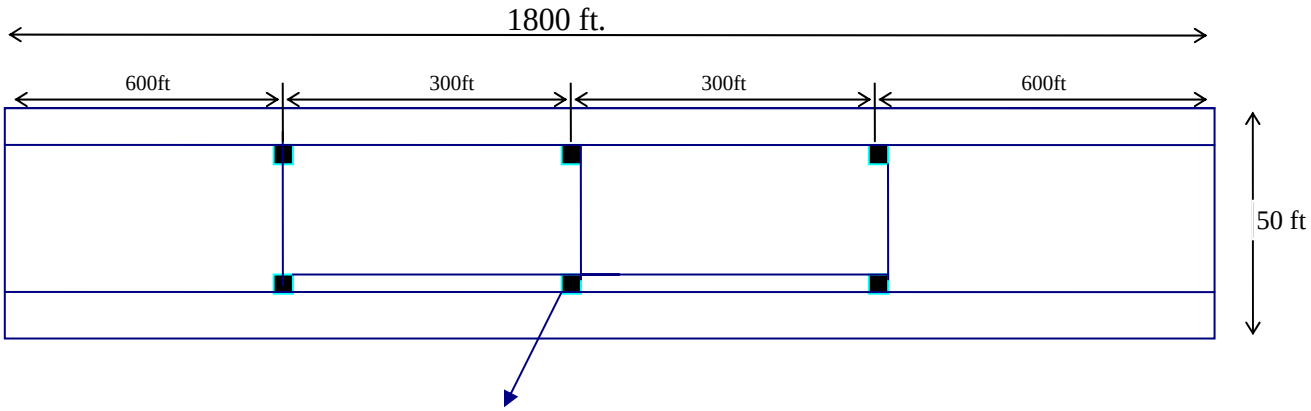
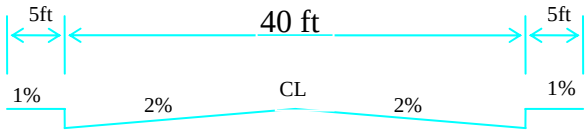
Example Basin

The basin we will be using today has the following description: A new two-lane roadway section is to be constructed near Seattle for access. The existing site conditions are approximately 1800 feet in length and 50 feet wide. The SCS soil type for the entire project is Type C and the ground cover is primarily forest in fair conditions. The average slope of the ground before the construction is 1%. The calculated time of concentration should be assumed that for the forested condition will be 50 feet of sheet flow with the remainder being shallow concentrated flow. The proposed conditions for the roadway will be slightly elevated and will utilize curb and gutter to control the flow. The develop site will have a sag in the profile. Please look at the plan, cross section, and profile view below for the proposed layout. Develop the pre and post flows for the before and after conditions.

