DRAINAGE DESIGN MANAGEMENT SYSTEM FOR WINDOWS

VERSION 5.3.0

TUTORIAL # 16

HGL EVALUATION OF STORM DRAINAGE SYSTEM

KVL Consultants, Inc.

HGL EVALUATION OF STORM DRAINAGE SYSTEM

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HGL EVALUATION OF STORM DRAINAGE SYSTEM

DATE UPDATED: JUNE 29, 2016

1.0 INTRODUCTION

This tutorial provides the procedure to develop and solve a storm drainage system model using DDMSW. The problem that is modeled in this tutorial is taken from the Design Example 4.6 presented in the Flood Control District's Hydraulics Manual (2013). The Storm Drain System Layout for the Example Problem is presented below. All the data used in DDMSW are exactly the same data from the Design Example in the Manual.

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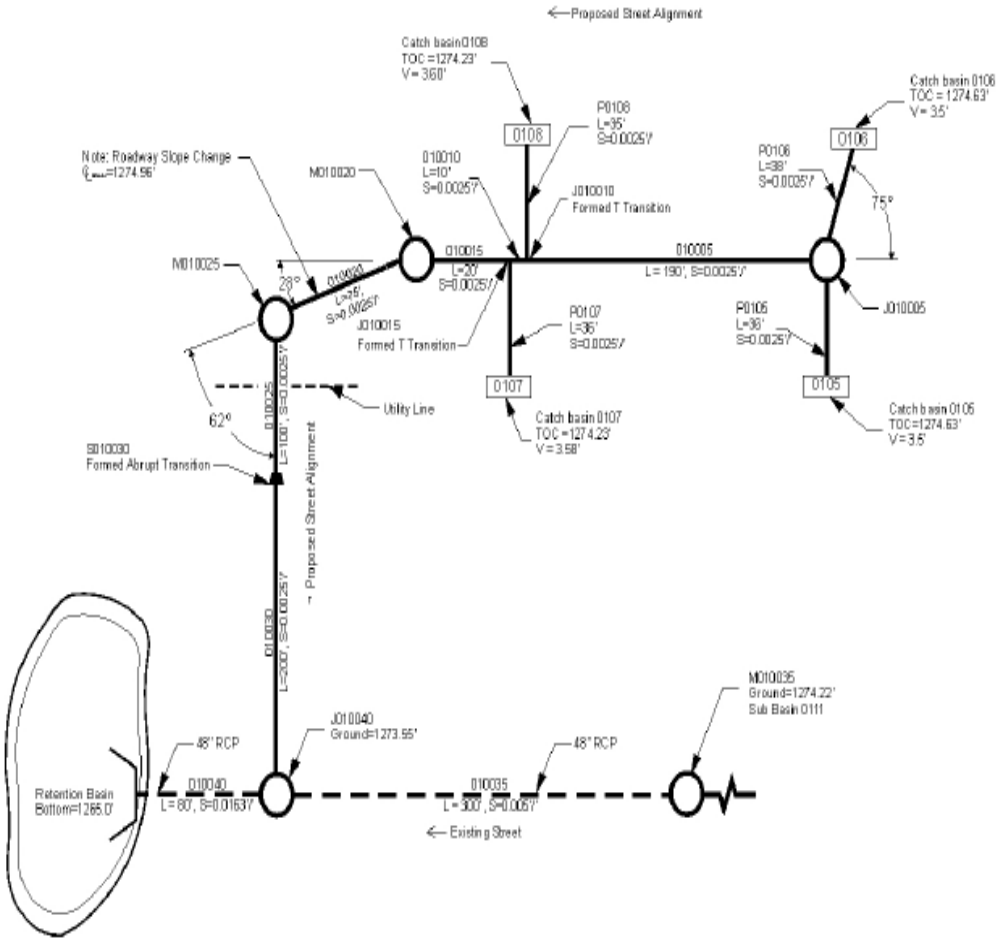
INITIAL STORM DRAIN LAYOUT FOR EXAMPLE PROBLEM



2.0 CREATING A NEW PROJECT

After launching DDMSW, open the **SELECT PROJECT** form (***File ➔ Select Project***) and click the ***'Add'*** button to create a new project. Enter a unique **Reference** (maximum 16 characters, no spaces) name together with appropriate **Title** (Optional), **Location** (Optional), and **Agency** (Optional). For the purpose of this tutorial, enter the following information:

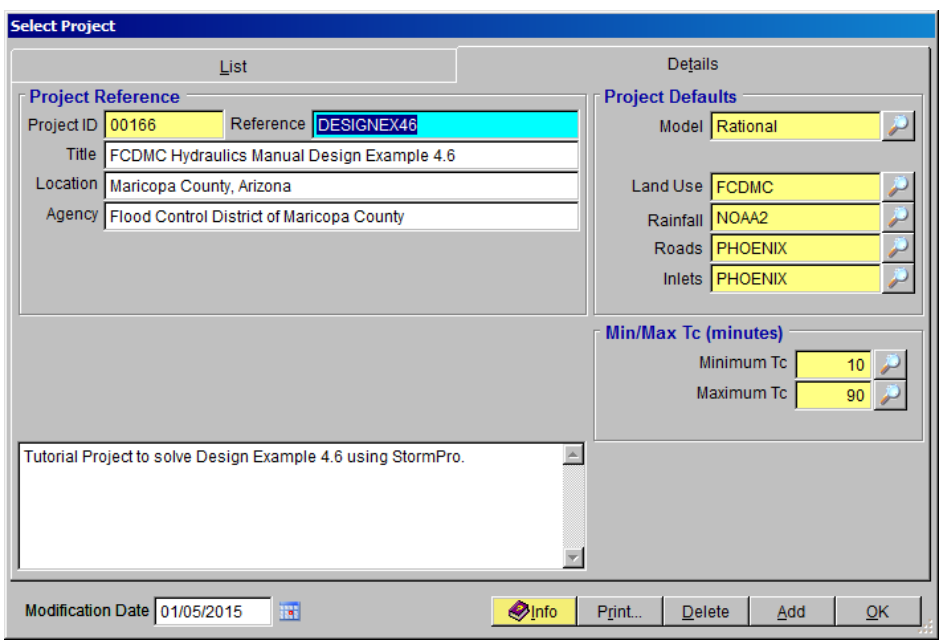
Project Reference and Other Info:

Reference	*DESIGNEX46*
Title	*FCDMC Hydraulics Manual Design Example 4.6*
Location	*Maricopa County, Arizona*
Agency	*Flood Control District of Maricopa County*
Comment Box	*Tutorial Project to solve Design Example 4.6 using StormPro*

Project Defaults:

Model	*Rational*
Land Use	*FCDMC*
Rainfall	*NOAA2*
Roads	*Phoenix*
Inlets	*Phoenix*

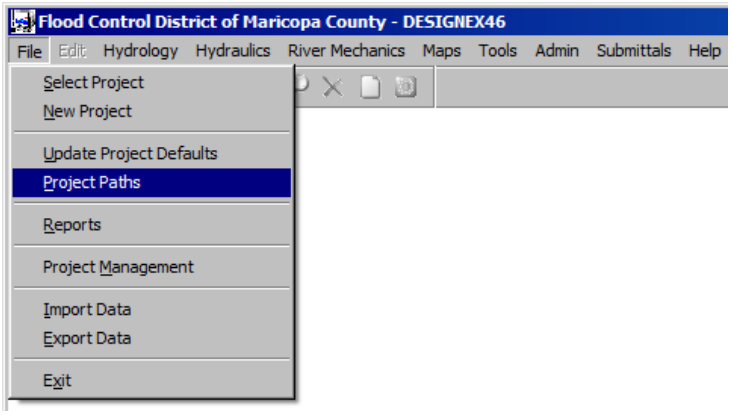
Click ***'Save'*** to save the entered data for the new project. Click ***'OK'*** to proceed. Click ***'OK'*** to accept the defaults.



