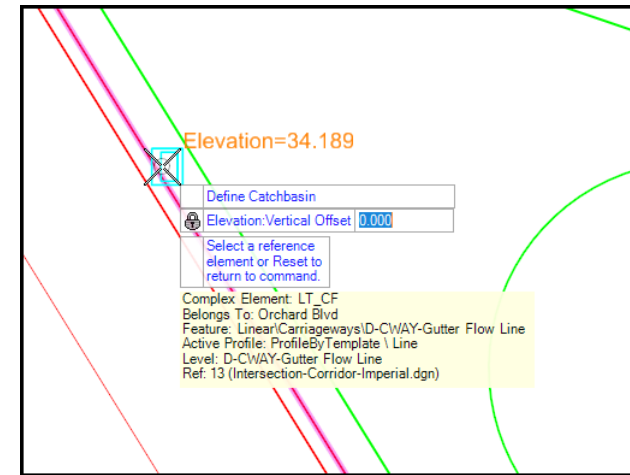
4. On the **Layout** ribbon, Select > **Place Node**
  - a. In the *Place Node* dialog set the following: -
  - b. Set the *Vertical Offset* > **0**
  - c. Set the *Rotation Mode* > **Relative to alignment**
  - d. Set the Feature Definition > *Node* > *StormWaterNode* > *Inlets* > **Training Combination Inlet**Ensure the *Catchment Feature Definition* is available in the dialog
  - e. Set the *Catchment Feature Definition* > *Drainage Area* > *Catchment* > **Pavement**
  - f. From the *Heads-up prompts* set the following: -
  - g. *Select Reference Element for Node Elevation. Reset to Type Elevation* prompt, select the **D-Terrain-Intersection** Terrain model from *View 2*.

5. At the *Define Catchbasin* prompt *Civil AccuDraw* input fields **Station** and **Offset** are now added to the prompt.
  - a. *Tab* to highlight the *Offset* input and type the letter '**o**'.

Station	2+60.24
Offset	0.000'
Define Catchbasin	
Elevation:Vertical Offset	0.000

**Note:** that '**o**' is the shortcut key for setting the reference element and stands for '**Origin**'

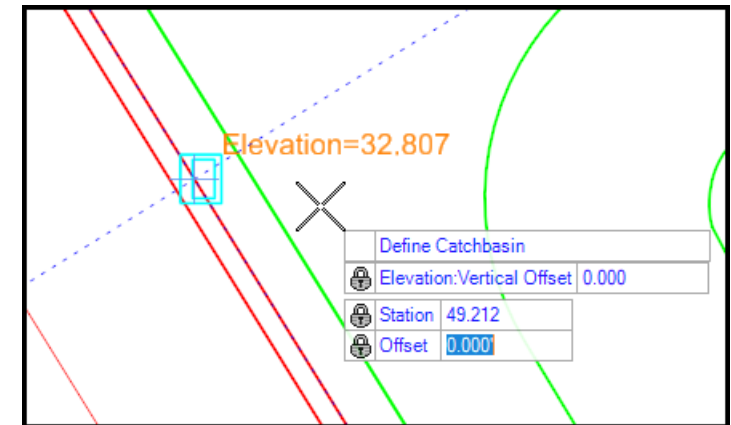
- b. At the *Select a reference element or Reset to return to command* prompt, Select > **Gutter Flow Line (LT\_CF)** feature (location is near the top end of the pond)
- c. *Civil AccuDraw* is now locked on the feature and by using the Tab key to highlight Station, set value to **49.212' [15m]**, press **Enter** on keyboard to accept and lock the value.



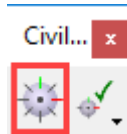
- d. *Offset* will now be active, set value to **0.0' [0.0m]**, press **Enter** on keyboard to accept and lock the value.
- e. **Data Point** to accept the location.
- f. **Data point** to accept the *Rotation Mode* > **Relative to alignment**
- g. At the *Locate Reference Element for Rotation* prompt, *data point* on the **D-CWAY-Gutter Flow Line**.

At this point the catch basin is placed.

- h. Type **90** for the Rotation and *Enter*, then **data point** to accept the rotation.

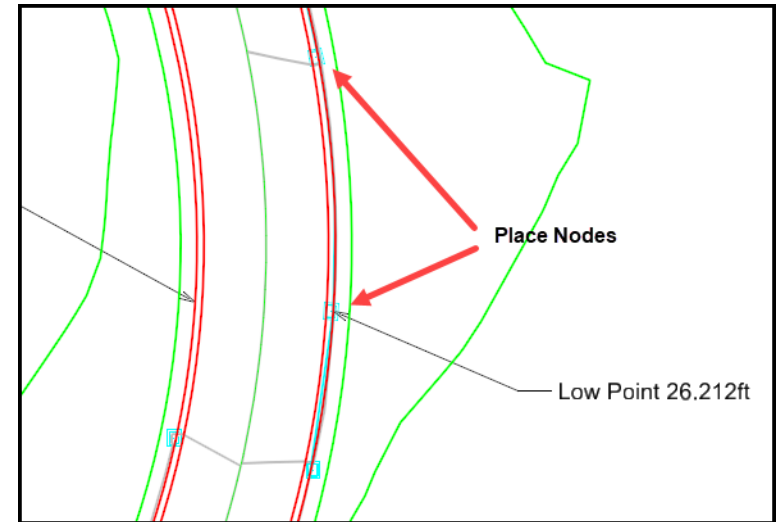


6. Using the steps **4 - 5** above, *Place Node* at *Station 255.9' [78m]*, with an *offset* of **0.0' [0.0m]**. *Place Node* at the *Low Point* position *Station 316.366' [96.429]* with an *offset* of **0.0' [0.0m]**.
  - a. Select the **Toggle Civil AccuDraw** icon on the toggle bar.
  - b. De-Select > **Toggle on** icon on the toggle bar, to toggle off AccuDraw.

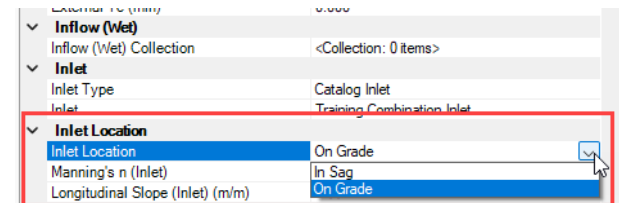


You will notice that the Node is at the Low Point, so it will accept flow from two directions.

- c. **<Esc>** to *Exit* the command

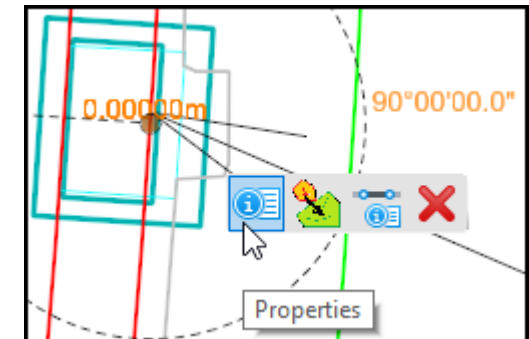


7. Using *Element Selection*, Select the node at the Low Point
  - a. From the *context sensitive toolbar* Select > **Utility Properties**
  - b. Scroll down to *Inlet Location*, Select > **On Grade** and change to **In Sag**



8. Check the **Properties** of the last catch basin you placed.

**Note:** The Station and Offset values that you just entered are shown. These values can be changed if required, to move the catch basin again.



> Point	1684036.039',21828922.3
X	1684036.039'
Y	21828922.336'
Rotation	N86°19'42.4"W
Rotation Offset	N90°00'00.0"E
Rotation Reference	LT_CF
Absolute Angle	False
Offset	0.000'
Station	3+16.37

## Exercise 2: Placing Gutters

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### Description

Once a system of catchment areas and catch basins has been placed, computing it will cause messages saying *'There is no gutter leaving the 'On Grade' catch basin. Bypassed flow is directed to the subnetwork outfall'*. This issue can be addressed by placing gutters. In the previous exercises we placed catch basins and catchment delineation but the catch basins placed manually have no gutters.

In this exercise, you will place gutters to define the flow path for any surface runoff that is not collected by the catch basin that it is connected to.

### Skills Taught

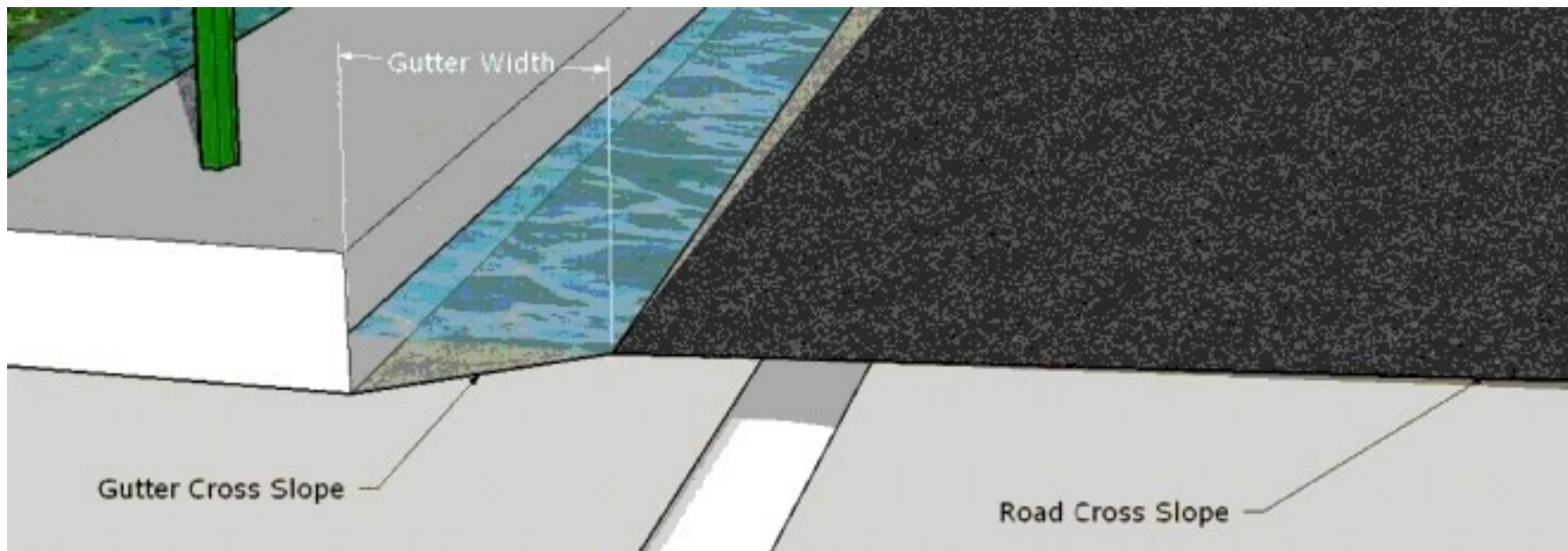
- What is a gutter
- Placing a Gutter
- Reviewing catch basin and gutter properties

## What is a gutter?

The term “gutter” is used to describe the depression in a road surface where runoff from the road surface will collect, before flowing along the gutter to a collection point, such as a catch basin.

One example of a gutter is where the edge of the road meets the face of a curb, which is sometimes created using a precast or slip formed curb and gutter unit, as shown here. In this example, note that the Gutter Cross Slope is steeper than the Road Cross Slope, which increases the depth of flow in the gutter, and improves its hydraulic efficiency.

Other examples of gutter shapes include triangular or trapezoidal. These are used when there is no curb.



## Methods of Placing a Gutter

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The software has two methods that can be used to place a gutter:

- Between Nodes - asks you to select the two catch basins that are to be linked by the gutter
- Using Trace Slope - only asks you to select the start catch basin

The Using Trace Slope method has two prerequisites:

- The catch basins were both placed using the same terrain model or mesh as the Elevation Reference
- The catch basins are located and rotated correctly within the gutter

When you select the start node, the software uses this as the starting location for a downstream flow trace, along with the terrain model or mesh element, to locate the next catch basin downstream. If the start node was not placed using a terrain model or mesh as the Elevation Reference, then you will not be able to select it.

The rotation of the catch basin is important if the prototype used by the gutter feature definition is set up so that cross-sections are created along the gutter. In this situation, the rotation of the catch basin should be perpendicular to the gutter flow line, so that a cross-section taken through the catch basin, along the bearing of the rotation, will include the shape of the gutter.

The rotation of the catch basin is important for another reason because it is how the software determines which side of the catch basin the gutter is on.



## Determining the Shape of a Gutter

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The software has two methods of determining the shape of a gutter:

- Defining the shape in the gutter feature definition
- Creating the shape by creating cross-sections along the gutter

The choice of which method to use is made in the prototype for the gutter feature definition. This can be set up in one of three ways:

- Specify the shape, such as conventional, triangular, or trapezoidal
- Inherit the shape from the start or stop node
- Derive the shape from cross-sections

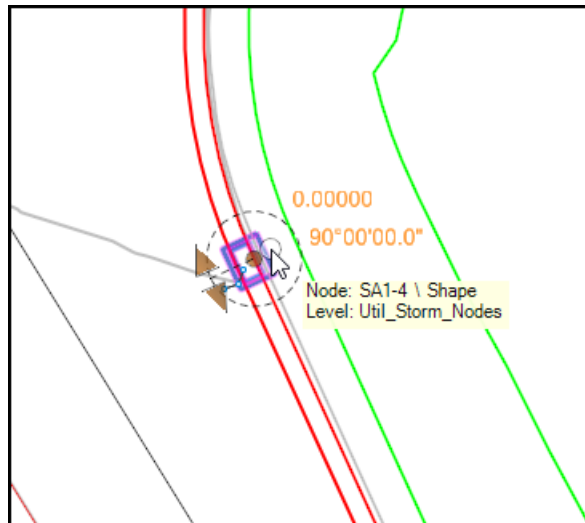
## Review Catch Basin and Gutter Properties

1. Select a catch basin south of the intersection fillet and view the **Utility Properties**

There are quite a lot of result fields that are populated from the **Feature Definition** for the *Training Combination Inlet*.