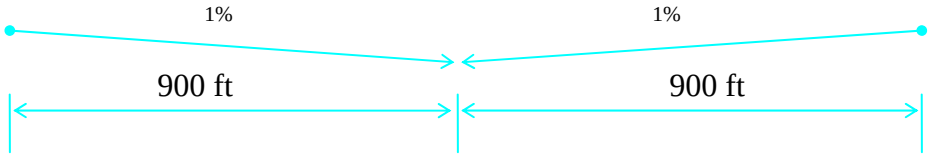
PLAN VIEW
Figure 1



CROSS SECTION
Figure 2

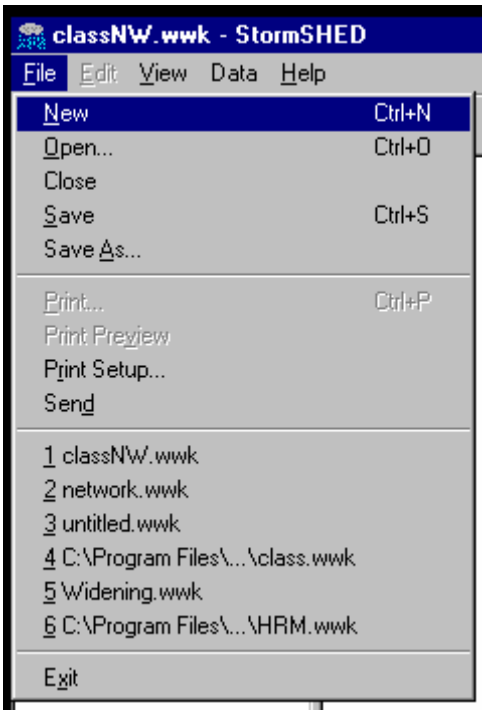


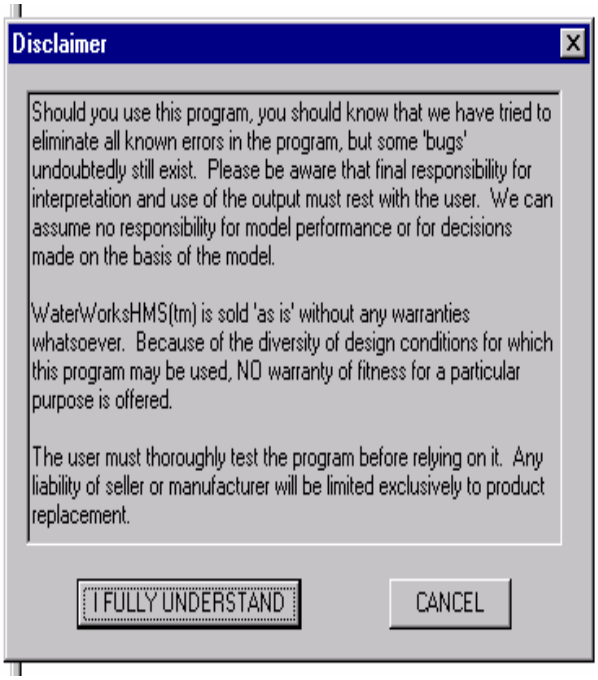
PROFILE
Figure 3

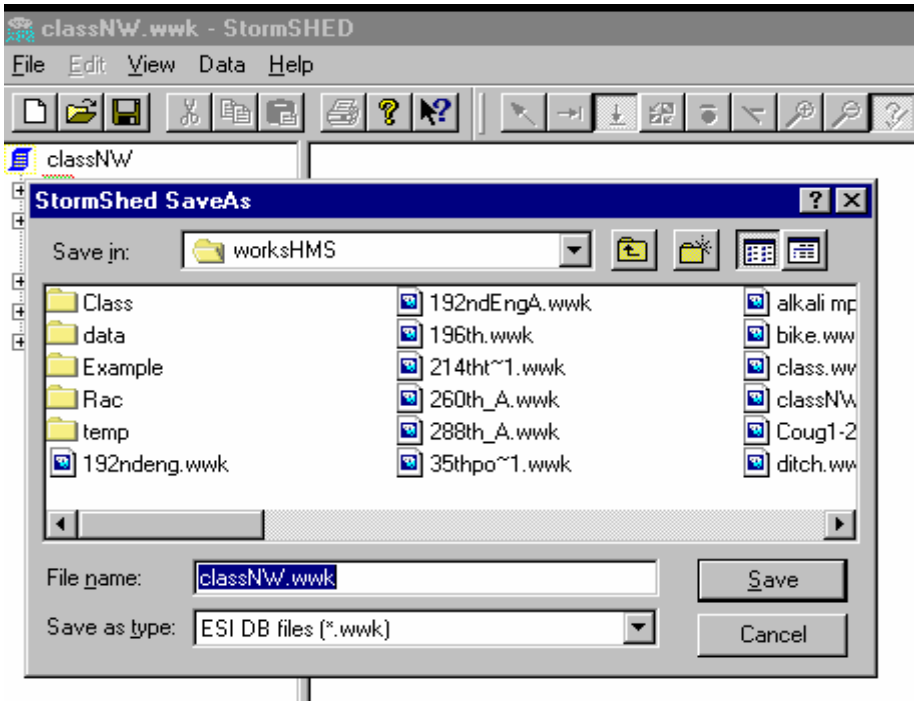


Example Basin

The first thing that needs to be done when starting StormSHED is to create a new project. Click on the new project icon (blank piece of paper) then use the Save As command in the File menu to give it a unique name.

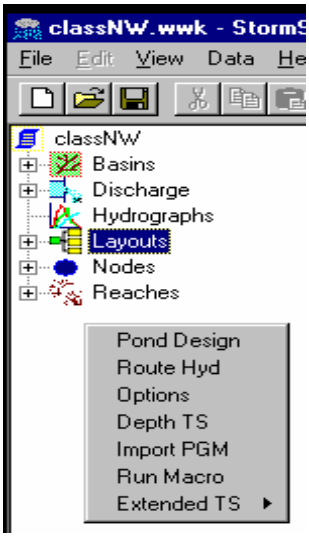




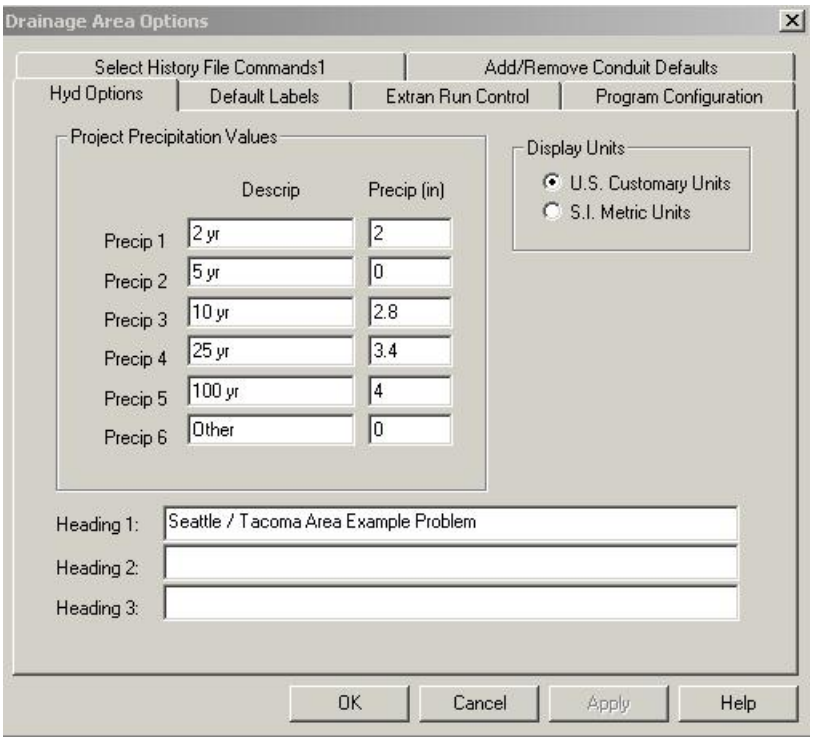


Example Basin

Next set the project defaults. Click with the right mouse button in a blank part of the Tree Menu.



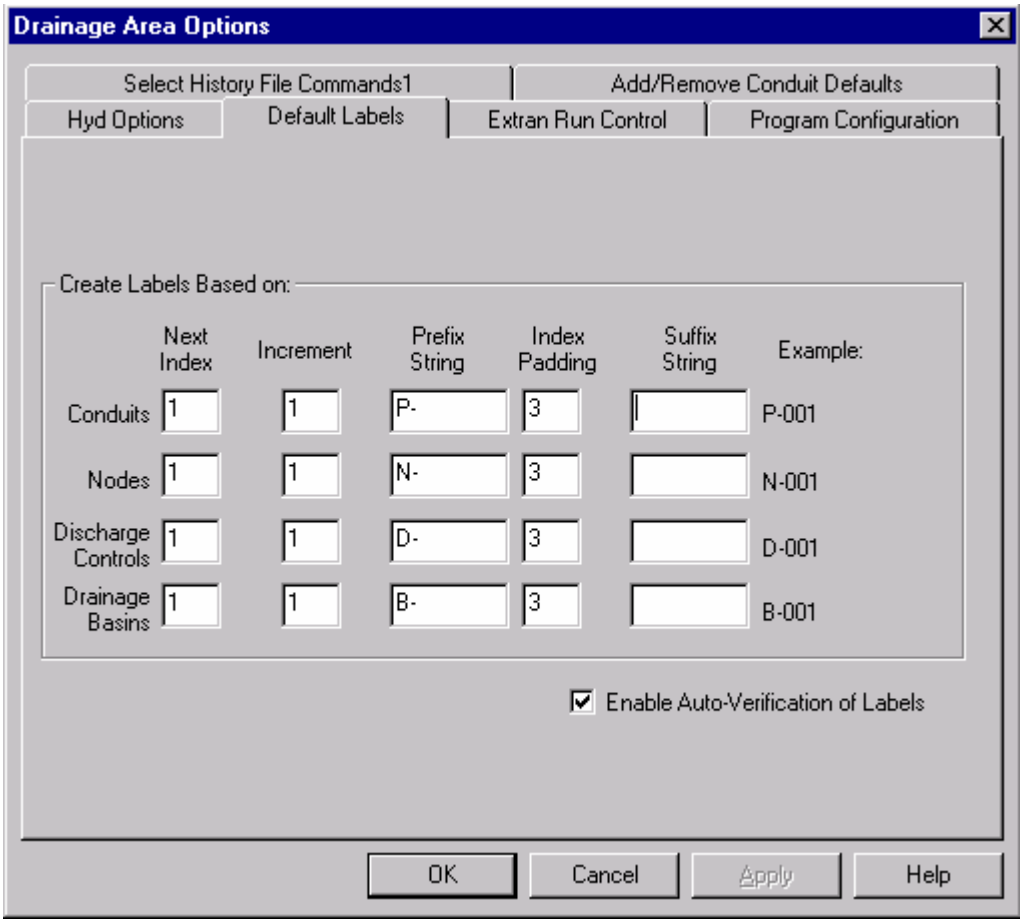
Click with the left mouse button on the Options selection in the menu that pops up.