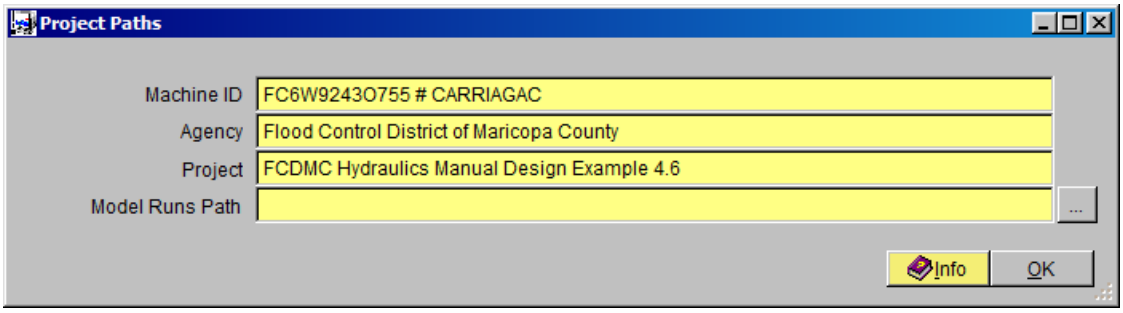
The name of the new project is **DESIGNEX46**.

3.0 SET THE PROJECT PATH

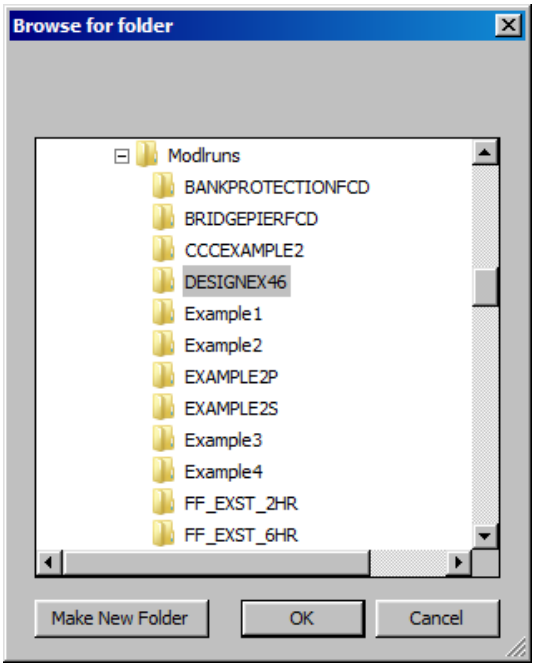
Open the **PROJECT PATHS** form (***File ➔ Project Paths***) to define the **Model Runs Path** for the new project.



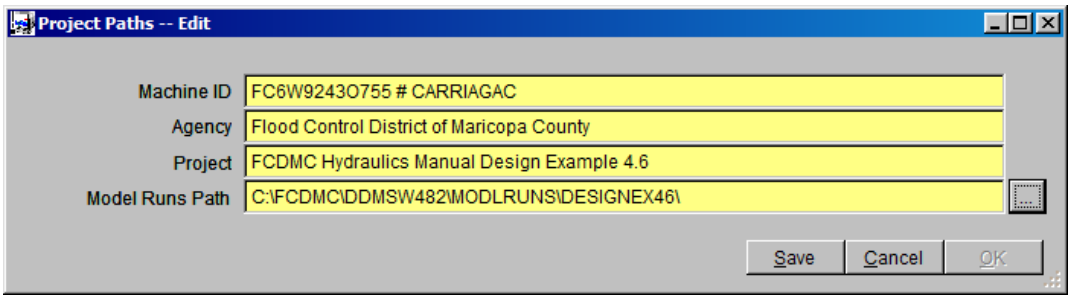
On the **PROJECT PATHS** form, click the ellipse (**…**) button on the right of the **Model Runs Path** textbox field.



On the **BROWSE FOR FOLDER** form, navigate to the desired folder location where model run files for the project will be saved. If the desired folder location does not exist, click the ***'Make New Folder'*** button to create the folder. Rename the folder (use *DESIGNEX46*) and select it. Click ***'OK'*** to close the form.

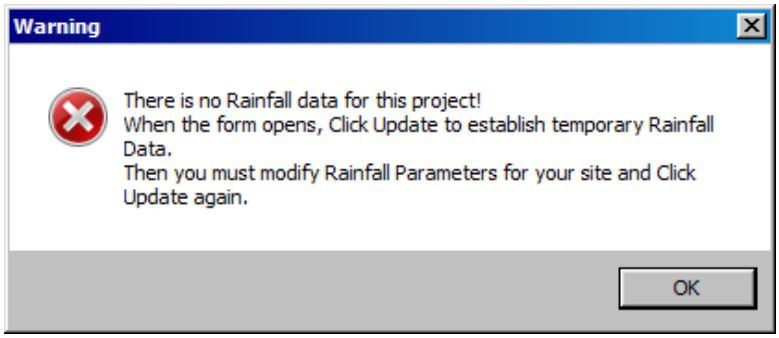


On the **PROJECT PATHS** form, click ***'Save'*** to save the data and click ***'OK'*** to close the form.