The **Hydraulic Properties** are populated from a Prototype. The road cross slope could come from the road surface, depending on the *'Measure Road Cross Slope'* property.

The *Longitudinal Slope (Inlet)* is populated from the Linear Feature that was selected when the catch basin was placed - in this case, the **D-CWAY-Gutter Flow Line** feature.



- a. **Close** > *Utility Properties*

▼ <b>Inlet Location</b>	
Inlet Location	On Grade
Manning's n (Inlet)	0.013
Longitudinal Slope (Inlet) (ft/ft)	0.03
▼ <b>Inlet Opening</b>	
Grate Length (ft)	3.379
Curb Opening Length (ft)	2.789
Clogging Factor (%)	20.0
> <b>Physical (Structure Losses)</b>	
> <b>Connecting Links</b>	
▼ <b>Physical</b>	
Elevation (Ground) (ft)	41.33
Set Rim to Ground Elevation?	True
Elevation (Rim) (ft)	41.33
Elevation (Invert) (ft)	38.60
Structure Type	Box Structure
Length (ft)	2.79
Width (ft)	2.79
Gutter Type	User Defined
Gutter Shape	Conventional
Road Cross Slope (ft/ft)	0.03
Depressed Gutter?	True
Gutter Cross Slope (ft/ft)	0.08
Gutter Width (ft)	1.640

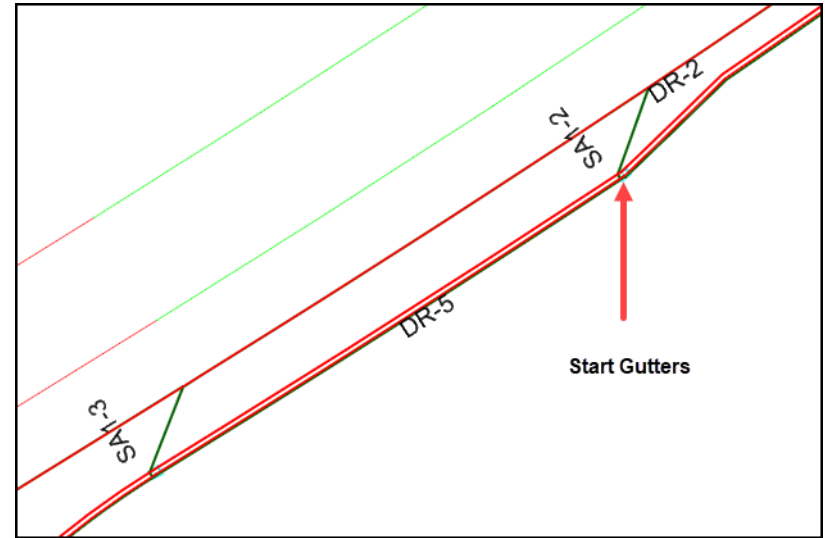
## Placing a Gutter

In this exercise we are going to place gutters for the catch basins for those who have no gutters plus the Catch Basins placed in Exercise 1.

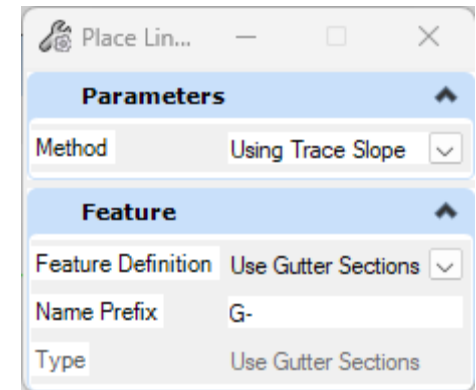
1. Window to the catch basin to the far right of the intersection  
We are going to place annotation labels on the drainage entities.
2. In the top left corner of *View 1*, Select > **View Attributes**
  - a. Ensure that the *Select Product* property is set to *Drainage*
  - b. *Check* > **Use Analytic Symbology**
  - c. Change the *Symbology Definition* from *<default>* to **Label-Only**

You can change back to *<default>* or other definitions later.

**Note:** That *Analytic Symbology* can be turned on and off in **View Attributes** anytime.

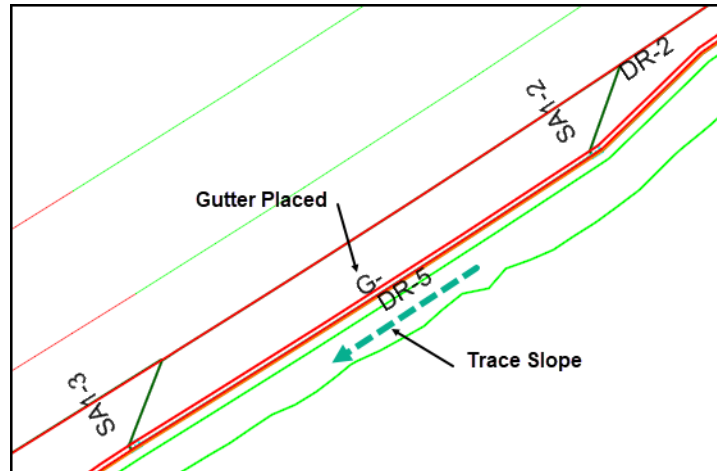


3. Select *Layout > Layout > Place Gutter*
  - a. Set the *Method* > **Using Trace Slope**  
The path of the gutter will be calculated by tracing a slope downhill along the Elevation Reference surface.
  - b. Set the *Feature Definition* > *Conduit* > *StormWater* > *Gutters* > **Use Gutter Sections**  
The Road Terrain Model will be sectioned along the gutter.
  - c. Set the *Name Prefix* to **G-**
  - d. Following the prompts, at *Select Start Node* > **data point** on **SA1-2** catch basin at the North East of the intersection



The path of the downstream flow trace to the downstream catch basin is shown in orange. Move the cursor prompt to near the end of the trace slope.

e. **Data point** to *Accept Trace Slope*.



Use the steps **1-3** to place gutters down the east side of the road.

Follow the list below:-

**SA1-3** to **SA1-4**

**SA1-4** to **SA1-5**

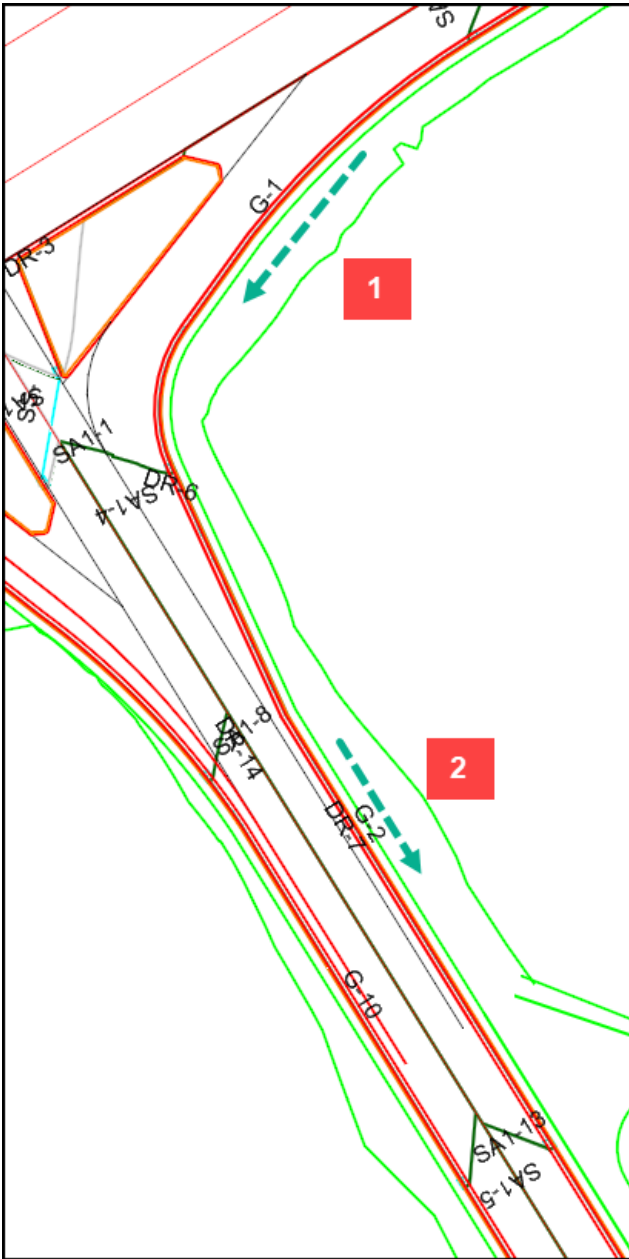
**SA1-5** to **SA1-6**

**SA1-6** to **SA1-7**

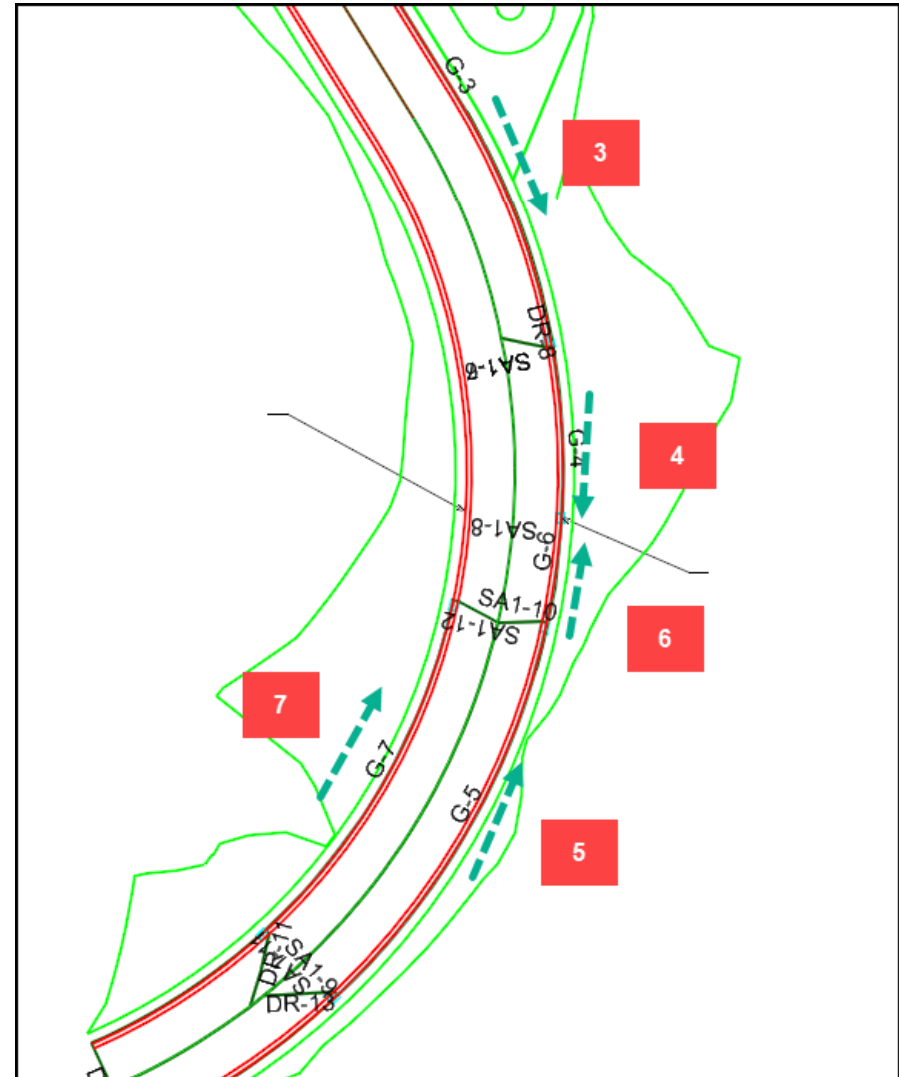
**SA1-11** to **SA1-12** (these catch basins are beyond the low point)

**SA1-12** to **SA1-7** (these catch basins are beyond the low point)

**SA1-9** to **SA1-10** (these catch basins are on the West side of the road)



Continue placing Gutters working downstream until you reach the Catch Basin at the sag point **SA1-7**.





## Exercise 3: Place a series of Catch Basins

---

### Description

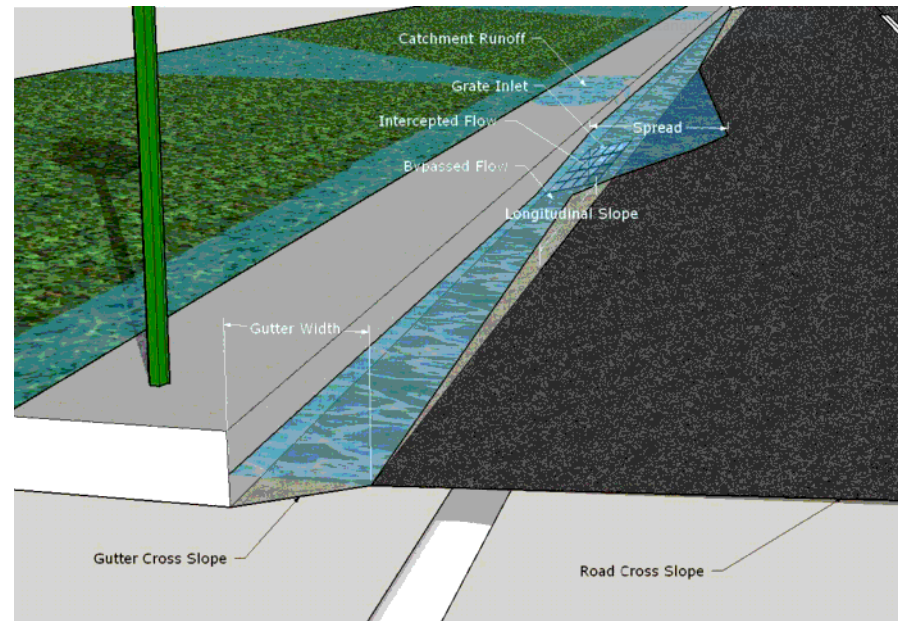
In this exercise, you will place a series of catch basins. This method will create catch basins equally spaced along a linear element by assessing the Road Cross and Longitudinal slopes, the flow, depth and allowable spread in the gutter. The catchments and gutters for each catch basin are automatically created.