The first "options" screen we see is where we set the precipitation for the design storms for the specific location of the project. This screen also lets us chose metric or English units. The first line must be used for the 2-year event. The program internally uses this precipitation to compute the time of concentration. The Precipitation values can be found in Isopluvial Maps for Western Washington in the 2004 Highway Runoff Manual at: http://www.wsdot.wa.gov/fasc/EngineeringPublications/Manuals/HighwayRunoff2004.pdf

Example Basin

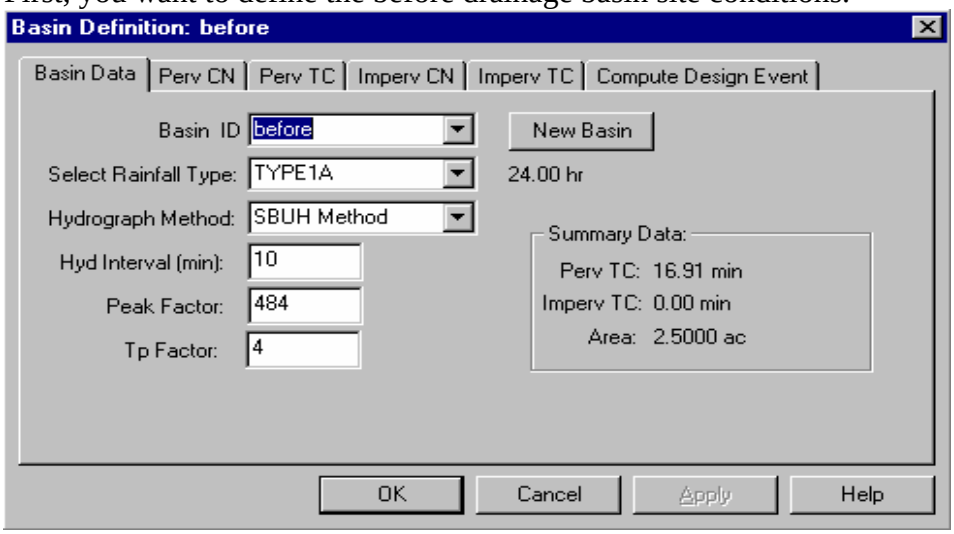
The only other thing we have to set at this time is the Default Labels. Click on the Default Labels tab to get the screen shown below.

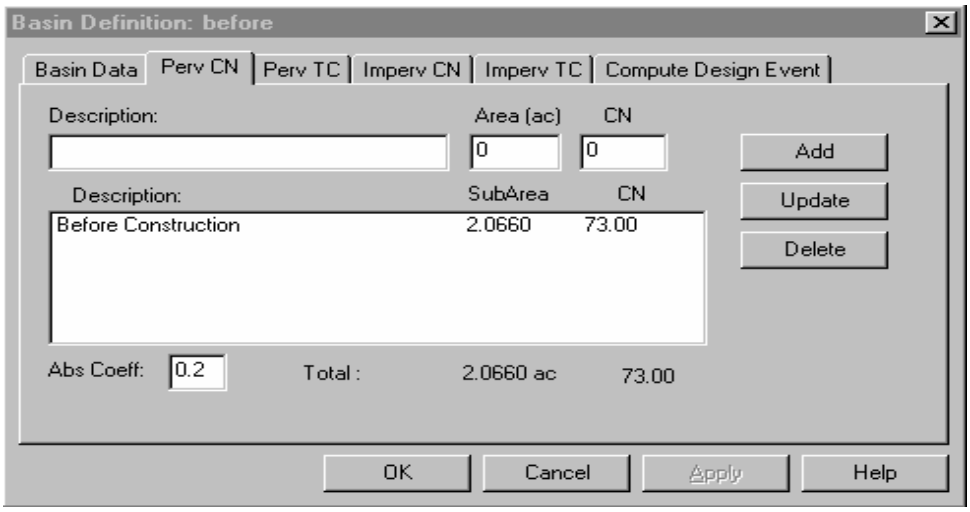


This screen allows you to tell StormSHED how you would like new pipes, ditches, ponds, catch basins, etc. to be labeled. While it is often convenient to use the auto labels, you should make sure that the "Enable Auto-Verification of Labels" box is checked. This lets you override StormSHED' auto labels when a new item is created and instead put in a label that is more meaningful to your project. When finished, click on OK to return to the main screen.

Example Basin

First, you want to define the before drainage basin site conditions.



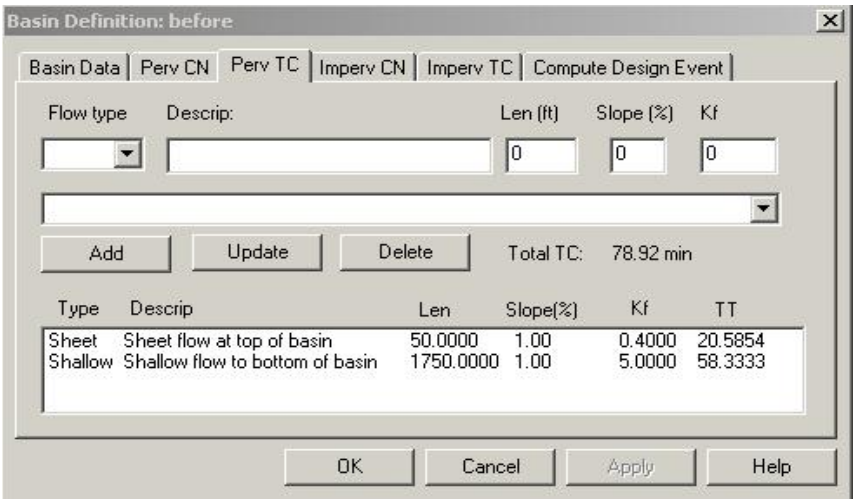


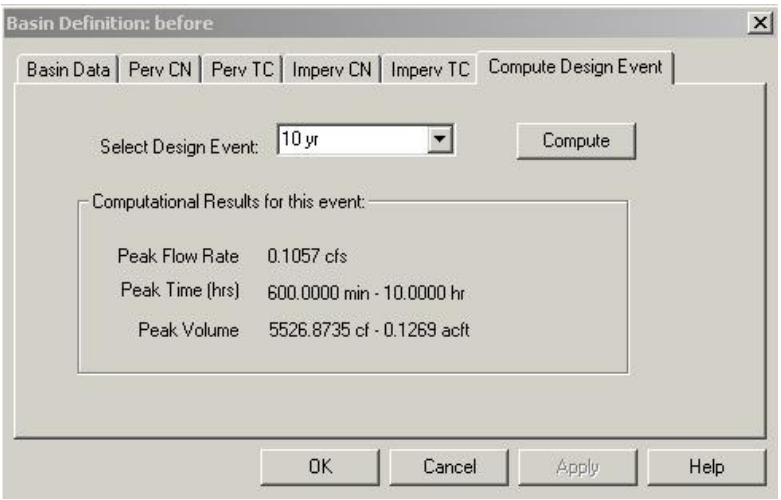
The Perv CN tab is where you define the basin area in acres and the Curve Number (CN) of the basin area for the pervious surface. The CN value is derived from the TR55 Curve Number table in Appendix 4B of the 2004 HRM, as shown below.