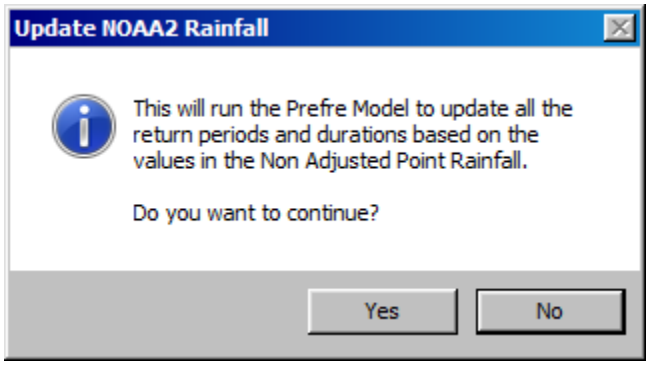


4.0 DEVELOP THE RAINFALL DATA

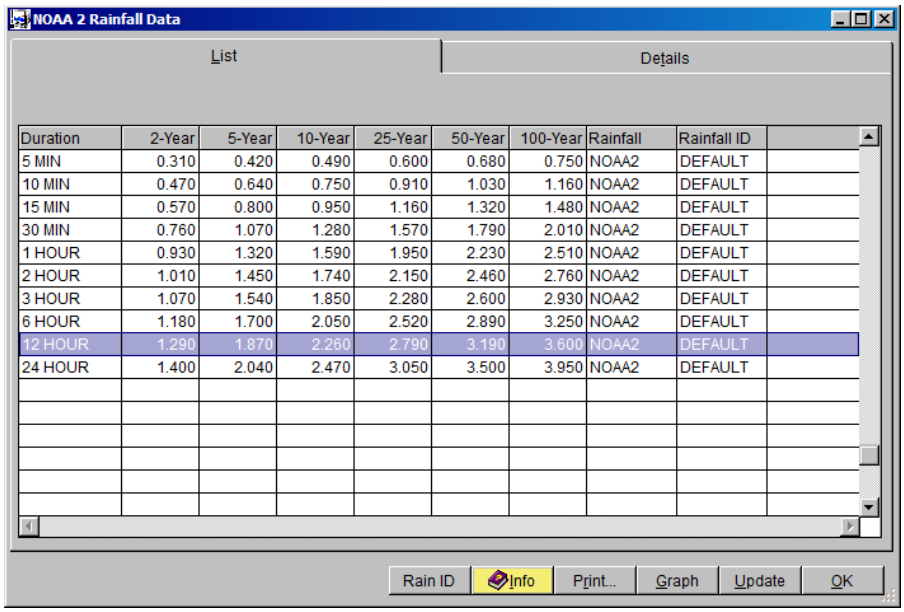
Open the **NOAA2 RAINFALL DATA** form (***Hydrology ➔ Rainfall***) to develop the rainfall data for the project. If a **WARNING** dialog box shows up indicating that *'There is no Rainfall data for the project',* click the ***'OK'*** button to create a temporary Rainfall Data.



On the **NOAA2 RAINFALL DATA** form, click the ***'Update'*** button to create a temporary data. Click ***'OK'*** to continue.



The **NOAA2 RAINFALL DATA FORM** shows the generated Rainfall Data.



Duration	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	Rainfall	Rainfall ID
5 MIN	0.310	0.420	0.490	0.600	0.680	0.750	NOAA2	DEFAULT
10 MIN	0.470	0.640	0.750	0.910	1.030	1.160	NOAA2	DEFAULT
15 MIN	0.570	0.800	0.950	1.160	1.320	1.480	NOAA2	DEFAULT
30 MIN	0.760	1.070	1.280	1.570	1.790	2.010	NOAA2	DEFAULT
1 HOUR	0.930	1.320	1.590	1.950	2.230	2.510	NOAA2	DEFAULT
2 HOUR	1.010	1.450	1.740	2.150	2.460	2.760	NOAA2	DEFAULT
3 HOUR	1.070	1.540	1.850	2.280	2.600	2.930	NOAA2	DEFAULT
6 HOUR	1.180	1.700	2.050	2.520	2.890	3.250	NOAA2	DEFAULT
12 HOUR	1.290	1.870	2.260	2.790	3.190	3.600	NOAA2	DEFAULT
24 HOUR	1.400	2.040	2.470	3.050	3.500	3.950	NOAA2	DEFAULT

<u>SPECIAL NOTES</u>: For this example, NOAA2 Rainfall will be used. This is to replicate the Rainfall Data that is used in the Design Example 4.6 of the Hydraulics Manual. Normally NOAA14 rainfall would be used but to create a similar rainfall data, it is most convenient to use NOAA2. Since the generated rainfall data are but temporary data, the data can be updated to match the data used in Design Example 4.6. In order to accomplish this, enter the following values on the **Details** tab of the **NOAA2 RAINFALL DATA** form:

<u>Non Adjusted Point Rainfall (in):</u>

2-Year, 6-Hour Rainfall	*1.20* inches
2-Year, 24-Hour Rainfall	*1.44* inches
100-Year, 6-Hour Rainfall	*3.25* inches
100-Year, 24-Hour Rainfall	*3.95* inches