### Skills Taught

- Use the Place Nodes tool to place several Catch Basins
- Review the 2D and 3D graphics, placement position, and orientation.
- Review the Catch Basin properties

## Spread Spacing Method

Starting at the Start Station or existing node, the command works downhill along the Node Location Reference. At each location, a catchment is delineated from a terrain model, its flow is calculated, and this is used to check whether the spread width or depth is exceeded if a catch basin were to be placed at this position. If the spread width or depth have not been exceeded, then the catch basin is moved to the location (defined by the Step Distance) and the checks are performed again. This process repeats until either the spread width or depth have been exceeded, in which case the location of the previous step distance is used for the catch basin, or the Maximum Spacing has been exceeded.





## Placing Catch Basins

The method we are going to use is “Spread”. This only lets you place catch basins that use an Inlet Catalog, with an Inlet Type of Combination, Curb, or Grate, and Catchments. The catch basins can be linked with gutters. The catch basins are placed at the optimum positions along a selected linear element to collect runoff from the catchment, without exceeding the spread criteria found in the Default Design Constraints.



1. Window to the junction area.
2. On the **Layout** ribbon, Select > **Place Nodes**
  - a. On the *Place Nodes* dialog set the following:
  - b. *Spacing method* > **Spread**
  - c. Check **Vertical Offset**, set value to **0**
  - d. *Maximum Spacing* > **164.042' [50.0m]**
  - e. *Relative Rotation* > **N90° 00' 00" W**
  - f. *Create Gutters* > **Check on**
  - g. *Gutter Feature Definition* > **Use Gutter Sections**
  - h. *Catchment Feature Definition* > **Pavement**
  - i. Set the *Feature Definition* > *Node* > *StormWaterNode* > *Inlets* > **Training Combination Inlet**

A screenshot of the 'Place Nodes' dialog box in a software application. The dialog is organized into several sections with expandable/collapsible headers. The 'Parameters' section is expanded, showing 'Spacing Method' set to 'Spread'. The 'Node Location' section is also expanded, showing 'Node Location Reference' as a dropdown, and several checked options: 'Vertical Offset' (0.000), 'Maximum Spacing' (164.042), 'Start Station' (196.850'), and 'End Station' (776.100'). The 'Relative Rotation' section shows 'Relative Rotation' checked with a value of 'N90°00'00.0"W'. The 'Gutters' section shows 'Create Gutters' checked, 'Gutter Feature Definition' set to 'Use Gutter Sections', 'Gutter Name Prefix' as 'G-', and 'Gutter Type' as 'Use Gutter Sections'. The 'Catchment Feature Definition' section shows 'Feature Definition' as 'Pavement' and 'Name Prefix' as 'DR-'. The 'Feature' section shows 'Feature Definition' as 'Training Combination Inlet' and 'Name Prefix' as 'SA1-'.

Parameters	
Spacing Method	Spread

Node Location	
Node Location Reference	
<input checked="" type="checkbox"/> Vertical Offset	0.000
<input checked="" type="checkbox"/> Maximum Spacing	164.042
<input type="checkbox"/> Step Distance	32.808
<input checked="" type="checkbox"/> Start Station	196.850'
<input checked="" type="checkbox"/> End Station	776.100'

Relative Rotation	
<input checked="" type="checkbox"/> Relative Rotation	N90°00'00.0"W

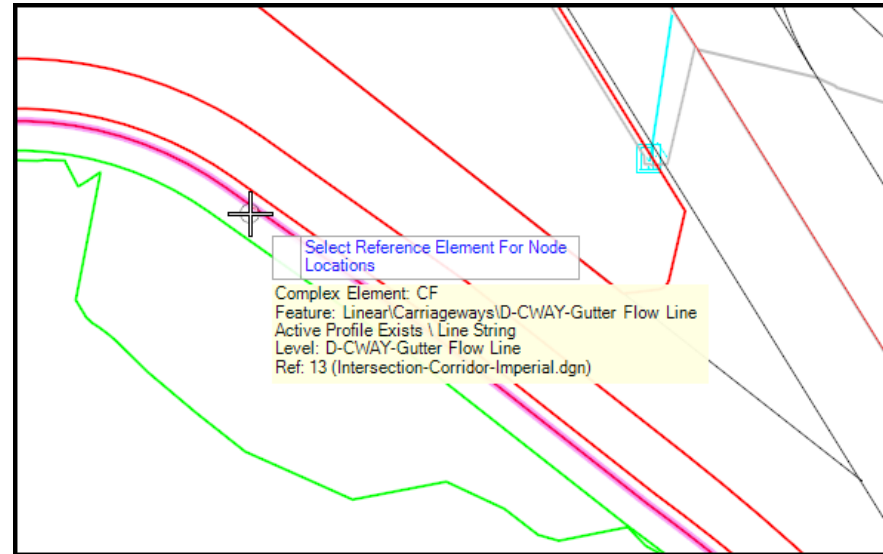
Gutters	
Create Gutters	<input checked="" type="checkbox"/>
Gutter Feature Definition	Use Gutter Sections
Gutter Name Prefix	G-
Gutter Type	Use Gutter Sections

Catchment Feature Definition	
Feature Definition	Pavement
Name Prefix	DR-

Feature	
Feature Definition	Training Combination Inlet
Name Prefix	SA1-

3. *Follow the heads-up prompts:*

- a. *Set Reference Element for Node Locations*, Select > **D-Cway Gutter Flow Line CF1**



- b. *Select Node for Reference Elevation*, Select > **D-Terrain-Intersection Model** (3D View)

- c. **Accept** > *Node Location Maximum Spacing*

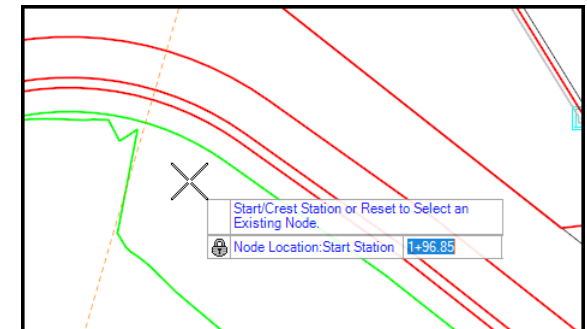
- d. **Accept** > *Node Location Step Distance*

- e. *Node Start Location* > **196.85'** [60m]

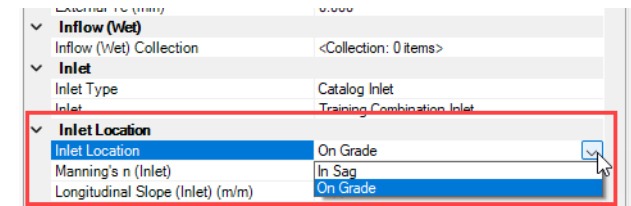
- f. *Node End Location* > **776.1'** [236.551m]

- g. *Relative Rotation* > **N90° 00' 00"W**

- h. **Data Point** to *Accept Design*



4. Using *Element Selection*, Select the node at the low point
  - a. From the *context sensitive toolbar* Select > **Utility Properties**
  - b. Scroll down to *Inlet Location*, Select > *On Grade* and change to **In Sag**
  - c. **Close** the *Utility Properties* dialog



You can turn on *Analytical Symbolology* at this point if it helps with node identification.

5. Place a gutter using *Trace Slope* between **SA1-10** and **SA1-15**
6. Place a gutter using *Between Nodes*, **SA1-1** and **SA1-8**

## Exercise 4: Checking Spread Widths

---

### Description

In this exercise, you will set up the data needed for a gradually varied flow scenario using a backwater analysis, compute it to calculate the hydrology and hydraulics, and review the messages for potential issues.

### Skills Taught

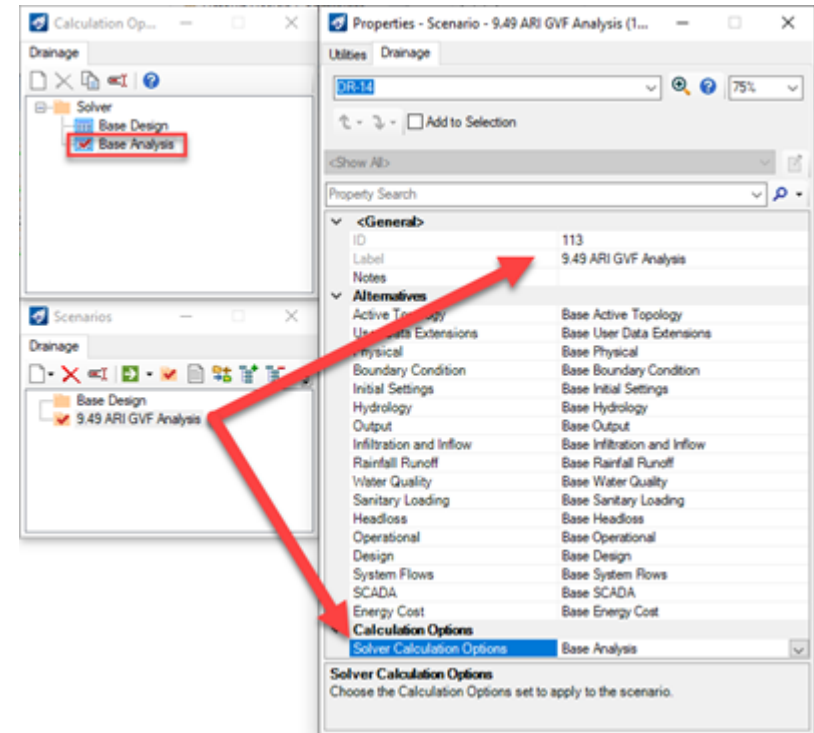
- Compute an Analysis Scenario to see how well the catch basins cope with a rainfall event
- Amend Calculation Solver Properties
- Review spread widths at the catch basins

## Checking the Active Scenario



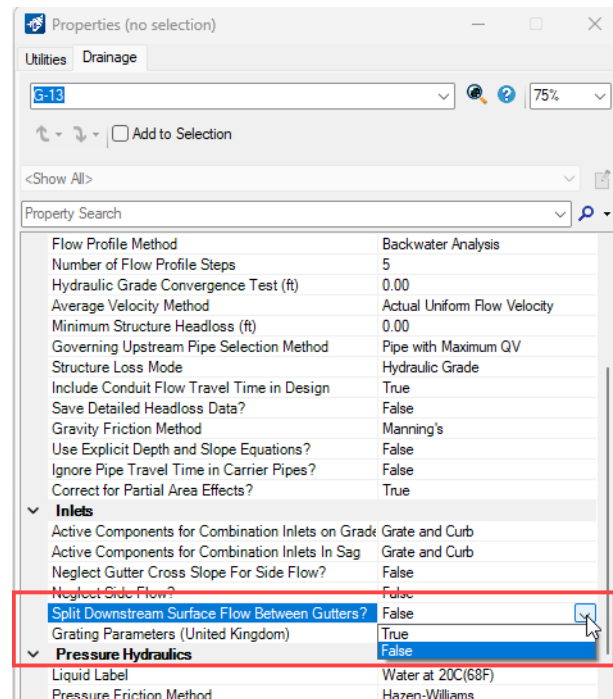
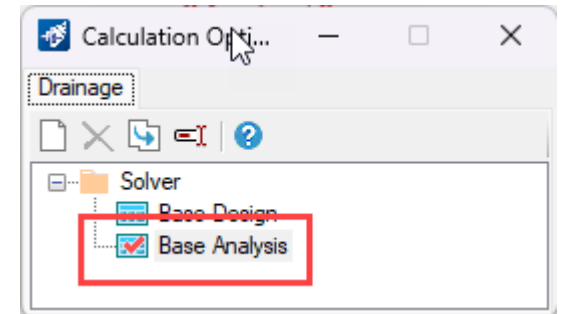
1. From the **Analysis** ribbon, select *Calculations* > **Scenario Manager**
  - a. Rename the *Base Analysis Scenario* to **9.49 ARI GVF Analysis**
  - b. Double click the *Scenario* and check that the *Calculation Options* are set to **Base Analysis**.
  - c. **Close** the *Properties* panel
  - d. **Close** > *Scenario Manager*

We need to make a change to the *Active Numerical Solver* as currently the category for *Inlets* has the *Split for Downstream Surface Flow for Gutters?* set to **False** and we require the surface flow to the downstream structure to be allocated to the gutters proportionally along their length. So we need to change the setting to **True**.



2. From the **Analysis** ribbon, select *Calculation* > **Options**
  - a. **Double Click** > **Base Analysis** option
  - b. **Scroll down** to **Inlets** category

c. Set the *Split Downstream Surface Flow for Gutters?* > **True**



d. **Close** the *Solver properties* dialog

e. **Close** the *Calculation Options* dialog

## Computing the Scenario



1. From the **Analysis** ribbon, select **Analysis Tools > Compute Center**

The tool-strip at the top of the Compute Center lets you access a number of Managers and tools, to help you use scenarios. It always displays the current scenario when you open the dialog, but you can change the scenario to compute if you need to.

2. Confirm that the **Scenario** is set to **9.49 ARI GVF Analysis**.

Review the other settings in the Compute Center dialog.

**Note:** Settings for the **Calculation Type**, is set to **Analysis**. This means that the physical properties of the drainage network will not be changed. A **Calculation Type** that is set to **Design** may well cause the physical properties, such as invert levels and pipe diameters, to change.