Table 4B-2. Runoff curve numbers for selected agricultural, suburban and rural areas (western Washington).

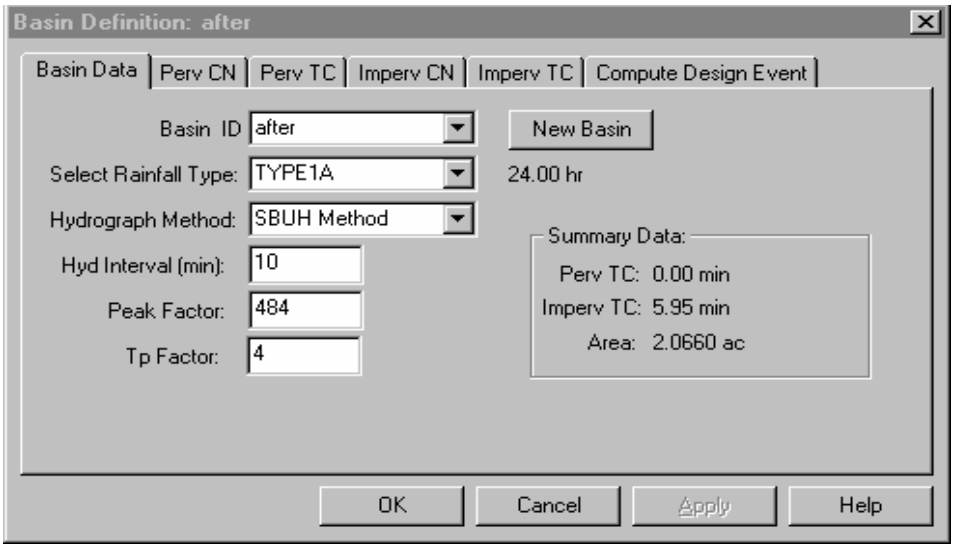
	CNs for hydrologic soil group			
Cover type and hydrologic condition	A	B	C	D
Curve Numbers for Pre-Development Conditions				
Pasture, grassland, or range-continuous forage for grazing:				
Fair condition (ground cover 50% to 75% and not heavily grazed).	49	69	79	84
Good condition (ground cover >75% and lightly or only occasionally grazed)	39	61	74	80
Woods:				
Fair (Woods are grazed but not burned, and some forest litter covers the soil).	36	60	73	79
Good (Woods are protected from grazing, and litter and brush adequately cover the soil).	30	55	70	77
Curve Numbers for Post-Development Conditions				
Open space (lawns, parks, golf courses, cemeteries, landscaping, etc.)[1]				
Fair condition (grass cover on 50% - 75% of the area).	77	85	90	92
Good condition (grass cover on >75% of the area)	68	80	86	90
Impervious areas:				
Open water bodies: lakes, wetlands, ponds etc.	100	100	100	100
Paved parking lots, roofs[2], driveways, etc. (excluding right-of-way)	98	98	98	98

Example Basin



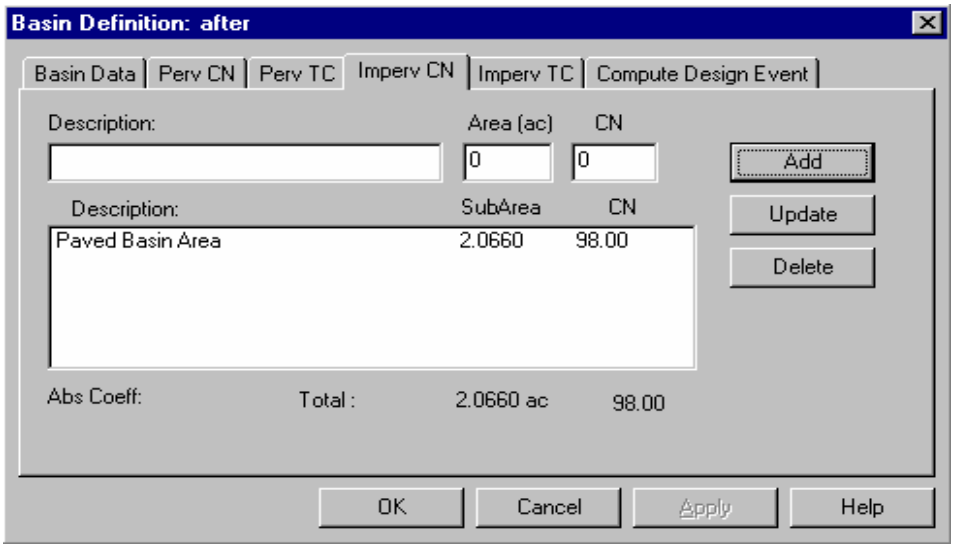


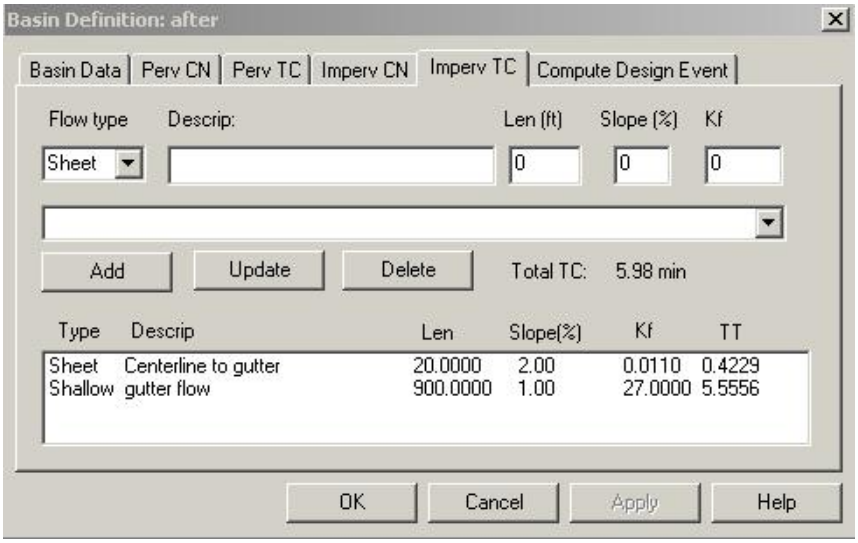
Second, you want to define the after drainage basin site conditions.