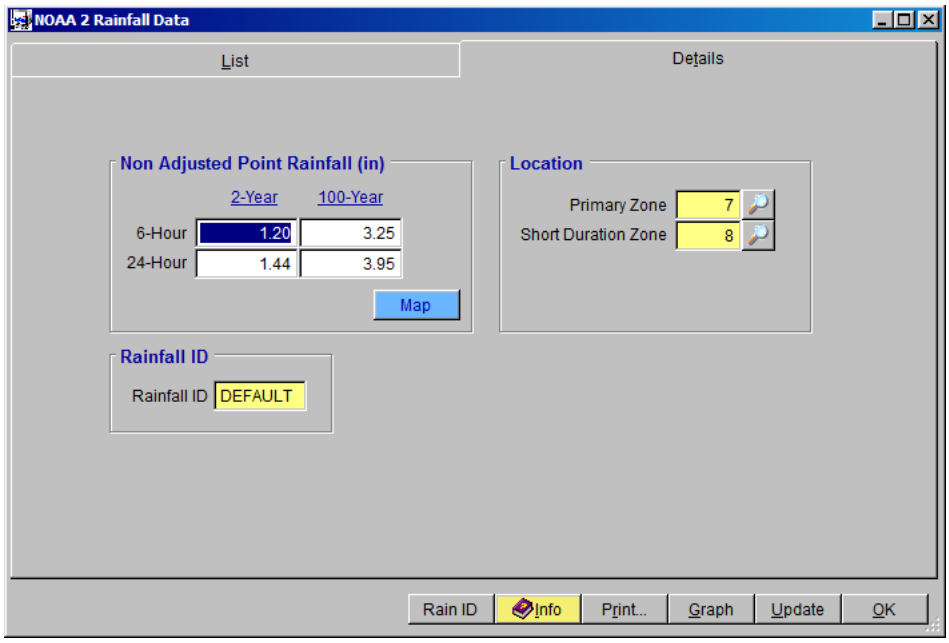
<u>Location:</u>

Primary Zone	*7*
Short duration Zone	*8*

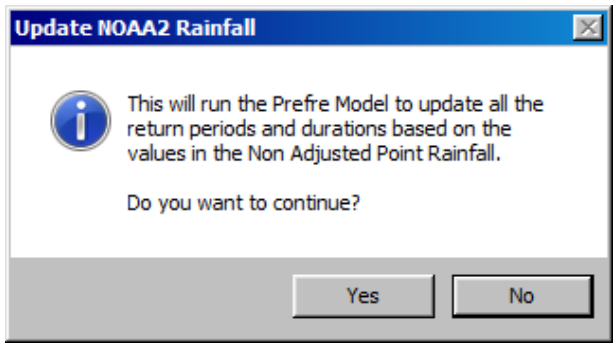
<u>Rainfall ID:</u>

Rainfall ID	*DEFAULT*

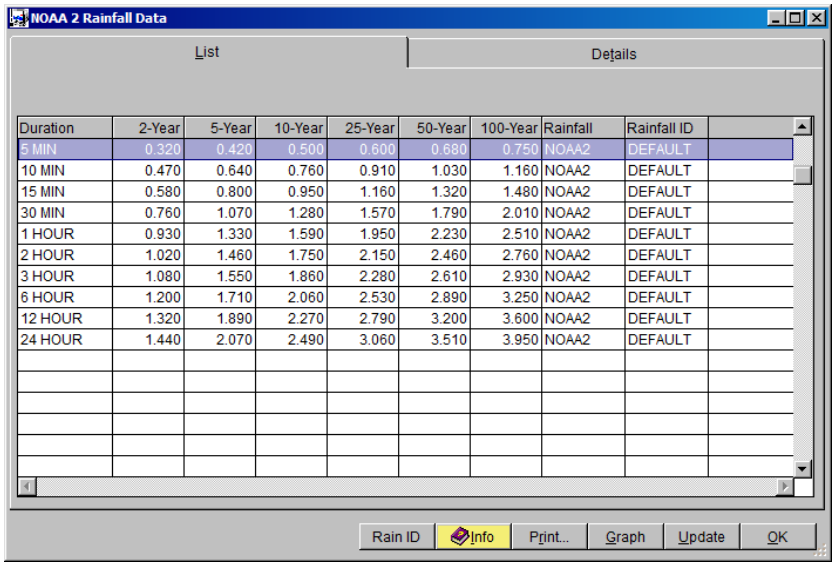
Click ***'Save'*** to save the data entered, then click ***'Update'*** to update the tabulated Rainfall data.



Click ***'OK'*** to continue.

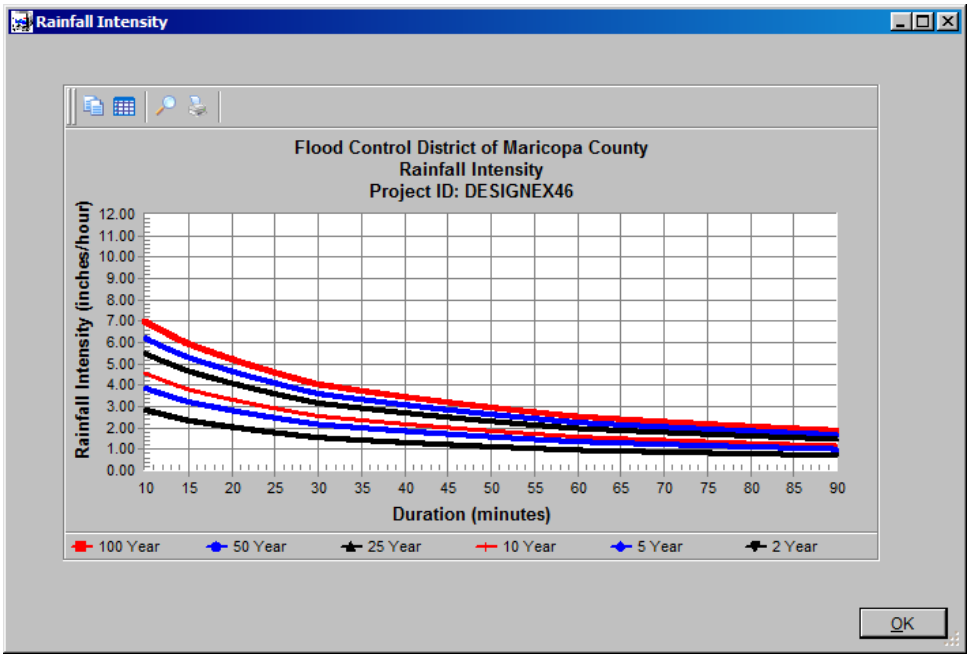


The updated **Rainfall data** generated from the new rainfall information entered are shown below:



Duration	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	Rainfall	Rainfall ID
5 MIN	0.320	0.420	0.500	0.600	0.680	0.750	NOAA2	DEFAULT
10 MIN	0.470	0.640	0.760	0.910	1.030	1.160	NOAA2	DEFAULT
15 MIN	0.580	0.800	0.950	1.160	1.320	1.480	NOAA2	DEFAULT
30 MIN	0.760	1.070	1.280	1.570	1.790	2.010	NOAA2	DEFAULT
1 HOUR	0.930	1.330	1.590	1.950	2.230	2.510	NOAA2	DEFAULT
2 HOUR	1.020	1.460	1.750	2.150	2.460	2.760	NOAA2	DEFAULT
3 HOUR	1.080	1.550	1.860	2.280	2.610	2.930	NOAA2	DEFAULT
6 HOUR	1.200	1.710	2.060	2.530	2.890	3.250	NOAA2	DEFAULT
12 HOUR	1.320	1.890	2.270	2.790	3.200	3.600	NOAA2	DEFAULT
24 HOUR	1.440	2.070	2.490	3.060	3.510	3.950	NOAA2	DEFAULT

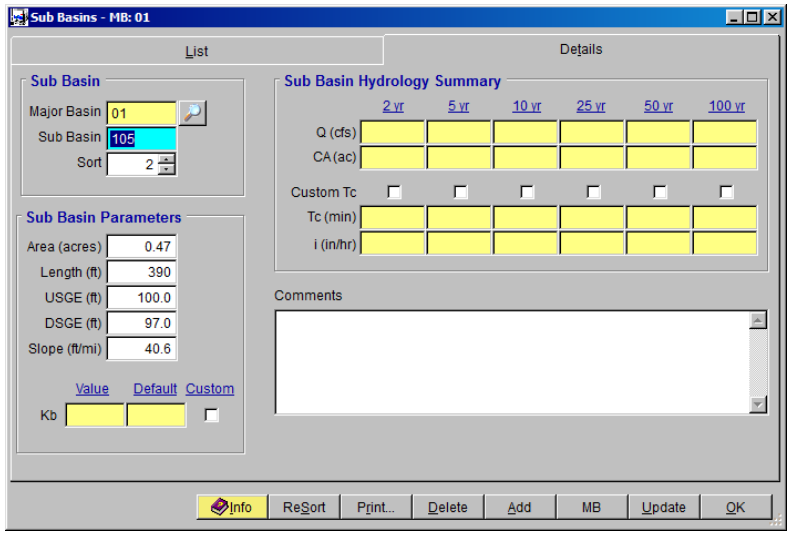
On the **NOAA2 RAINFALL DATA** form, click ***'Graph'*** to view the IDF curves.



Click ***'OK'*** to close the **RAINFALL INTENSITY** form. Click ***'OK'*** to exit the **NOAA2 RAINFALL DATA** form.

5.0 DEVELOP THE SUB BASIN DATA

To enter the Sub Basin data, open the **SUB BASINS** form (***Hydrology ➔ Sub Basins***). Click the ***'Add'*** button to start the data entry process. Enter the data for Sub Basins *0105, 0106, 0107, 0108* and *0111* as shown below. Do not click ***'Update'*** yet until the land use data has been entered. If you click ***'Save'*** after entering the **USGE** and **DSGE**, the **Slope** will be automatically calculated.