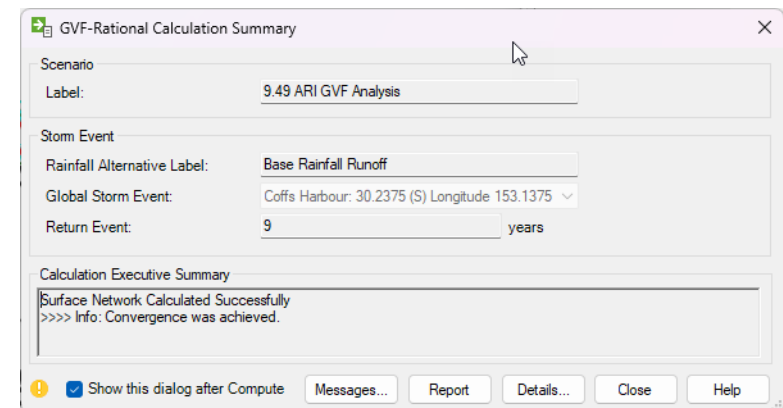
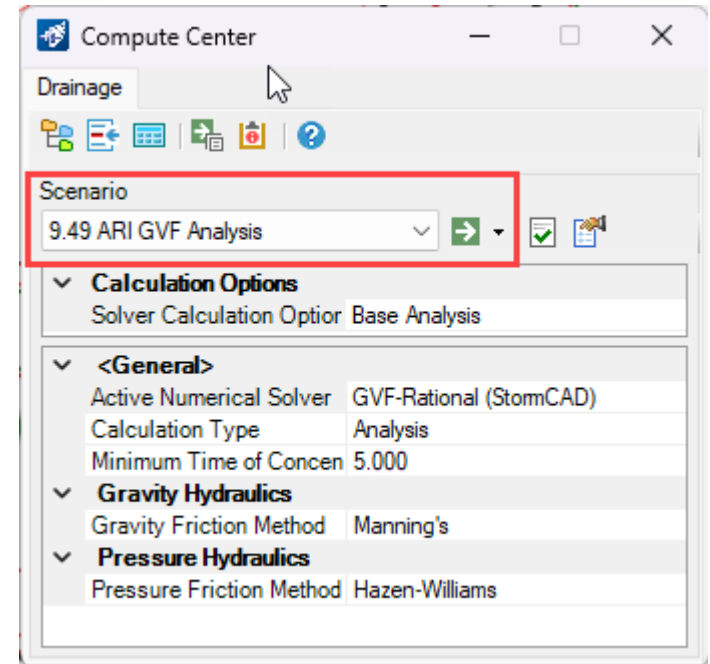
4. Click **Compute**. This computes the current scenario.

After a few moments, the **GVF-Rational Calculation Summary** dialog is displayed.

Due to the system only consisting of catch basins and catchments, and no conduits or outfall, no details are displayed in the **Calculation Executive Summary** area of the dialog.

3. On the **GVF-Rational Calculation Summary** panel, Click **Details**

This dialog is a good way to get an overview of a conveyance system, without selecting individual objects. Because we don't have any conduits yet, some of the tabs don't show any useful information, but the **Inlet Summary** tab does.



4. Select > **Inlet Summary** tab and review the data.

You can see the *Capture Efficiency* of each catch basin, and the *Spread / Top Width*, so you can easily find any big issues.

Calculation Detailed Summary										
Calculation Options Catchment Summary Link Summary Node Summary Inlet Summary Pond Summary										
	Label	Inlet Type	Catalog Inlet Type	Catalog Inlet	Flow (Captured) (cfs)	Flow (Total Bypassed) (cfs)	Bypass Target	Capture Efficiency (Calculated) (%)	Depth (Gutter) (in)	Spread / Top Width (ft)
	SA1-	Catalog Inlet	Combination	Training Combin:	0.05	0.04	SA1-4	56.4	0.363	0.378
	SA1-1	Catalog Inlet	Combination	Training Combin:	0.04	0.03	SA1-8	59.4	0.350	0.365
	SA1-9	Catalog Inlet	Combination	Training Combin:	0.08	0.00	SA1-10	100.0	0.694	0.723
	SA1-10	Catalog Inlet	Combination	Training Combin:	0.00	0.00	SA1-16	100.0	0.000	0.000
	SA1-11	Catalog Inlet	Combination	Training Combin:	0.02	0.07	SA1-12	24.3	0.345	0.360
	SA1-12	Catalog Inlet	Combination	Training Combin:	0.02	0.05	SA1-7	35.2	0.311	0.324
	SA1-2	Catalog Inlet	Combination	Training Combin:	0.00	0.63	SA1-3	0.0	0.706	0.736
	SA1-3	Catalog Inlet	Combination	Training Combin:	1.21	0.13	SA1-4	90.1	2.284	3.609
	SA1-4	Catalog Inlet	Combination	Training Combin:	1.41	0.31	SA1-5	82.1	2.623	4.552
	SA1-5	Catalog Inlet	Combination	Training Combin:	1.22	0.13	SA1-6	90.4	2.269	3.568
	SA1-6	Catalog Inlet	Combination	Training Combin:	0.75	0.09	SA1-7	89.7	2.372	3.856
	SA1-7	Catalog Inlet	Combination	Training Combin:	0.46	0.00	(N/A)	100.0	3.530	1.471
	SA1-8	Catalog Inlet	Combination	Training Combin:	1.20	0.18	SA1-13	86.9	2.425	4.002
	SA1-13	Catalog Inlet	Combination	Training Combin:	0.72	0.01	SA1-14	98.7	1.840	2.376
	SA1-14	Catalog Inlet	Combination	Training Combin:	0.59	0.01	SA1-15	98.0	1.902	2.548
	SA1-15	Catalog Inlet	Combination	Training Combin:	0.21	0.00	SA1-16	100.0	1.543	1.607
	SA1-16	Catalog Inlet	Combination	Training Combin:	0.23	0.00	(N/A)	100.0	2.309	0.962

The *Catchment Summary* tab is also a useful one to check at this stage, as it could reveal an issue with the storm data.

- a. **Close** the *Details* dialog.

5. On the *GVF-Rational Calculation Summary* panel, click **Messages**

- a. Review the messages.

**Note:** The messages about time of concentration, no outfall, and no valid network can be ignored as this is to be expected.



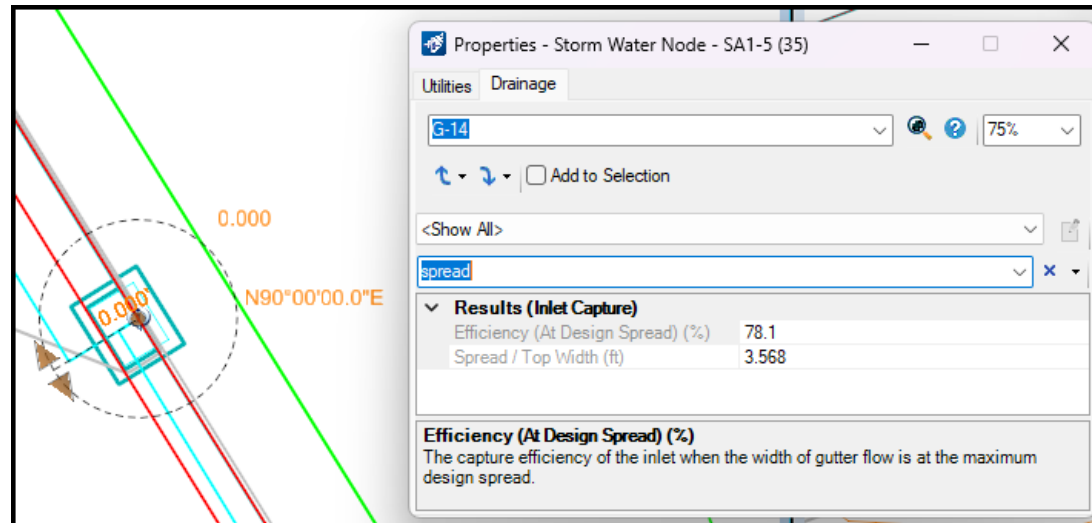
b. **Close** the *User Notifications* dialog.

6. **Close** the *GVF-Rational Calculation Summary* and the *Compute Centre* dialogs.

Message Id	Scenario	Element Type	Element Id	Label	Time (min)	Message
44045	9.49 ARI GVF Analysis	Catchment	222	DR-10	(N/A)	Time of concentration for catchment is less than the minimum Tc v2
44045	9.49 ARI GVF Analysis	Catchment	295	DR-17	(N/A)	Time of concentration for catchment is less than the minimum Tc v2
44045	9.49 ARI GVF Analysis	Catchment	255	DR-8	(N/A)	Time of concentration for catchment is less than the minimum Tc v2
44045	9.49 ARI GVF Analysis	Catchment	247	DR-5	(N/A)	Time of concentration for catchment is less than the minimum Tc v2
44045	9.49 ARI GVF Analysis	Catchment	253	DR-7	(N/A)	Time of concentration for catchment is less than the minimum Tc v2
44045	9.49 ARI GVF Analysis	Catchment	289	DR-15	(N/A)	Time of concentration for catchment is less than the minimum Tc v2
44045	9.49 ARI GVF Analysis	Catchment	251	DR-6	(N/A)	Time of concentration for catchment is less than the minimum Tc v2
44045	9.49 ARI GVF Analysis	Catchment	286	DR-14	(N/A)	Time of concentration for catchment is less than the minimum Tc v2
44045	9.49 ARI GVF Analysis	Catchment	210	DR-4	(N/A)	Time of concentration for catchment is less than the minimum Tc v2
44045	9.49 ARI GVF Analysis	Catchment	284	DR-9	(N/A)	Time of concentration for catchment is less than the minimum Tc v2
44045	9.49 ARI GVF Analysis	Catchment	208	DR-3	(N/A)	Time of concentration for catchment is less than the minimum Tc v2
44045	9.49 ARI GVF Analysis	Catchment	241	DR-1	(N/A)	Time of concentration for catchment is less than the minimum Tc v2
44045	9.49 ARI GVF Analysis	Catchment	292	DR-16	(N/A)	Time of concentration for catchment is less than the minimum Tc v2
44045	9.49 ARI GVF Analysis	Catchment	245	DR-2	(N/A)	Time of concentration for catchment is less than the minimum Tc v2
44045	9.49 ARI GVF Analysis	Catchment	228	DR-13	(N/A)	Time of concentration for catchment is less than the minimum Tc v2
44045	9.49 ARI GVF Analysis	Catchment	226	DR-12	(N/A)	Time of concentration for catchment is less than the minimum Tc v2
44045	9.49 ARI GVF Analysis	Catchment	224	DR-11	(N/A)	Time of concentration for catchment is less than the minimum Tc v2
20321	9.49 ARI GVF Analysis	(N/A)	0	(N/A)	(N/A)	There is no outfall or storage node in the network, or the outfall bou
44110	9.49 ARI GVF Analysis	Catch Basin	207	SA1-	(N/A)	The captured surface flow at this node does not connect a valid su
44110	9.49 ARI GVF Analysis	Catch Basin	209	SA1-1	(N/A)	The captured surface flow at this node does not connect a valid su

## Checking Hydraulic Properties

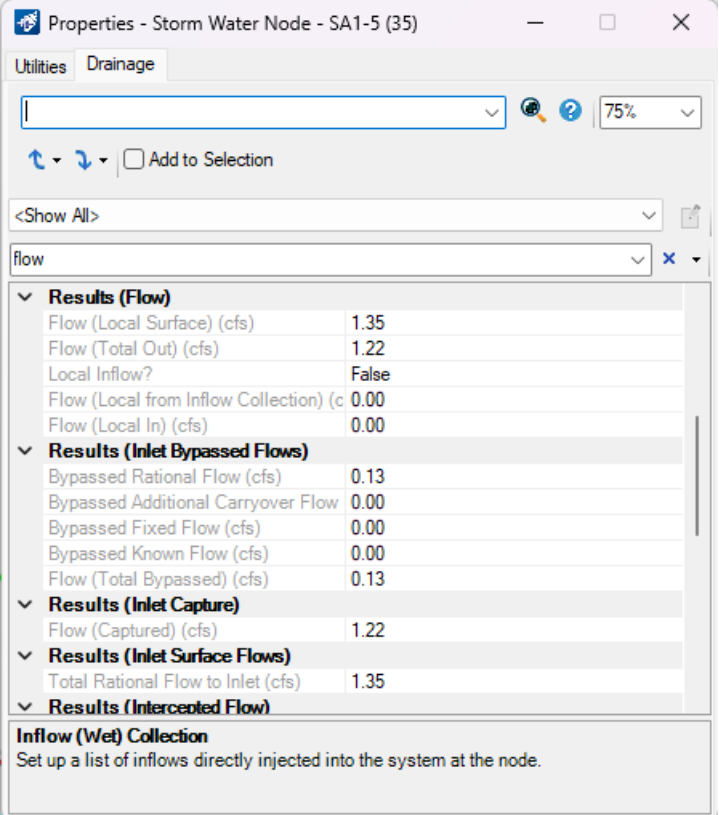
1. Select the catch basin south of the intersection fillet (this was the first catch basin we placed using Station Offset) **SA1-5** and view the **Utility Properties**.
2. There are quite a lot of result fields so if you want to look at the spread width in the gutter just type in the word '*spread*' in the *Property Search*.
  - a. You can see that the inlet is operating at **78.1%** of its efficiency.
  - b. You can also see the width of flow in the gutter is approximately **3.568'** [1.042m].



**Note:** that your values may differ slightly, as they depend on exactly where you placed the catch basin. The Hydraulic Prototype for the Feature Definition is set up to use an Inlet Catalog, which uses HEC-22 equations to calculate the capacity of the inlet using grate and curb parameters, cross and longitudinal slopes.