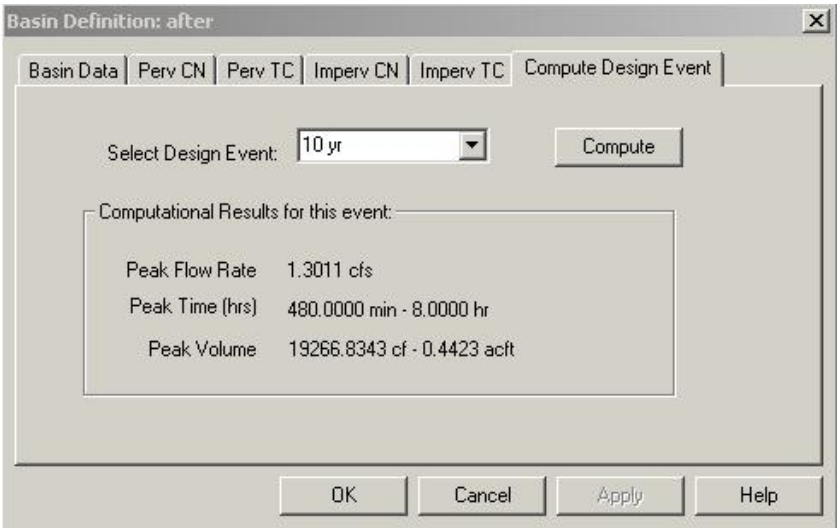


Remember to go through each tab and clear the Perv Calc.

Example Basin







Example Basin

Once information for each basin is entered, the designer will need to provide this information in the hydraulic report. The designer can send this information to the History View and then copy it into the hydraulic report word document. This can be done by clicking on the RMB on each basin and clicking on the To History option with your left mouse button. A dialog box asking which design event you want will appear. Check the design event you would like a report on and the record will be copied into the History View. These steps need to be repeated for each additional design event desired. The following information should appear in the project History View.

Drainage Area: before

Hyd Method:	SBUH Hyd		Loss Method:	SCS CN Number		
Peak Factor:	484.00		SCS Abs:	0.20		
Storm Dur:	24.00 hrs		Intv:	10.00 min		
	Area	CN	TC			
Pervious	2.0660 ac	73.00	1.32 hrs			
Impervious	0.0000 ac	0.00	0.00 hrs			
Total	2.0660 ac					
Supporting Data:						
Pervious CN Data:						
Before Construction		73.00	2.0660 ac			
Pervious TC Data:						
Flow type:	Description:		Length:	Slope:	Coeff:	Travel Time
Sheet	Sheet flow at top of basin		50.00 ft	1.00%	0.4000	20.59 min
Shallow	Shallow flow to creek		1750.00 ft	1.00%	5.0000	58.33 min

Example Ditch Design

At this time, we'd like to introduce threshold discharge areas (TDAs), which is in the new 2004 Highway Runoff Manual and is directly related to conveyance design. A TDA is defined as an on-site area draining to a single natural discharge location or multiple natural discharge locations that combine within one-quarter mile downstream (as determined by the shortest flowpath) in western Washington. The purpose of this definition is to clarify how the thresholds are applied to project sites with multiple discharge points. All TDAs must be verified in the field.

To map a TDA, the designer must have an understanding of drainage basin delineation. A drainage basin includes all of the area that will contribute runoff to the point of interest. For example, in Figure 4-1, the designer must quantify offsite flow that discharges to the ditch, which is the point of interest. To determine the offsite area of land that contributes runoff to the ditch, topographic contours are needed. Where a contour forms a chevron or the letter "V" pointing in the direction of decreasing elevation, that contour depicts a ridge. Ridges are the limits of a drainage basin, since precipitation falling on a ridge or peak will flow either to or away from the point of interest. Connecting the ridges and peaks on the contour map will form the boundary of the drainage basin.

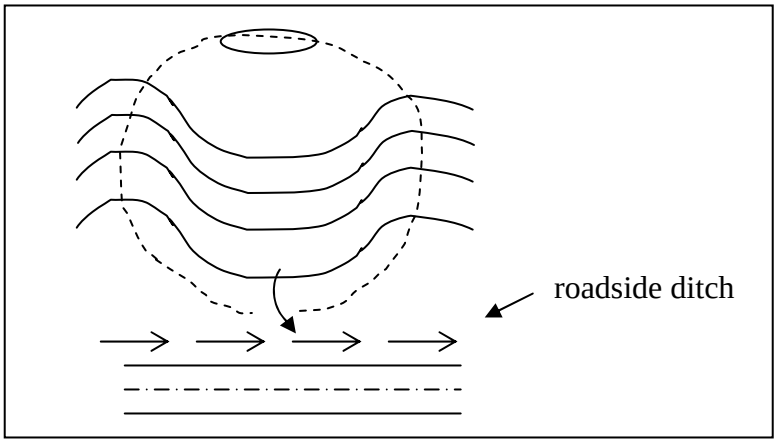
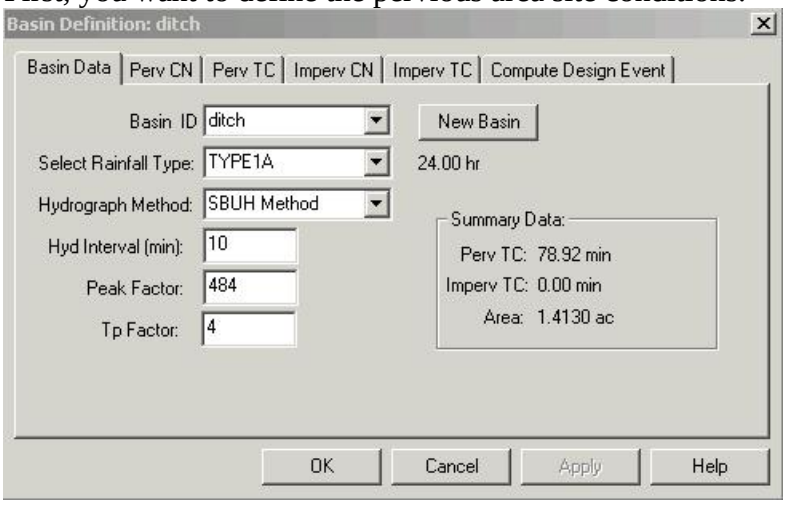