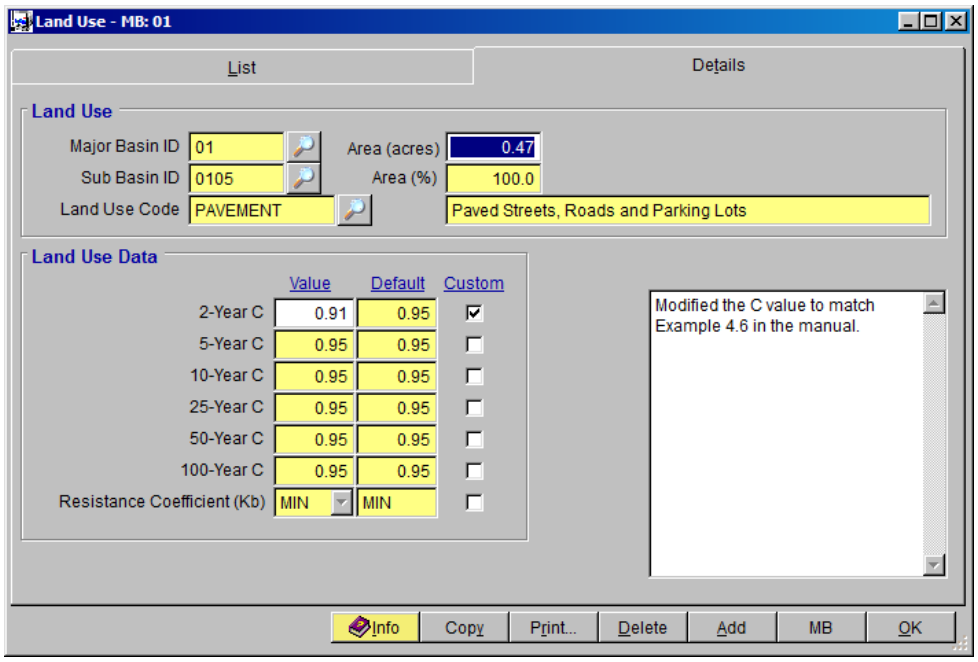


Sub Basin	Sort	Area (acres)	Length (ft)	USGE (ft)	DSGE (ft)	Slope (ft/mi)
0105	*10*	*0.47*	*390*	*100.0*	*97.0*	*40.6*
0106	*20*	*0.86*	*1000*	*100.0*	*83.0*	*89.8*
0107	*30*	*0.47*	*450*	*100.0*	*95.0*	*58.7*
0108	*40*	*0.67*	*510*	*100.0*	*97.0*	*31.1*
0111	*50*	*50.00*	*1350*	*100.0*	*90.0*	*39.1*

After data are entered and saved for each Sub Basin, click ***'Add'*** to enter subsequent **Sub Basin** data. When finished, click '***OK'*** to close the **SUB BASINS** form.

6.0 DEVELOP THE LAND USE DATA

To enter the land use data, open the **LAND USE** form (***Hydrology ➔ Land Use***). Enter the **Land Use** data for Sub Basins *0105, 0106, 0107, 0108* and *0111* as provided in the table below. It is necessary to modify the C values to come close to matching the values in Design Example 4.6

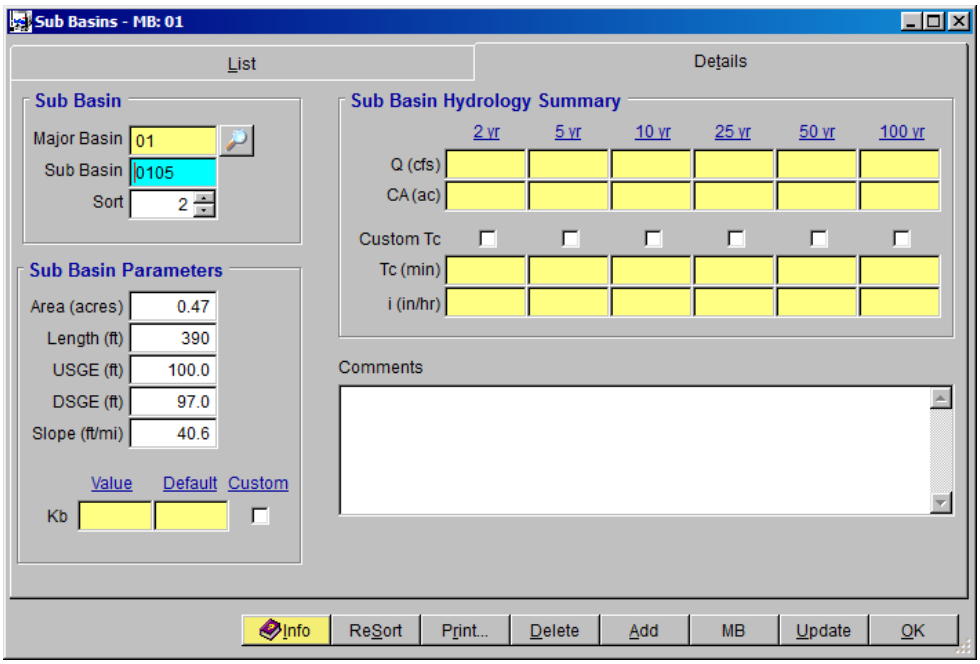


Sub Basin ID	Land Use Code	Area (acres)	2-Year Custom C	5-Year Custom C	10-Year Custom C	25-Year Custom C
0105	*PAVEMENT*	*0.47*	*0.91*			
0106	*PAVEMENT*	*0.86*	*0.91*			
0107	*PAVEMENT*	*0.47*	*0.91*			
0108	*PAVEMENT*	*0.67*	*0.91*			
0111	*COMM*	*50.00*	*0.85*	*0.85*	*0.85*	*0.85*

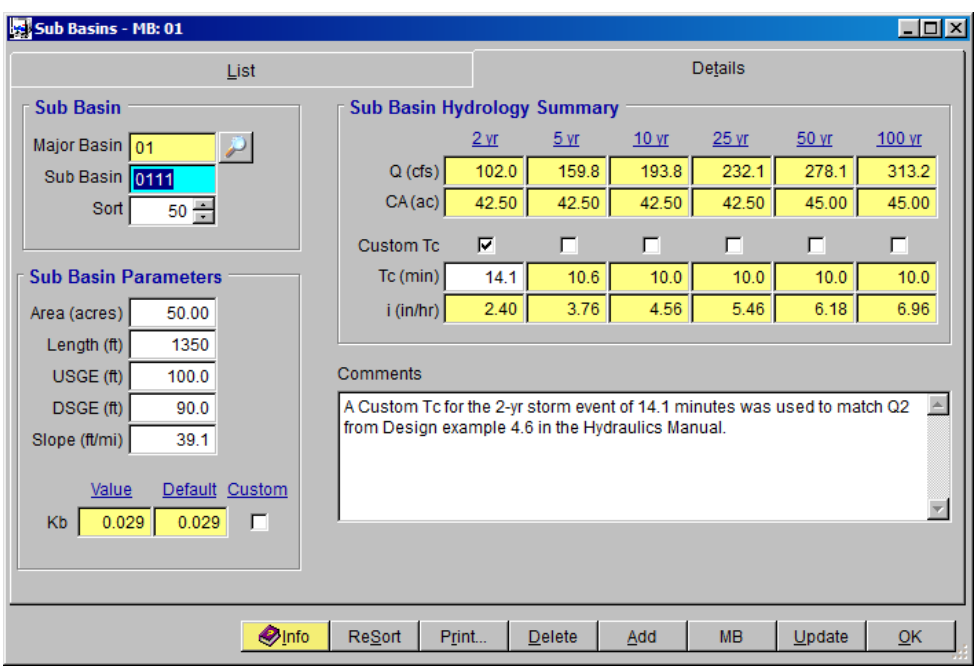
After individual Land Use data are entered into the form, click ***'Save*** to save the data and click ***'Add'*** to enter the next Land Use record. When all the Land use data have been entered, click ***'OK'*** to close and exit the **LAND USE** form.