- c. Remove the '*spread*' text from the **Property Search** if you typed it in.
- d. Type in the word '*flow*' in the *Property Search*.

e. Look at the *Results* for **Inlet Bypassed Flows** and **Inlet Capture**



Results (Flow)	
Flow (Local Surface) (cfs)	1.35
Flow (Total Out) (cfs)	1.22
Local Inflow?	False
Flow (Local from Inflow Collection) (cfs)	0.00
Flow (Local In) (cfs)	0.00

Results (Inlet Bypassed Flows)	
Bypassed Rational Flow (cfs)	0.13
Bypassed Additional Carryover Flow	0.00
Bypassed Fixed Flow (cfs)	0.00
Bypassed Known Flow (cfs)	0.00
Flow (Total Bypassed) (cfs)	0.13

Results (Inlet Capture)	
Flow (Captured) (cfs)	1.22

Results (Inlet Surface Flows)	
Total Rational Flow to Inlet (cfs)	1.35

Results (Intercepted Flow)	
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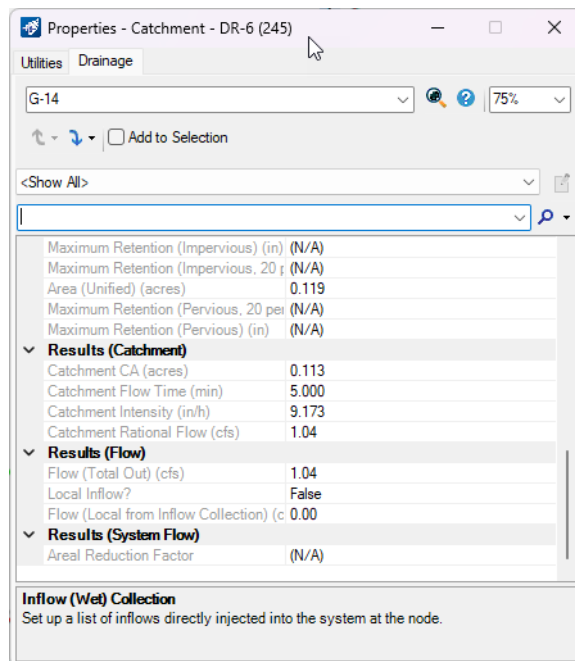
**Inflow (Wet) Collection**  
Set up a list of inflows directly injected into the system at the node.

Obviously, the *Inlet capture* values are the flow that enters the Catch Basin and the *Inlet Bypassed Flows* values are the flow that is not captured by a Catch Basin and is passed to the gutter. In this case the spread width and depth at the start of the gutter will be greater than zero.

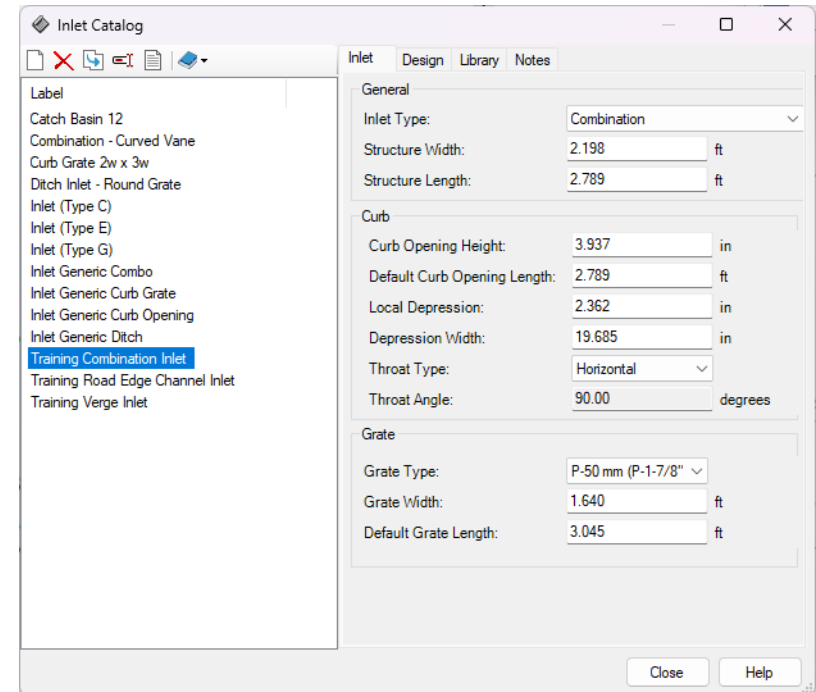
The inlet properties can be found in the Inlet catalog

3. Select, **Components** > **Catalog** > **Inlet Catalog** > **Training Combination Inlet**
  - a. **Close** the **Inlet Catalog** dialog
4. Select catchment associated to **SA1-5**
  - a. Remove the **'flow'** text from the **Property Search** if you typed it in.

You can see the results for the catchment, including how much flow is coming off it.



- a. **Close** the **Properties** dialog



## Exercise 5: Moving Catch Basins

---

### Description

This exercise will look at moving catch basins to optimize their locations. This will also show the power of using catchment delineation, because the catchments are linked to the catch basins and will update automatically.

### Skills Taught

- Moving a catch basin using Manipulators
- Automatically calculate the Road Cross Slope
- Measuring the Road Cross Slope
- Finding the route of a bypass flow path
- Moving a catch basin to collect bypass flow

## Moving a Catch Basin using Properties

You are going to move a catch basin in a moment. First though, check its hydraulic properties.

1. Select the catch basin **SA1-5**, south of the intersection fillet

a. View the **Utility Properties**.

b. Find the *Road Cross Slope* property.

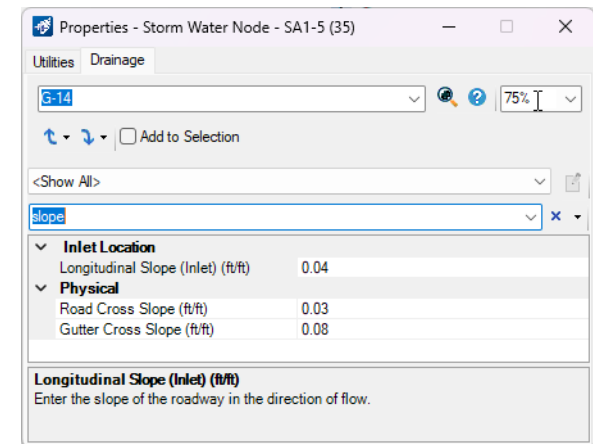
There are quite a lot of result fields so if you want to look at the spread width in the gutter just type in the word '*slope*' in the *Property Search*.

c. **Note** the value – **0.03 (ft/ft) [0.03 m/m]**

This value came from the road cross slope option which is set in the properties of the feature definition. The gutter cross slope comes from the prototype and this isn't measured from the road surface because its usually a constant value.

While you are reviewing the **Utility Properties**, note the value for the *Longitudinal Slope (Inlet)*, which happens to be **0.04 (ft/ft) [0.04 m/m]**. This value is set automatically when the catch basin is placed or moved.

d. **Close** the properties dialog.



2. Select Catch Basin **SA1-5**

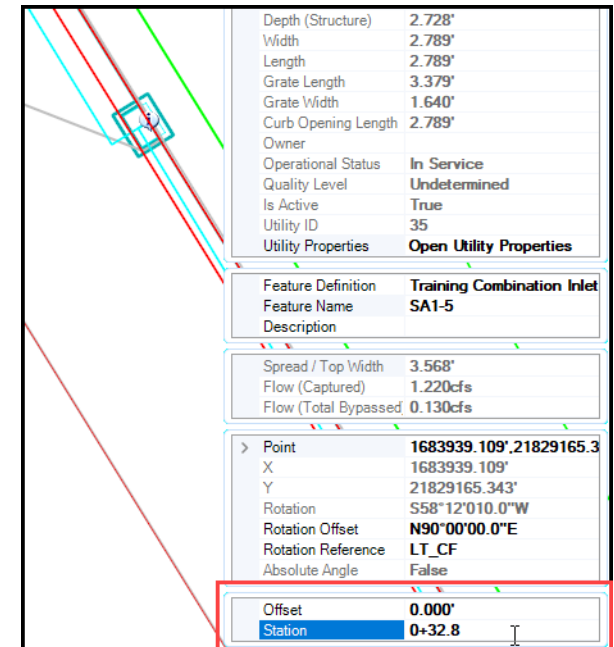
Because this Catch Basin was placed using Civil AccuDraw we can use the station to move the Catch Basin to a different location

a. From the *context sensitive toolbar* Select > **Properties**

b. Select the Station value (it says **49.212' [15m]**)

c. Change the Station value > **32.8' [10m]**

d. Select > **Enter**



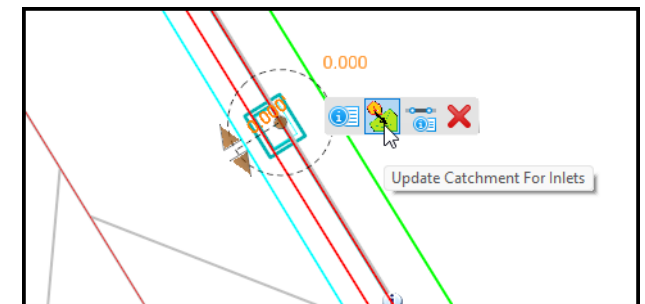
Depth (Structure)	2.728'
Width	2.789'
Length	2.789'
Grate Length	3.379'
Grate Width	1.640'
Curb Opening Length	2.789'
Owner	
Operational Status	In Service
Quality Level	Undetermined
Is Active	True
Utility ID	35
Utility Properties	Open Utility Properties
Feature Definition	Training Combination Inlet
Feature Name	SA1-5
Description	
Spread / Top Width	3.568'
Flow (Captured)	1.220cfs
Flow (Total Bypassed)	0.130cfs
> Point	1683939.109', 21829165.3
X	1683939.109'
Y	21829165.343'
Rotation	S58°12'010.0"W
Rotation Offset	N90°00'00.0"E
Rotation Reference	LT_CF
Absolute Angle	False
Offset	0.000'
Station	0+32.8

3. Update the *Catchment Delineation*

a. Select Catch Basin **SA1-5** again

b. From the *context sensitive toolbar*, Select > **Update Catchment For Inlets**

The catchment will update automatically.

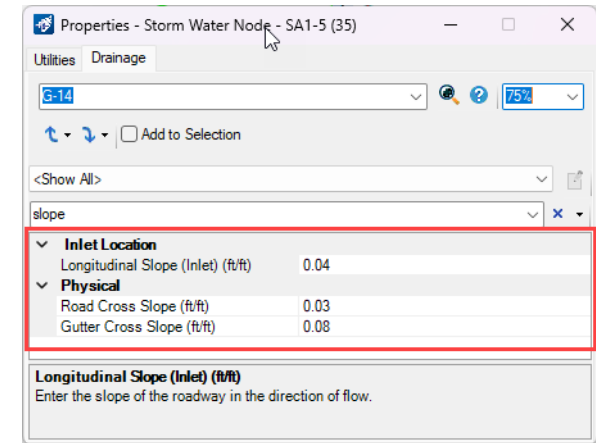


4. Repeat the *Update Catchment for Inlets* process for the downstream Catch Basin **SA1-6**

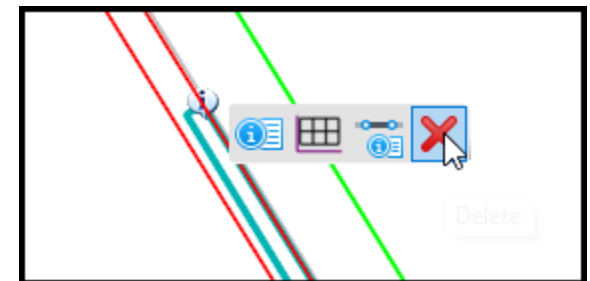
5. Check the *Properties* of the repositioned Catch Basin **SA1-5**
  - a. Select the Catch Basin, from the *context sensitive toolbar*, Select > **Open Utility Properties**

**Note** the values are the same as we are on the same feature for the longitudinal gradient.

  - b. **Close** the *Utility Properties*



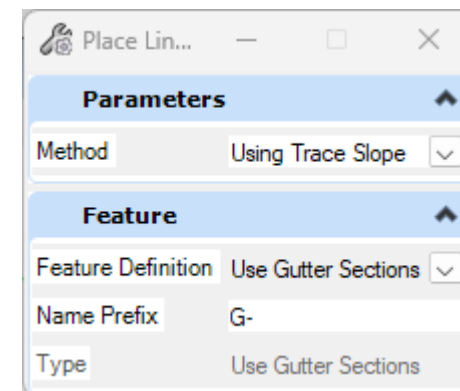
6. The last step we have to take is to re-create the gutters for the catch basin we moved.
7. First we have to *delete* the existing Gutters **G-2** and **G-3**
  - a. Select Gutter > **G-2**
  - b. Wait for the *context sensitive toolbar* Select > **Delete**
  - c. Repeat for Gutter **G-3**







8. Select > **Place Gutter**
  - a. Select *Method* > **Using Trace Slope**
  - b. *Feature Definition* > **Use Gutter Sections**
  - c. Select *Start Node* > **SA1-4**
  - d. **Data Point** to *Accept Trace Slope*Continuing...
  - e. Select *Start Node* > **SA1-5**
  - f. **Data Point** to *Accept Trace Slope*
  - g. **<Esc>** to exit command



Compute

9. From the **Analysis** ribbon, Select *Calculation* > *Compute* > **Compute Scenario**
  - a. Click **Messages** on the *GVF-Rational Calculation Summary* dialog.  
Review the messages.
  - b. **Close** the *Messages* dialog
  - c. **Close** *GVF-Rational Calculation Summary* dialog

## Finding the Route of a Bypass Flow Path



1. For checking the modified position of the catch basin use *Home > Model Analysis > Civil Analysis > Analyze Trace Slope*.

This tool traces along a surface either following a user-specified slope value or the steepest slope. You can trace upstream or downstream.

2. Window to the area of the road traffic island at the junction

Set the *settings* as shown on the right.