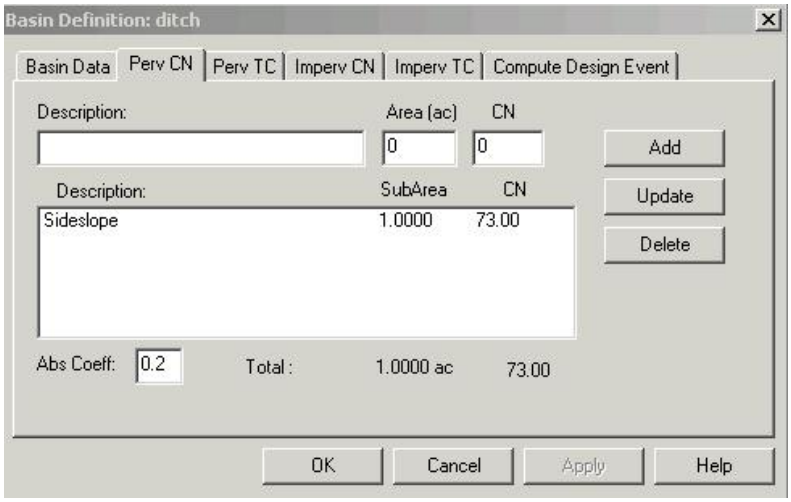
Figure 4-1. TDA mapping example

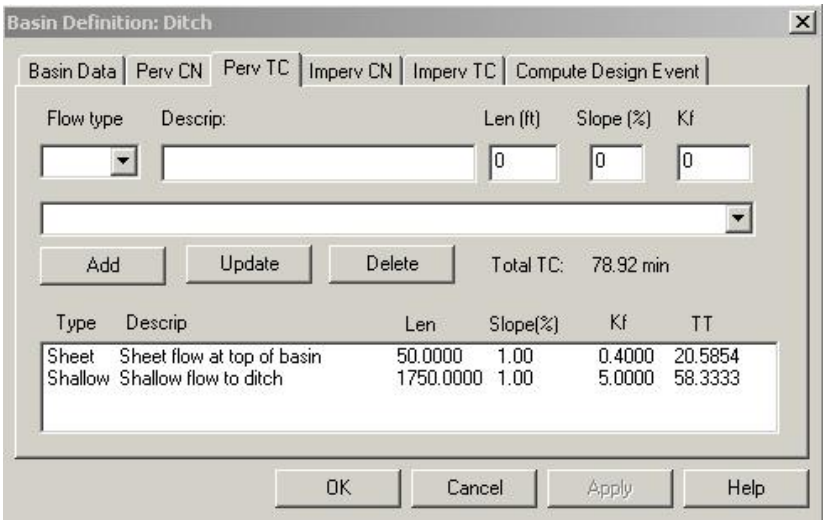
In conveyance design, the designer is only concerned with the developed conditions as this is the flow that the new conveyance structure will need to convey. Set up the TDA for the roadside ditch shown in Figure 4-1 assuming the pervious area within WSDOT Right of Way contributing to the ditch is **1.0 acre**. The SCS soil type is Type C and the ground cover is primarily forest in fair conditions. The average slope of the ground is **1%**. The calculated time of concentration should be assumed that for the forested condition will be **50 feet** of sheet flow and **1750 feet** of shallow concentrated flow to end of ditch. The **20' x 900'** roadway contributes to the ditch with a cross slope of **2%** and longitudinal slope of **1%.**

Example Ditch Design

First, you want to define the pervious area site conditions.

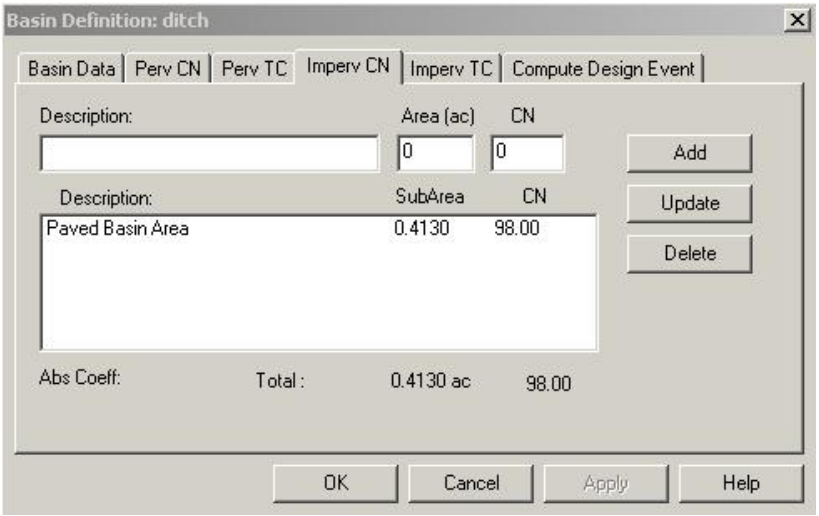


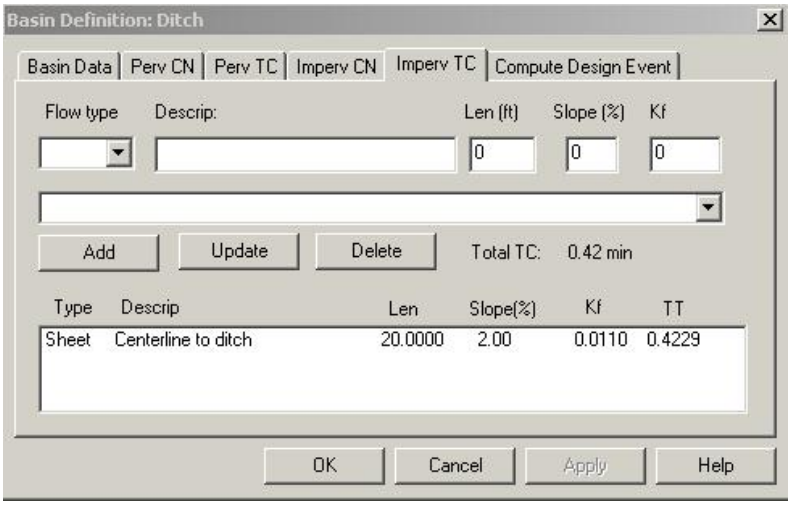


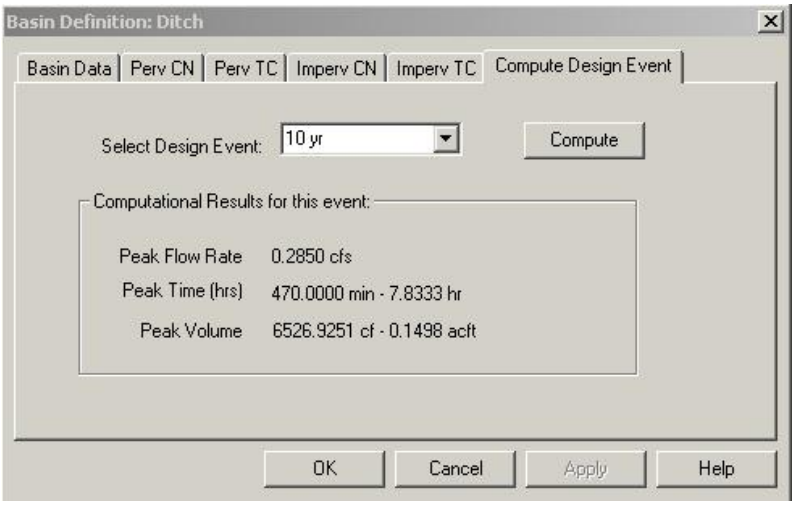


Example Ditch Design

Second, you want to define the impervious area site conditions.