Parameters	
Trace Method	Maximum Slope Trace
Minimum Depth	0.328
Trace Slope Direction	Down

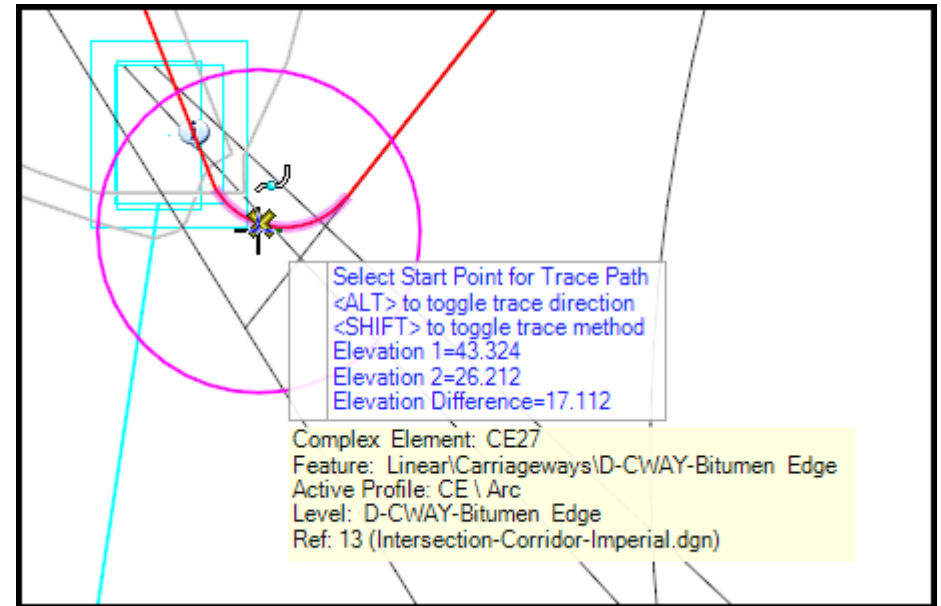
  

Feature	
Feature Definition	Trace Slope
Name	Trace Slope

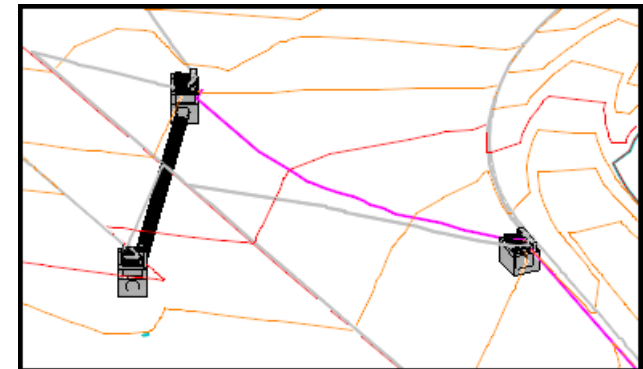
- a. Select Snap Mode *AccuSnap* > **Near Snap Point**.
- b. Select the **Intersection - Terrain** model in the *Default-3D View*.

- c. Data point on the corner of the deflection island in the 2D *Default View*.

The trace slope is displayed in the *Default-3D View*.



As you can see the placement of the Catch Basin is correct so in this instance there is no need to reposition.



## Exercise 6: Checking Catch Basin Hydraulics and Gutters

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### Description

This exercise will look at checking the catch basins to ensure that they are hydraulically efficient. Also we will review the gutters and look at spread widths and depths.

### Skills Taught

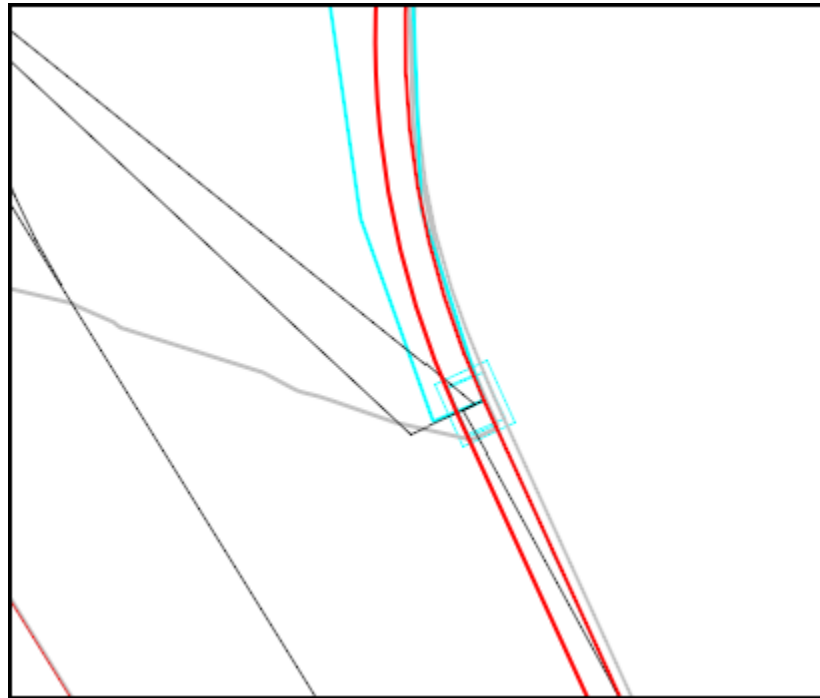
- Make a Local Design Constraints change
- Computing the active scenario
- Checking the hydraulic properties
- Checking Gutters

## Changing the Local Spread width of a Catch Basin

When you have computed the system previously, you have used the default settings for the spread width and depth. At an intersection, where there may be pedestrians, you may want to reduce these values. We could change spread width and depth in the Default Design Constraints but its much better to change those properties where the intersection occurs so that we are not affecting any other catch basin.

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1. Window to the Intersection area and locate catch basin **SA1-4**

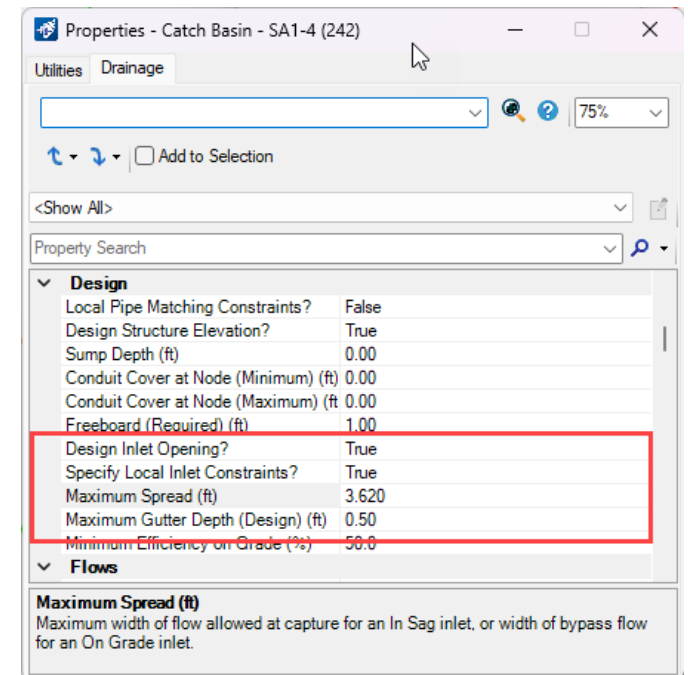
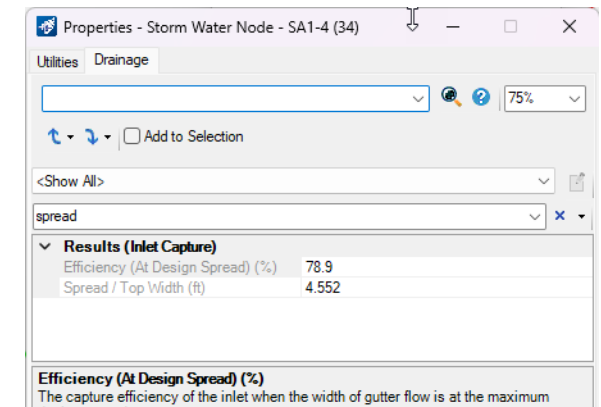


2. Select, **SA1-4** and wait for the *context sensitive toolbar*
  - a. Select > **Utility Properties**



- b. In the search area type 'spread'
- c. You can see that the *Efficiency* is at **78.9%**
- d. *Spread/Top width* is at **4.552' [1.199m]**
- e. **Clear** the search area of the word 'spread'
- f. Scroll the categories and locate 'Design'
- g. Opposite the property *Design Inlet Opening* > change the value to **True**
- h. Select the property *Specify Local Inlet Constraints* > change the value to **True**
- i. Set the *Maximum Spread* property > **3.62' [1.0m]**
- j. **Close** the Utility Properties dialog
- k. *De-Select* the inlet **SA1-4**

What we have just set is the *maximum spread width* we will allow at this catch basin, all the other catch basins will conform to the values in the *Default Design Constraints*.





3. From the **Analysis** ribbon, Select *Calculation > Compute > Compute Scenario*

a. Click **Messages** on the *GVF-Rational Calculation Summary* dialog.

Review the messages. Because you have changed the *design constraint for the spread* width on **SA1-4**, a new warning is now being shown - *The maximum spread constraint has been exceeded for this 'On Grade' inlet*. Which is to be expected as we have just changed that value.

Message Id	Scenario	Element Type	Element Id	Label	Time (min)	Message
44110	9.49 ARI GVF Analysis	Catch Basin	223	SA1-10	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from t
44110	9.49 ARI GVF Analysis	Catch Basin	240	SA1-2	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from t
44110	9.49 ARI GVF Analysis	Catch Basin	244	SA1-3	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from t
44110	9.49 ARI GVF Analysis	Catch Basin	246	SA1-4	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from t
44110	9.49 ARI GVF Analysis	Catch Basin	250	SA1-5	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from t
44110	9.49 ARI GVF Analysis	Catch Basin	252	SA1-6	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from t
44110	9.49 ARI GVF Analysis	Catch Basin	254	SA1-7	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from t
44110	9.49 ARI GVF Analysis	Catch Basin	283	SA1-8	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from t
44110	9.49 ARI GVF Analysis	Catch Basin	285	SA1-13	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from t
44110	9.49 ARI GVF Analysis	Catch Basin	288	SA1-14	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from t
44110	9.49 ARI GVF Analysis	Catch Basin	291	SA1-15	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from t
44110	9.49 ARI GVF Analysis	Catch Basin	294	SA1-16	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from t
44111	9.49 ARI GVF Analysis	(N/A)	0	(N/A)	(N/A)	Only surface flow and inlet capture calculations were computed.
44116	9.49 ARI GVF Analysis	Catch Basin	246	SA1-4	(N/A)	The maximum spread constraint has been exceeded for this 'On Grade' inlet.

**Note:** the messages about time of concentration, no outfall and no valid network can be ignored as this is to be expected.

You can also click Details and review the *Inlet Summary* tab.

b. **Close** the *User Notifications* dialog.

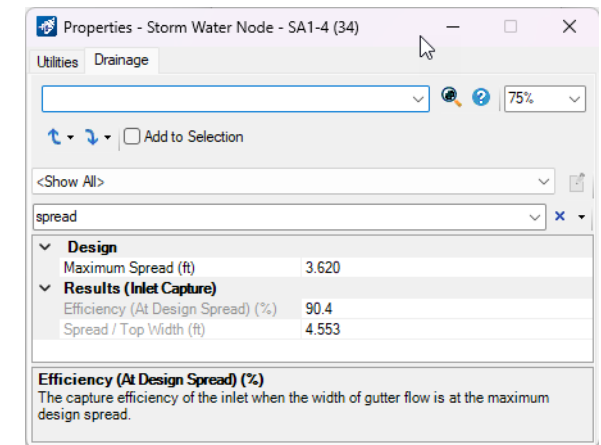
c. **Close** the *GVF-Rational Calculation Summary* dialog.

## Checking the Hydraulic Properties

1. Select catch basin **SA1-4** and view the **Utility Properties**.

a. There are quite a lot of result fields so if you want to look at the spread width in the gutter just type in the word '*spread*' in the *Property Search*.

**Note** that your values may be slightly different to those shown in the picture on the right, because they depend on the exact position of the catch basin.



You can see that the inlet is now operating at over **90%** of its efficiency.

You can also see the width of flow at the upstream face of the catch basin is over **3.62' [1.0m]**.

Hydraulic Prototype for the Feature Definition is set up to use an Inlet Catalog, which uses HEC-22 equations to calculate the capacity of the inlet using grate and curb parameters, cross and longitudinal slopes

There is a design decision to be made, do we move **SA1-4**, northwards, so we can decrease the width of flow or do we move **SA1-3** towards **SA1-4**, or do we insert another catch basin between them.

Let's insert a catch basin to see if that resolves the problem.



Before we do that it will be easier to move the node if we switch off the Levels for Gutters and Catchment areas.

2. Select *Home* > *Primary* > **Level Display**

a. *De-Select* the levels > **Util\_Storm\_Conduits** and **Util\_Storm\_Areas**

3. On the **Layout** ribbon, Select > **Place Node**

a. On the *Place Node* dialog set the following:

b. Set the *Feature Definition* > *Node* > *StormWaterNode* > *Inlets* > **Training Combination Inlet**

c. Check **Vertical Offset**, set value to **0**

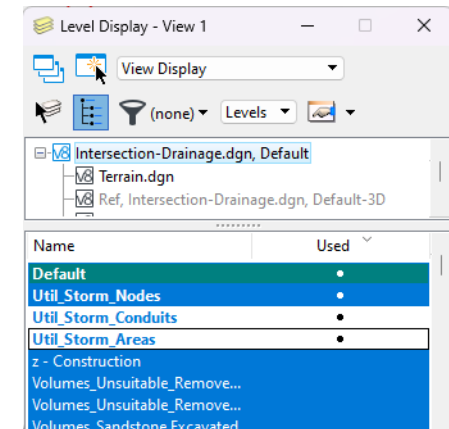
d. Select *Rotation Mode* > **Relative to alignment**

e. **Check Catchment** > **Catchment Delineation**

f. Select Snap Mode *AccuSnap* > **Near Snap Point**

Place the Catch Basin to the postilion marked with the note '*Catch Basin Position Ex 6'*

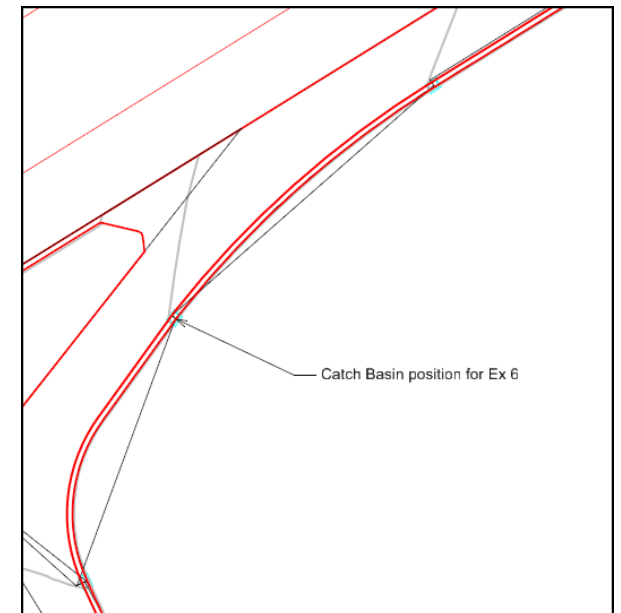
g. Set the *Catchment Feature Definition* to *Drainage Area* > *Catchment* > **Pavement**



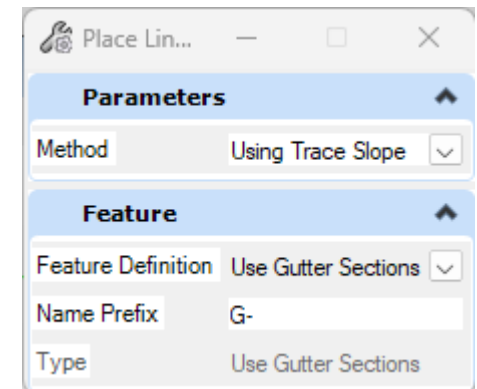
4. Following the *Heads-up prompts*, set the following: -
- At the *Select Reference Element for Node Elevation. <Reset> to Type Elevation* prompt, select the **D-Terrain-Intersection** Terrain model from *View 2*. Select any contour
  - At the *Define Catch basin* prompt, data point on the **D-CWAY-Gutter Flow Line** feature opposite the catch basin on the intersection approach in View 1.
  - Data point** to accept the *Rotation Mode* > **Relative to alignment**
  - At the *Locate Reference Element for Rotation* prompt, **Data point** on the **D-CWAY-Gutter Flow Line**

At this point the catch basin is placed.

  - Type **90** for the *Rotation* and *Enter*, then **Data point** to accept the rotation.
  - <Esc>** to exit command.



5. Select *Home* > *Primary* > **Level Display**
  - a. Turn the levels back on > **Util\_Storm\_Conduits** and **Util\_Storm\_Areas**
6. Update the *Catchment Delineation*
  - a. Select Catch Basin **SA1-4**
  - b. From the *context sensitive toolbar*, Select > **Update Catchment For Inlets**  
The catchment will update automatically.
7. Repeat this process for the Catchment at **SA1-3**
8. We will now have to delete the existing Gutters to SA-1-4 then regenerate the gutters for SA1-3 and SA1-17.
  - a. Select Gutter > **G-1**
  - b. Wait for the *context sensitive toolbar* and Select > **Delete**
9. The next step we have to take is to re-create the gutters.
  - a. Select > **Place Gutter**
  - b. Select *Method* > **Using Trace Slope**
  - c. *Feature Definition* > **Use Gutter Sections**
  - d. Select *Start Node* > **SA1-3**
  - e. **Data Point** to *Accept Trace Slope*
10. Continue with re-creating the gutters.
  - a. Select *Start Node* > **SA1-17**
  - b. **Data Point** to *Accept Trace Slope*
  - c. **<Esc>** to exit command



In order to see if we have corrected the spread width in the gutter we need to re-run the Scenario



11. From the **Analysis** ribbon, Select *Calculation* > *Compute* > **Compute Scenario**

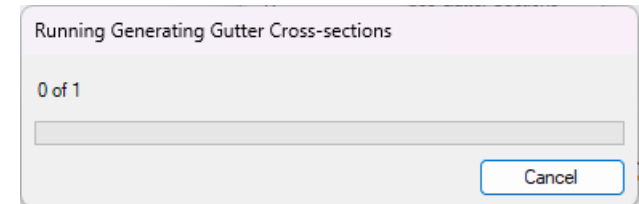
- a. Click **Messages** on the *GVF-Rational Calculation Summary* dialog.
- b. View the messages and you will see that we have no messages regarding spread width
- c. **Close** the *Messages* dialog
- d. **Close** the *Calculation Summary* dialog

## Checking Gutters

In this section we will review the gutters we have created by looking at the gutter cross sections.

1. *Gutter sections* are generated when the gutter is created, provided that the *Feature Definition* is set to **Use Gutter Sections**.

When the Place Gutter option is used you will see a notification panel saying *Running Generating Gutter Cross-sections*



2. Review the Gutter Section Settings.



- a. Select, **Tools > Project Tools > Gutter Section Settings**

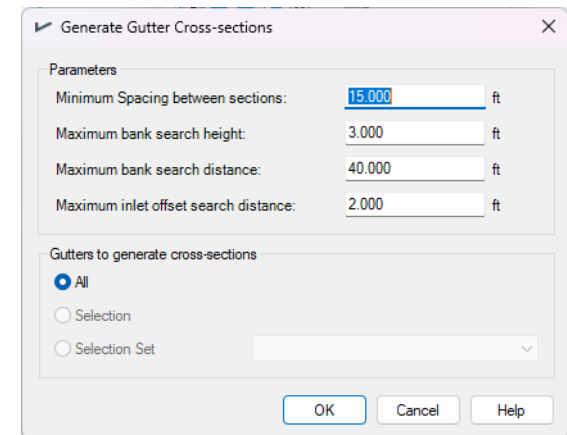
On the dialog the following options are available:

*Minimum Spacing Between Sections:* Only when distance between 2 gutter cross-sections is larger than this value will a gutter section be added. Sections at the upstream inlet and downstream inlet are always added.

*Maximum Bank Search Height:* For a composite terrain model with road design and natural area, the left or right bank of the gutter may be much higher than the gutter invert and many more points can be added to the gutter station-elevation curve.

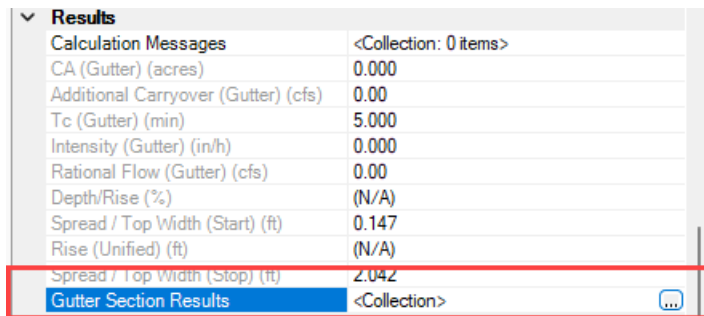
*Maximum Bank Search Distance:* For a natural terrain model, if the bank slope is small, the bank horizontal length can be very large. Maximum bank search distance is used to avoid having very long gutter banks.

*Maximum Inlet Offset Search Distance:* To create a valid gutter link between 2 inlets, the downstream inlet must be in the downstream trace path from the upstream inlet. Since the inlet may not be exactly laid out in the gutter, a Maximum Inlet Offset Search Distance (or Inlet In Path Tolerance) is used to check if the downstream inlet is in the downstream path from an upstream inlet.



- b. Select > **Cancel**

3. Review a Gutter Section.
  - a. Locate gutter **G-15**
  - b. Select *Gutter* > **G-15**
  - c. Wait for the *context sensitive toolbar*, Select > **Utility Properties**
  - d. Find the *Property* > *Results* > **Gutter Section Results**
  - e. Select > *Gutter Sections Results* > **<Collection>**
  - f. Click > **ellipsis**



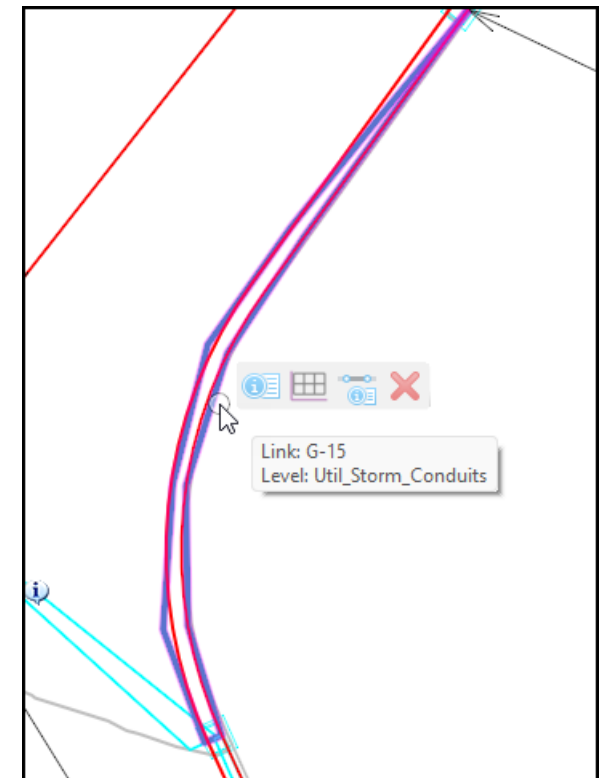
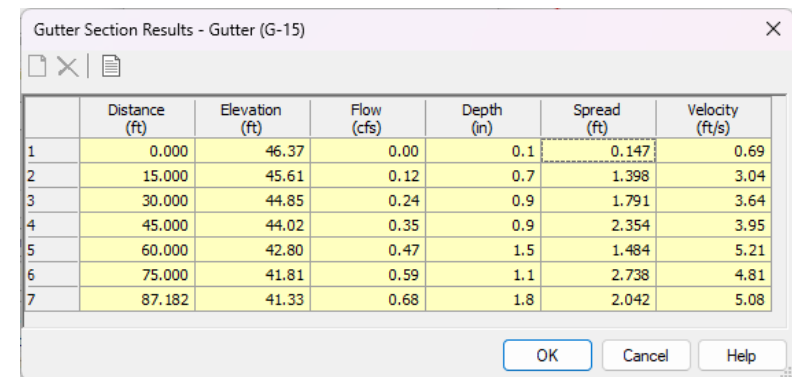
Results	
Calculation Messages	<Collection: 0 items>
CA (Gutter) (acres)	0.000
Additional Carryover (Gutter) (cfs)	0.00
Tc (Gutter) (min)	5.000
Intensity (Gutter) (in/h)	0.000
Rational Flow (Gutter) (cfs)	0.00
Depth/Rise (%)	(N/A)
Spread / Top Width (Start) (ft)	0.147
Rise (Unified) (ft)	(N/A)
Spread / Top Width (Stop) (ft)	2.042
Gutter Section Results	<Collection>

The **Gutter Section Results** dialog appears

- g. Select the column heading > **Spread**
- h. *Right Click* > **Units and Formating**
- i. Change *Display Precision* > **3**

If you look at *row 5*, you will notice that the spread is less than that at row 4 and 6. The spread width at each gutter section uses the *cross slope* and *longitudinal slope* and these tend to flatten off around a fillet, as in this case.

- j. Select, **OK** to *Close* the dialog
- k. Find the *Property* > **Geometry**
- l. Select > *Gutter Sections Results* > **<Collection>**

	Distance (ft)	Elevation (ft)	Flow (cfs)	Depth (in)	Spread (ft)	Velocity (ft/s)
1	0.000	46.37	0.00	0.1	0.147	0.69
2	15.000	45.61	0.12	0.7	1.398	3.04
3	30.000	44.85	0.24	0.9	1.791	3.64
4	45.000	44.02	0.35	0.9	2.354	3.95
5	60.000	42.80	0.47	1.5	1.484	5.21
6	75.000	41.81	0.59	1.1	2.738	4.81
7	87.182	41.33	0.68	1.8	2.042	5.08

m. Select > **ellipsis**

The **Gutter cross section** dialog opens

The dialog is split into 3 areas, *Station* along the gutter, *Cross section view* and *Gutter properties*. Review the *spread* and *depth* at cross section **0+60' [0+18m]** and again you can see the spread is reduced at this location.

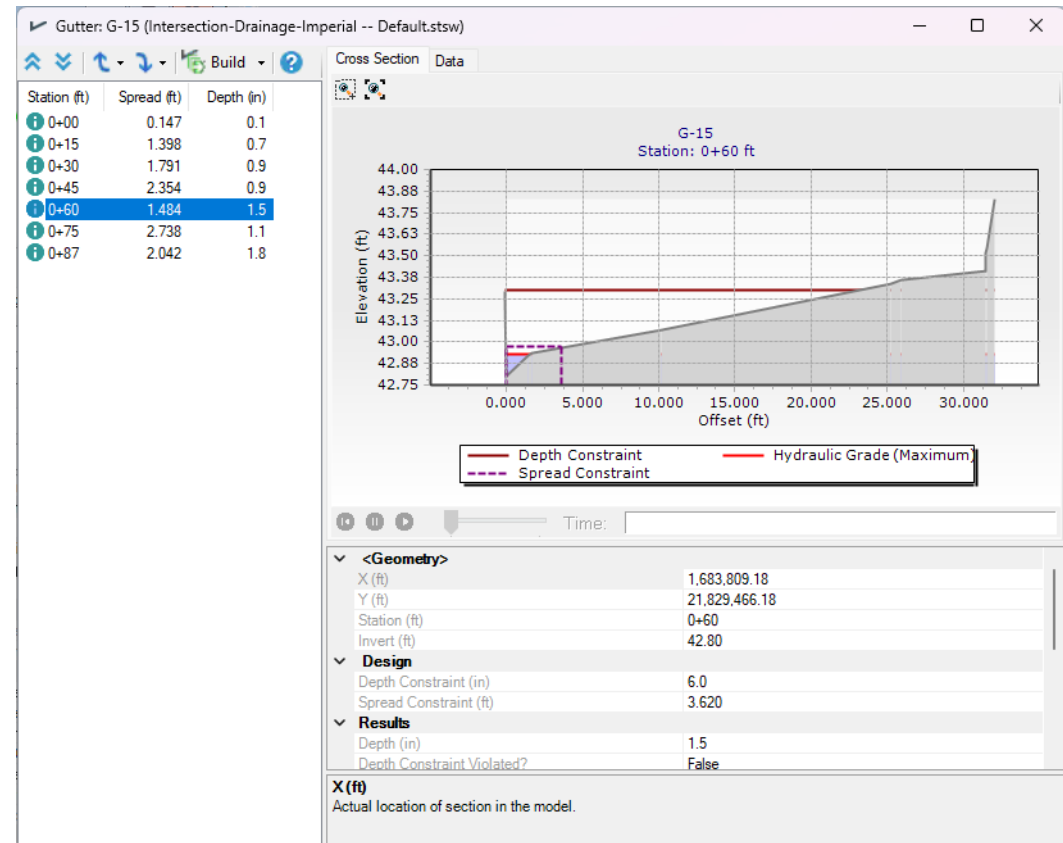
In the *Properties* pane scroll down to *Results (Physical)*. You will see that the gutter shape is set to **Conventional**, this is because the shape of the gutter cross section that the software has found is in accordance with the “*Conventional*” shape in the *HEC-22 standard*, so the *HEC-22 equations* will be used to calculate the spread width and depth.