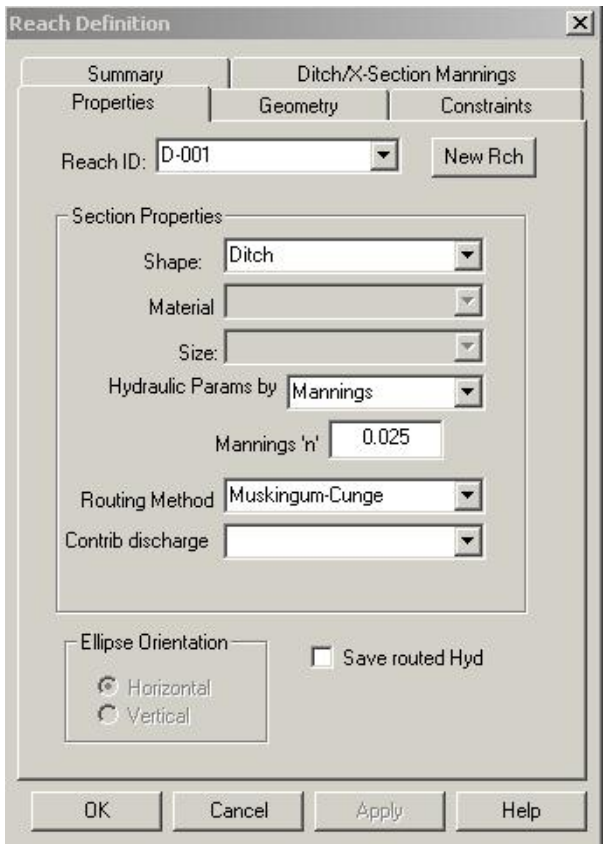




Example Ditch Design

Based on the basin areas previously created, design a ditch utilizing the reach commands to convey the 10-year design storm. The first step is to create a Reach in StormShed.

- In the Tree View, click on the "+" symbol next to the Reaches node.
- Double click on "PROTOTYPE" under the Reaches node.
- Click on the **New Rch** button in the Reach Definition dialog.
- Rename the default label to D-001 and Click **OK**

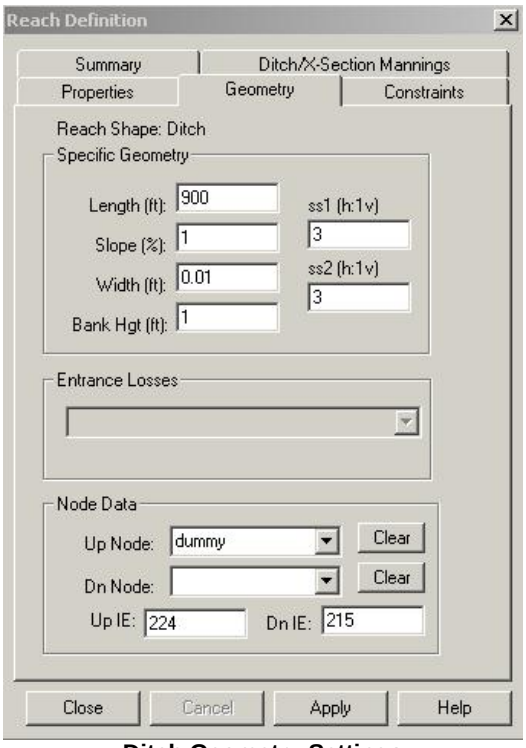


Ditch Reach Definition

- Change the "Shape" to Ditch by selecting from the drop down.
- Change the "Routing Method" to Muskingum-Cunge.

This is really an optional feature. Generally simple travel time translation is used, however, in this case we will take the opportunity to do something different. Simple travel time translation uses the Manning's equation to compute hydraulic parameters based of the peak flow rate. All the other options, including the Muskingum-Cunge routing method actually routes the hydrograph through the reach***, taking advantage of the storage that is available in the reach***. The result is a slightly modified hydrograph at the bottom end of the reach. This slightly modified hydrograph has an attenuated peak from the original.

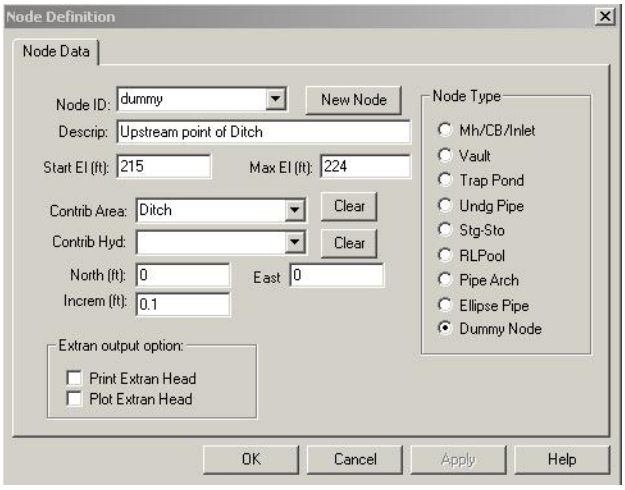
- Select the “Geometry” tab.



Ditch Geometry Settings

Note that no “Up Node” is defined. It is necessary to attach an “Up Node” to this reach so that flows can automatically be associated with it.

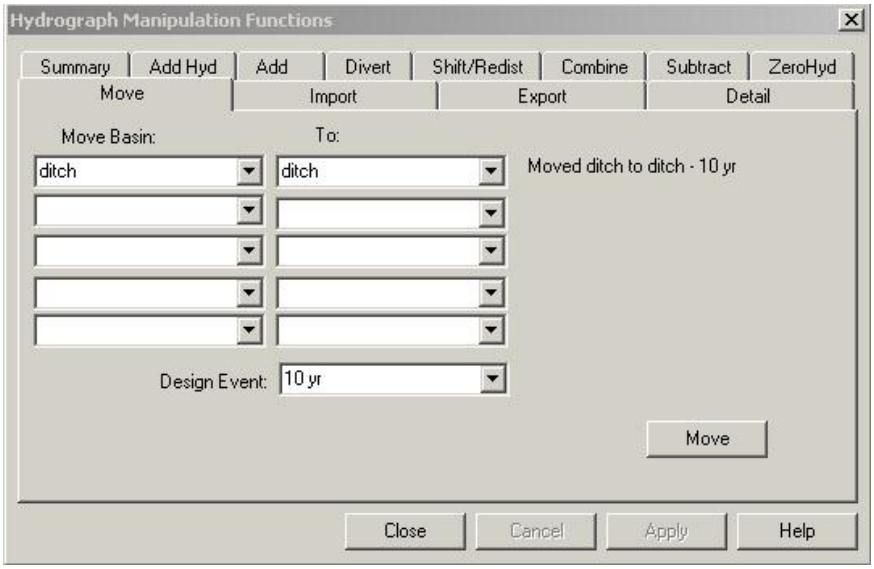
- Click on the **Close** button to close the dialog.
- Open the “PROTOTYPE” node in the Nodes section of the TreeView.
- Click on the **New Node** button.
- Rename the default node ID to dummy.
- Click on the **OK** button to close the autolabel dialog.



- Change the Node Type to Dummy Node.
- Under the “Contrib Area” input field, use the drop down and select the Ditch basin.
- Set the Start El and Max El as shown in Figure above.
- Click on the **OK** button to close the node dialog.
- Re-open the “D-001” reach in the Tree View
- Click on the “Geometry” tab.
- In the “Node Data” section, use the drop down to select **dummy**.
- Click on the **Close** button to close the dialog
- All that is left is to route a hydrograph through the **D-001** reach and see how it performs.
- Right Mouse click in the Tree View and select the *Route Hyd* menu selection.

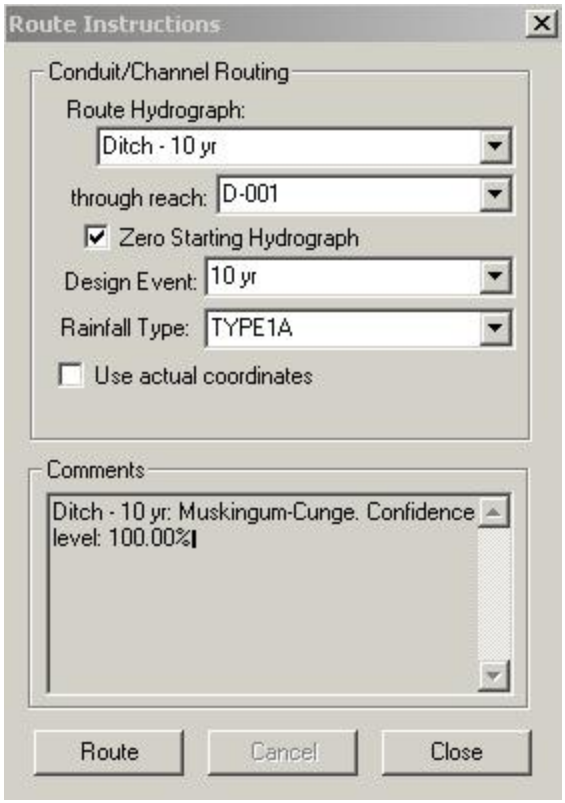
The dialog box requires that a hydrograph is routed through a reach. You will need to create a hydrograph for the 10-year storm event for the Ditch basin.

The Move hydrograph dialog allows for up to five (5) drainage basins to be “moved” to a hydrograph at one time. Under the “Move Basin” column, select a previously defined basin. When a basin is selected, the “To” column will mirror the basin name as the default. When a Design Event is selected, and the “Move” button is pressed, the program will append the design event to the default ID in the “To” column. Note that the “To” column only mirrors and provides a recommended ID for the yet to be create hydrograph. It can be modified to whatever is appropriate. After the “Move” button has been pressed, a new hydrograph will be created. The summary data is visible in the “Summary” tab.



Example Ditch Design

"Ditch – 10yr" is being used as a placeholder for the hydrograph. Since "Ditch" was defined as the Contributing Basin to "dummy" node, and "dummy" node is defined as the "Up Node" to the "D-001" reach, the "Zero Starting Hydrograph" checkbox must be checked so that only the hydrograph from the contributing basin is routed through the reach. If the "Zero Starting Hydrograph" checkbox is not checked, the program will first create a hydrograph from the contributing basin using a "10-year", Type1A design event, then add it to the contents of "Ditch – 10-yr", then route it through the reach. The result would be twice the hydrograph peak and volume than intended.

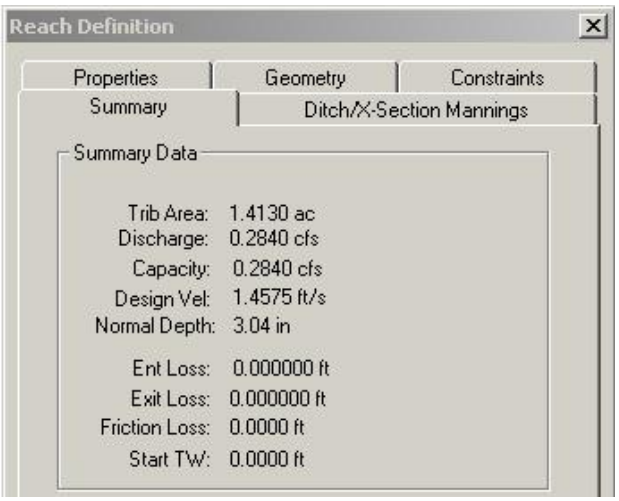


Route Instructions for Ditch

- From the "Route Hydrograph" drop down; select the "Ditch – 10 yr" hydrograph that was previously created.
- Select the "D-001" reach from the second drop down.
- Check the "Zero Starting Hydrograph" check box.
- Select 10-year for the "Design Event".
- Select TYPE1A fro the "Rainfall type"
- Click on the **Route** button.

Example Ditch Design

- Click on the **Close** button
- Open the D-001 reach dialog and click on the “Summary” tab.



Ditch Summary Tab

The summary tab indicates that the velocity is 1.4575 fps with a depth of 3.04 inches. The results are also acceptable.

The other area for results is in the History file.

ROUTEHYD [Ditch - 10 yr] THRU [D-001] USING TYPE1A AND [10 yr] ZERO RELATIVE

Reach	Area	Flow	Full Q	% Full	nDepth	Size	nVel	fVel	CBasin / Hyd
-----	ac	cfs	cfs	ratio	ft	----	ft/s	ft/s	----------
D-001	1.4130	0.2840	----	1.00	0.2532	Ditch	1.4575	-----	Ditch