If the gutter shape was **Irregular Manning's equation** is used.

▼ <b>Results (Physical)</b>	
Gutter Shape	Irregular
▼ <b>Results (Statistics)</b>	
Depth (Maximum) (in)	1.5
Depth Constraint Ever Violated?	False
Spread (Maximum) (ft)	1.484
Spread Constraint Ever Violated?	False

n. **Close** the dialog.

o. **Close** the *Utility Properties*



## Exercise 7: Setting the Time Of Concentration

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### Description

Warnings about the Time Of Concentration are being shown in the Notifications. This warning occurs because the catchment areas do not have a Time Of Concentration set, so the default is used. This issue is addressed in this Exercise.

### Skills Taught

- Setting the Minimum Time Of Concentration
- Setting the Time Of Concentration for the Catchment Areas
- Reviewing the Time Of Concentration
- Computing the Active Scenario



## Setting the Minimum Time of Concentration



1. Click *Analysis* > *Calculation* > **Options**
  - a. Double click the **Base Analysis** and check the *Properties*.

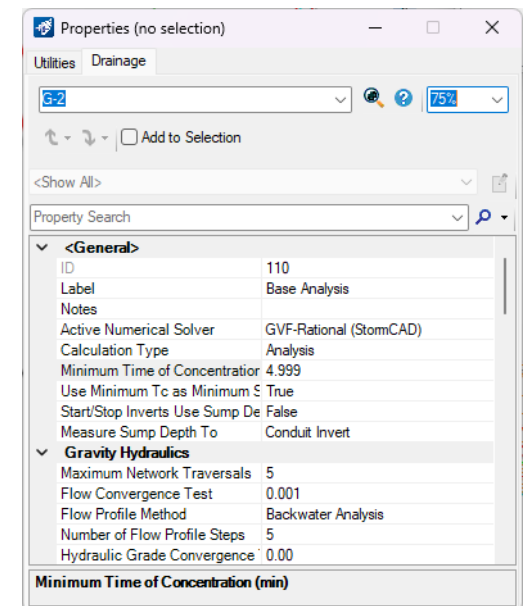
This is where the default value is set for the **Minimum Time of Concentration** for your catchments. This value is used if it has not been set on the individual catchment areas.

- b. Change **Minimum Time of Concentration** from *5.000* to *4.9999* as this value is just less than *5.000*.

Why are you using four decimal places – not two or three? Because the precision of this property is set to three decimal places, so by using four, the result will be displayed to three, and so appear as *5.000*.

You can check the precision by right clicking on the property, then clicking *Units and Formatting*.

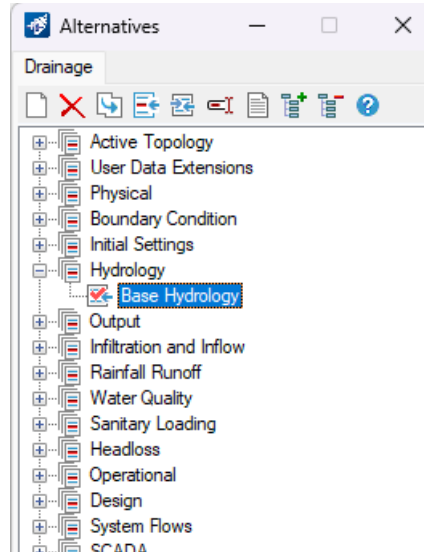
- c. **Close** the *Properties* dialog.
  - d. **Close** the *Calculation Options*.



## Setting the Time of Concentration for the Catchment Areas



1. On the *Analysis* > **Calculations** ribbon, Select > **Alternatives**
  - a. In the *Alternatives* dialog, locate the *Hydrology* > **Base Hydrology** Alternative.



- b. **Double Click** on *Base Hydrology* to view the Hydrology.
    - c. Select the **Catchment** tab.

- d. The **Time of Concentration** values can be set here for individual or all catchments.

Method	Outflow Element	Use Scaled Area?	Area (User Defined) (ha)	Delineation Type	Time of Concentration (min)	Runoff Coefficient (Rational)
208: DR-3	SA1-	<input checked="" type="checkbox"/>		Automatic	0.000	0.350
210: DR-4	SA1-1	<input checked="" type="checkbox"/>		Automatic	0.000	0.350
222: DR-10	SA1-9	<input type="checkbox"/>	0.000	Automatic	0.000	0.350
224: DR-11	SA1-10	<input type="checkbox"/>	0.000	Automatic	0.000	0.350
226: DR-12	SA1-11	<input type="checkbox"/>	0.000	Automatic	0.000	0.350
228: DR-13	SA1-12	<input type="checkbox"/>	0.000	Automatic	0.000	0.350
241: DR-1	SA1-2	<input checked="" type="checkbox"/>		Automatic	0.000	0.950
243: DR-2	SA1-3	<input checked="" type="checkbox"/>		Automatic	0.000	0.950
245: DR-5	SA1-4	<input checked="" type="checkbox"/>		Automatic	0.000	0.950
247: DR-6	SA1-5	<input checked="" type="checkbox"/>		Automatic	0.000	0.950
249: DR-7	SA1-6	<input checked="" type="checkbox"/>		Automatic	0.000	0.950
251: DR-8	SA1-7	<input checked="" type="checkbox"/>		Automatic	0.000	0.950
253: DR-9	SA1-8	<input checked="" type="checkbox"/>		Automatic	0.000	0.950
255: DR-14	SA1-13	<input checked="" type="checkbox"/>		Automatic	0.000	0.950

- e. Right click on the *Time of Concentration (min)* column heading and select **Global Edit**.

Global Edit

Operation: Set

Value: 5

WHERE: <no filter active>

OK Cancel

- f. Set the value to **5** and click **OK**

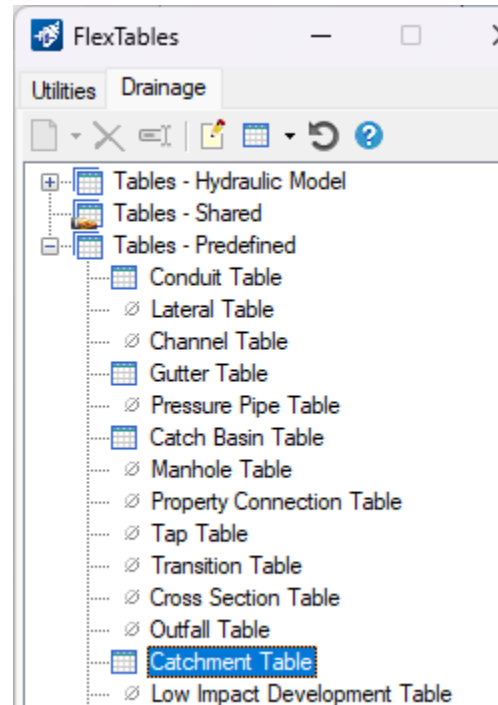
The values are now updated. Remember that individual modifications can be made if required

- g. **Close** the Dialog

## Reviewing the Time of Concentration in a FlexTable



1. On the *Analysis* > **Analysis Views** ribbon, Select > **FlexTables**
  - a. From the *Drainage* tab, double click on *Tables Predefined* > **Catchment Table**



The modified *Base Hydrology* for the *Catchments* can be confirmed here.

**Note** that the modification could also have been made in this dialog. Why have two dialogs – *Alternatives* and *FlexTables* – that both allow modifications? FlexTables always show values from the current scenario, so it's important that you check this before you start making changes. By using the *Alternatives* dialog, you are specifically choosing the Alternative to edit. Both workflows will achieve the same result.

b. **Close** the *Catchment Table* flex table

c. **Close** the *FlexTables* dialog.

FlexTable: Catchment Table (Current Time: 0.000 min) (Intersection-Drainage -- Default.stsw)

	Label	Outflow Element	Area (User Defined) (ha)	Runoff Method	Loss Method	Time of Concentration (min)	Unit Hydrograph Method	Flow (Total Out) (L/s)
208: DR-3	DR-3	SA1-		Rational Method		5.000		2.31
210: DR-4	DR-4	SA1-1		Rational Method		5.000		2.11
222: DR-10	DR-10	SA1-9	0.000	Rational Method		5.000		0.00
224: DR-11	DR-11	SA1-10	0.000	Rational Method		5.000		0.00
226: DR-12	DR-12	SA1-11	0.000	Rational Method		5.000		0.00
228: DR-13	DR-13	SA1-12	0.000	Rational Method		5.000		0.00
241: DR-1	DR-1	SA1-2		Rational Method		5.000		17.69
243: DR-2	DR-2	SA1-3		Rational Method		5.000		20.46
245: DR-5	DR-5	SA1-4		Rational Method		5.000		43.76
247: DR-6	DR-6	SA1-5		Rational Method		5.000		28.02
249: DR-7	DR-7	SA1-6		Rational Method		5.000		19.37
251: DR-8	DR-8	SA1-7		Rational Method		5.000		11.36
253: DR-9	DR-9	SA1-8		Rational Method		5.000		33.05

16 of 16 elements displayed

2. From the **Analysis** ribbon, Select *Calculation* > *Compute* > **Compute Scenario**

a. Click **Messages** on the *GVF-Rational Calculation Summary* dialog.

View the messages and you will see that we now have no messages regarding Time Of Concentration.

User Notifications

Drainage

User Notifications Engineering Standards

Message Id	Scenario	Element Type	Element Id	Label	Time (min)	Message
20321	9.49 ARI GVF Analysis	(N/A)	0	(N/A)	(N/A)	There is no outfall in the network, or the outfall is inactive.
44110	9.49 ARI GVF Analysis	Catch Basin	207	SA1-	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from the system.
44110	9.49 ARI GVF Analysis	Catch Basin	209	SA1-1	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from the system.
44110	9.49 ARI GVF Analysis	Catch Basin	240	SA1-2	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from the system.
44110	9.49 ARI GVF Analysis	Catch Basin	242	SA1-3	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from the system.
44110	9.49 ARI GVF Analysis	Catch Basin	244	SA1-4	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from the system.
44110	9.49 ARI GVF Analysis	Catch Basin	246	SA1-5	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from the system.
44110	9.49 ARI GVF Analysis	Catch Basin	248	SA1-6	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from the system.
44110	9.49 ARI GVF Analysis	Catch Basin	250	SA1-7	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from the system.
44110	9.49 ARI GVF Analysis	Catch Basin	252	SA1-8	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from the system.
44110	9.49 ARI GVF Analysis	Catch Basin	254	SA1-13	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from the system.
44110	9.49 ARI GVF Analysis	Catch Basin	257	SA1-14	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from the system.
44110	9.49 ARI GVF Analysis	Catch Basin	260	SA1-15	(N/A)	The captured surface flow at this node does not connect a valid subsurface network. The flow is lost from the system.
44111	9.49 ARI GVF Analysis	(N/A)	0	(N/A)	(N/A)	Only surface flow and inlet capture calculations were computed.
44053	9.49 ARI GVF Analysis	Catch Basin	240	SA1-2	(N/A)	'On Grade' inlet capture efficiency does not meet minimum capture efficiency constraint.
44053	9.49 ARI GVF Analysis	Catch Basin	252	SA1-8	(N/A)	'On Grade' inlet capture efficiency does not meet minimum capture efficiency constraint.
44053	9.49 ARI GVF Analysis	Catch Basin	254	SA1-13	(N/A)	'On Grade' inlet capture efficiency does not meet minimum capture efficiency constraint.

- b. **Close** the *Messages* dialog
- c. **Close** the *Calculation Summary* dialog

## Skills Assessment

The questions below will test your retention of the skills covered in this course.

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1. Where are the default Hydraulic Properties of a Catchment to be found?
  - a. Alternatives
  - b. Options
  - c. Prototypes
  - d. Scenarios
2. When Placing Catch Basins which tool do we use?
  - a. AccuSnap
  - b. Civil AccuDraw
  - c. Line to Element
  - d. Line from Element
3. Why might the spread width at the start of a gutter not be zero?
  - a. Because there has been too much rainfall
  - b. The flow has bypassed the inlet
  - c. The inlet is blocked

## Skills Assessment - Answers

The answers to the skills assessment questions are highlighted below.

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1. Where are the default Hydraulic Properties of a Catchment to be found?
  - a. Alternatives
  - b. Options
  - c. **Prototypes**
  - d. Scenarios
2. When Placing Catch Basins which tool do we use?
  - a. **AccuSnap**
  - b. **Civil AccuDraw**
  - c. Line to Element
  - d. Line from Element
3. Why might the spread width at the start of a gutter not be zero?
  - a. Because there has been too much rainfall
  - b. **The flow has bypassed the inlet**
  - c. The inlet is blocked



## Summary

In this class will showed you how to place inlets with catchment delineation and create gutters, to collect the runoff from a road surface. We covered two methods in the class, place inlets manually and place inlets automatically.

We also checked whether the inlet efficiencies, and the spread widths of the flows along the road edge, are acceptable, and adjust the design so that they are.