7.0 UPDATE THE SUB BASIN DATA

To evaluate the parameters of individual Sub Basin with consideration of the Rainfall and the Land Use data developed in the previous Sections 4 and 6, open the **SUB BASINS** form (***Hydrology ➔ Sub Basins***). On the **Details** tab of the form, click the ***'Update'*** button.



For **Sub Basin** *0111,* check the **Custom Tc** checkbox for the 2-yr storm event. The rationale for this customized Tc of *14.1 min* is to come close to matching the data in Design Example 4.6.



Click ***'OK'*** to close and exit the **SUB BASINS** form.

8.0 DEVELOP THE CONVEYANCE FACILITIES DATA

The Storm Drain Layout in Section 1.0 shows one (1) Main Line, one (1) Lateral Line that feeds into the Main Line, and 4 Connector Pipes that feed into the Lateral Line. For this tutorial project, the StormPro backwater model is used to develop the hydraulic grade line (HGL) of the storm drain system. It is, therefore, necessary to sort the Conveyance Facilities in the correct order and establish the Line ID for each Conveyance Facility. With respect to the System Layout, Conveyance Facilities *010035* and *010040* will be **Line ID** *10* which outfalls into a Retention Basin. All remaining conveyance facilities (Lateral Line and Connector Pipes) with be designated as **Line ID** *20.* **Line ID** *20* outfalls into Conveyance Facilities *010040*.

The physical data (pipe size, pipe length, pipe invert elevations, etc.) of all the conduits / pipes in the system are tabulated below.

To enter the Conveyance Facilities data, open the **CONVEYANCE FACILITIES** form (***Hydraulics ➔ Conveyance Facilities***). Click the ***'Add'*** button to start the data entry for the first record.

ID			Model Options					Elevations				Section		
Facility ID	Line ID	Sort	Custom Q	Model Road	First Pipe	Outfall	DS Pipe ID	USGE	DSGE	USIE	DSIE	Length	Dia	Road ID
010040	10	10	105.2	X		X		1273.55	1270.50	1266.80	1265.50	80.00	48	PH-MJC-XSE-80
010035	10	20	102.0	X	X			1274.22	1273.55	1268.30	1266.80	300.00	48	PH-MJC-XSE-80
010030	20	30	5.8	X		X	010040	1274.36	1273.55	1269.30	1268.80	200.00	24	PH-MJC-XSE-80
010025	20	40	5.8	X				1274.77	1274.36	1270.05	1269.80	100.00	18	PH-MJC-XSE-80
010020	20	50	5.8					1274.59	1274.77	1270.24	1270.05	75.00	18	
010015	20	60	5.8					1274.44	1274.59	1270.29	1270.24	20.00	18	
010010	20	70	4.7					1274.44	1274.44	1270.31	1270.29	10.00	18	
010005	20	80	3.4	X	X			1274.96	1274.44	1270.79	1270.31	190.00	18	PH-MJC-XSE-80

For the first Conveyance Facilities data, enter the following:

ID:

- **Facility ID** *010040*
- **Line ID** *10*
- **Sort** *10*

Model Options:

- **RP (yrs)** 2
- **Custom** checkbox *Check*
- **Q (cfs)** *105.2*
- **Model Road** checkbox *Check*
- **First Pipe** checkbox *Uncheck*

- **Outfall** checkbox *Check*
- **D/S Pipe ID** *Blank*

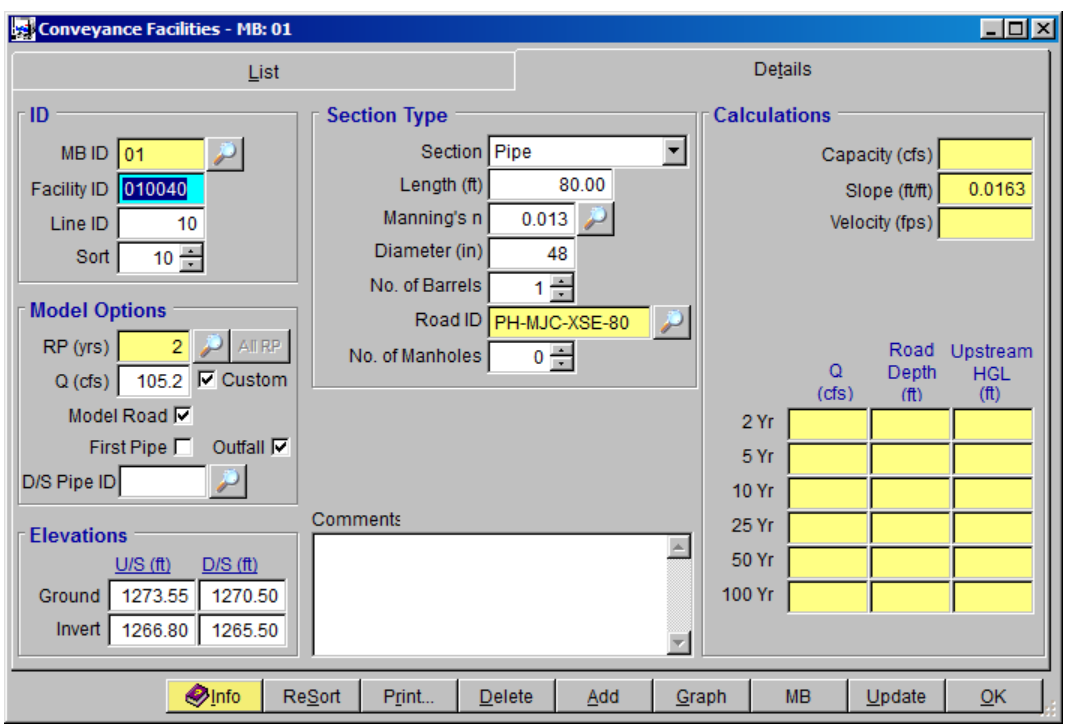
Elevations:

- **U/S Ground Elevation (ft)** *1273.55*
- **D/S Ground Elevation (ft)** *1270.50*
- **U/S Invert Elevation (ft)** *1266.80*
- **D/S Invert Elevation (ft)** *1265.50*

Section Type:

- **Section** *Pipe*
- **Length (ft)** *80.00*
- **Manning's n** *0.013*
- **Diameter (in)** *48*
- **No. of Barrels** *1*
- **Road ID** *PH-MJC-XSE-80*
- **No. of Manholes** *0*

After entering all the data for the first record (**Facility ID** *010040*), press ***'Save'.***



Click ***'Add'*** to enter the next record. Enter the following data for **Facility ID** *010035.*

ID:

- **Facility ID** *010035*
- **Line ID** *10*
- **Sort** *20*

Model Options:

- **RP (yrs)** 2
- **Custom** checkbox *Check*
- **Q (cfs)** *102.0*
- **Model Road** checkbox *Check*
- **First Pipe** checkbox *Check*
- **Outfall** checkbox *Uncheck*

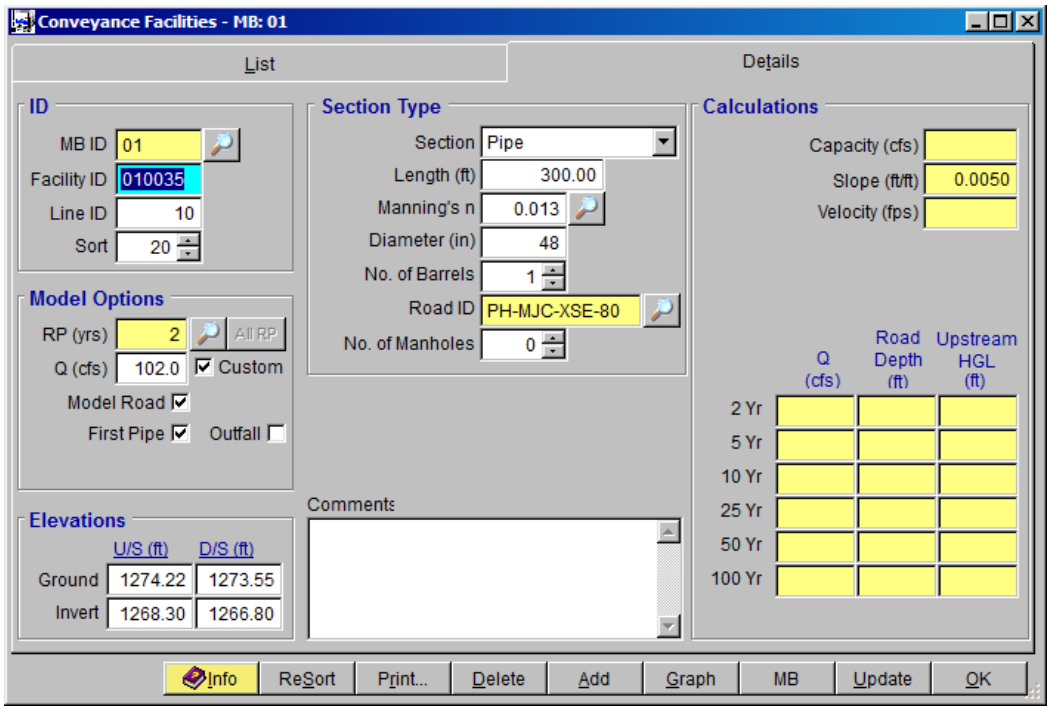
Elevations:

- **U/S Ground Elevation (ft)** *1274.22*
- **D/S Ground Elevation (ft)** *1273.55*
- **U/S Invert Elevation (ft)** *1268.30*
- **D/S Invert Elevation (ft)** *1266.80*

Section Type:

- **Section** *Pipe*
- **Length (ft)** *300.00*
- **Manning's n** *0.013*
- **Diameter (in)** *48*
- **No. of Barrels** *1*
- **Road ID** *PH-MJC-XSE-80*
- **No. of Manholes** *0*

After entering all the data for the second record (**Facility ID** *010035*), press ***'Save'.***



Click ***'Add'*** to enter the next record. Enter the following data for **Facility ID** *010030.*

ID:

- **Facility ID** *010030*
- **Line ID** *20*
- **Sort** *30*

Model Options:

- **RP (yrs)** 2
- **Custom** checkbox *Check*
- **Q (cfs)** *5.8*
- **Model Road** checkbox *Check*
- **First Pipe** checkbox *Uncheck*
- **Outfall** checkbox *Check*
- **D/S Pipe ID** *010040*

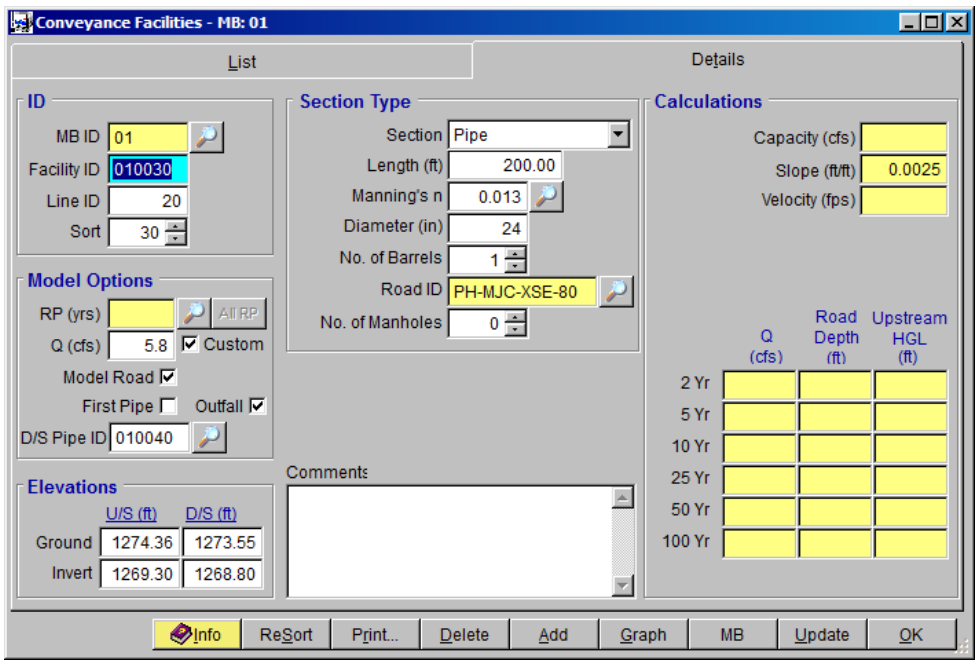
Elevations:

- **U/S Ground Elevation (ft)** *1274.36*
- **D/S Ground Elevation (ft)** *1273.55*
- **U/S Invert Elevation (ft)** *1269.30*
- **D/S Invert Elevation (ft)** *1268.80*

Section Type:

- **Section** *Pipe*
- **Length (ft)** *200.00*
- **Manning's n** *0.013*
- **Diameter (in)** *24*
- **No. of Barrels** *1*
- **Road ID** *PH-MJC-XSE-80*
- **No. of Manholes** *0*

After entering all the data for the third record (**Facility ID** *010030*), press ***'Save'.***



Click ***'Add'*** to enter the next record. Enter the following data for **Facility ID** *010025.*

ID:

- **Facility ID** *010025*
- **Line ID** *20*
- **Sort** *40*

Model Options:

- **RP (yrs)** 2
- **Custom** checkbox *Check*
- **Q (cfs)** *5.8*
- **Model Road** checkbox *Check*
- **First Pipe** checkbox *Uncheck*
- **Outfall** checkbox *Uncheck*

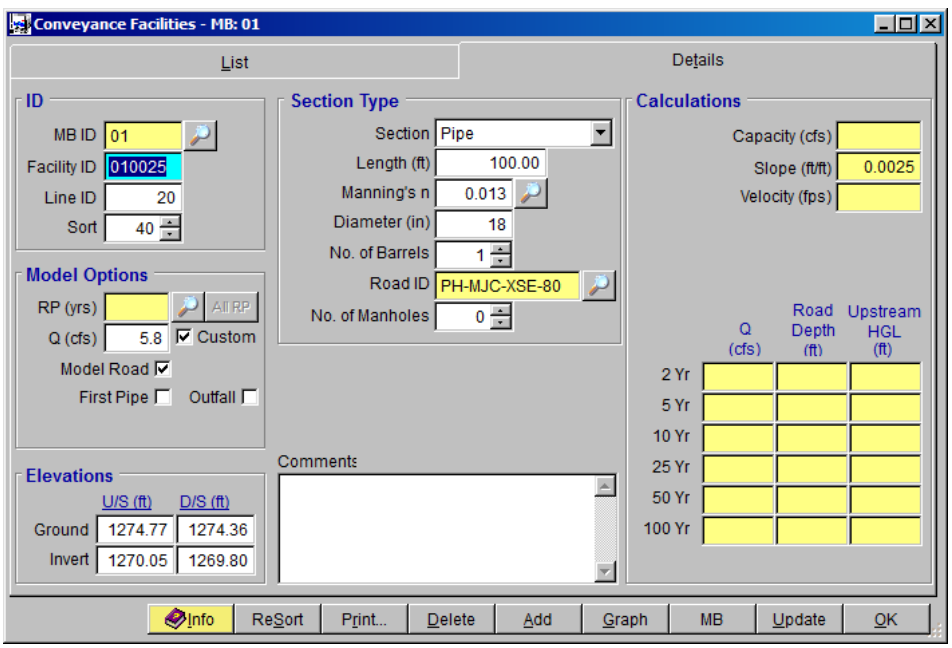
Elevations:

- **U/S Ground Elevation (ft)** *1274.77*
- **D/S Ground Elevation (ft)** *1274.36*
- **U/S Invert Elevation (ft)** *1270.05*
- **D/S Invert Elevation (ft)** *1269.80*

Section Type:

- **Section** *Pipe*
- **Length (ft)** *100.00*
- **Manning's n** *0.013*
- **Diameter (in)** *18*
- **No. of Barrels** *1*
- **Road ID** *PH-MJC-XSE-80*
- **No. of Manholes** *0*

After entering all the data for the fourth record (**Facility ID** *010025*), press ***'Save'.***



Click ***'Add'*** to enter the next record. Enter the following data for **Facility ID** *010020.*

ID:

- **Facility ID** *010020*
- **Line ID** *20*
- **Sort** *50*

Model Options:

- **RP (yrs)** 2
- **Custom** checkbox *Check*

- **Q (cfs)** *5.8*
- **Model Road** checkbox *Uncheck*
- **First Pipe** checkbox *Uncheck*
- **Outfall** checkbox *Uncheck*

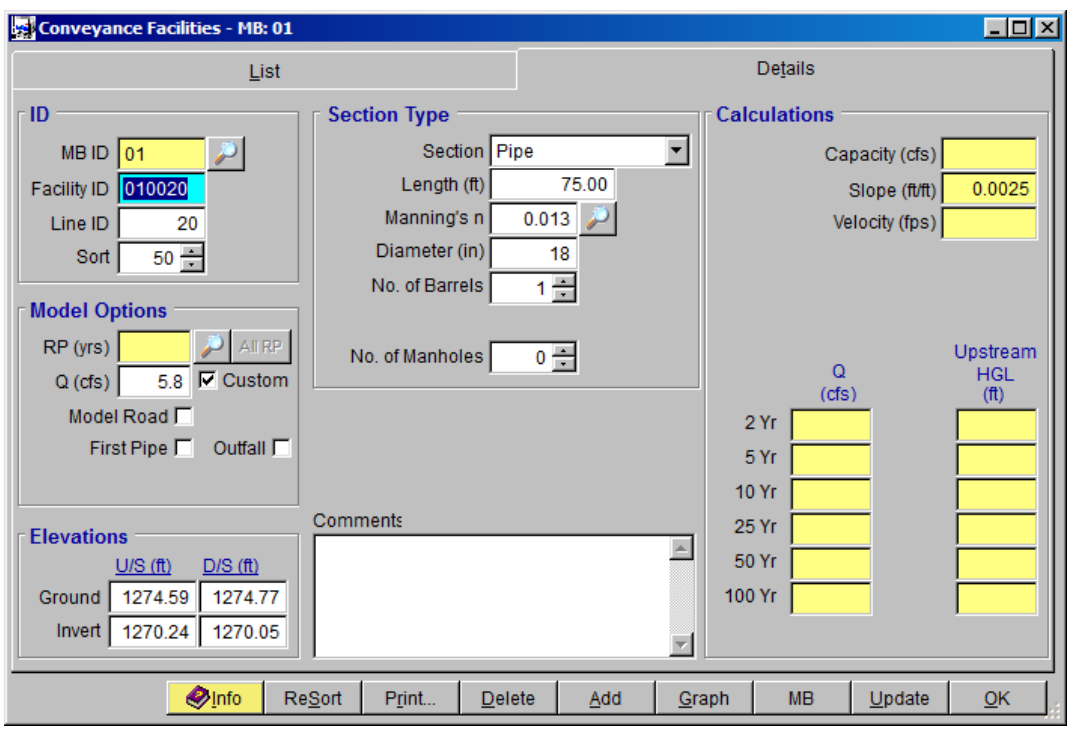
Elevations:

- **U/S Ground Elevation (ft)** *1274.59*
- **D/S Ground Elevation (ft)** *1274.77*
- **U/S Invert Elevation (ft)** *1270.24*
- **D/S Invert Elevation (ft)** *1270.05*

Section Type:

- **Section** *Pipe*
- **Length (ft)** *75.00*
- **Manning's n** *0.013*
- **Diameter (in)** *18*
- **No. of Barrels** *1*
- **No. of Manholes** *0*

After entering all the data for the fifth record (**Facility ID** *010020*), press ***'Save'.***



Click ***'Add'*** to enter the next record. Enter the following data for **Facility ID** *010015.*

ID:

- **Facility ID** *010015*
- **Line ID** *20*
- **Sort** *60*

Model Options:

- **RP (yrs)** 2
- **Custom** checkbox *Check*
- **Q (cfs)** *5.8*
- **Model Road** checkbox *Uncheck*
- **First Pipe** checkbox *Uncheck*
- **Outfall** checkbox *Uncheck*

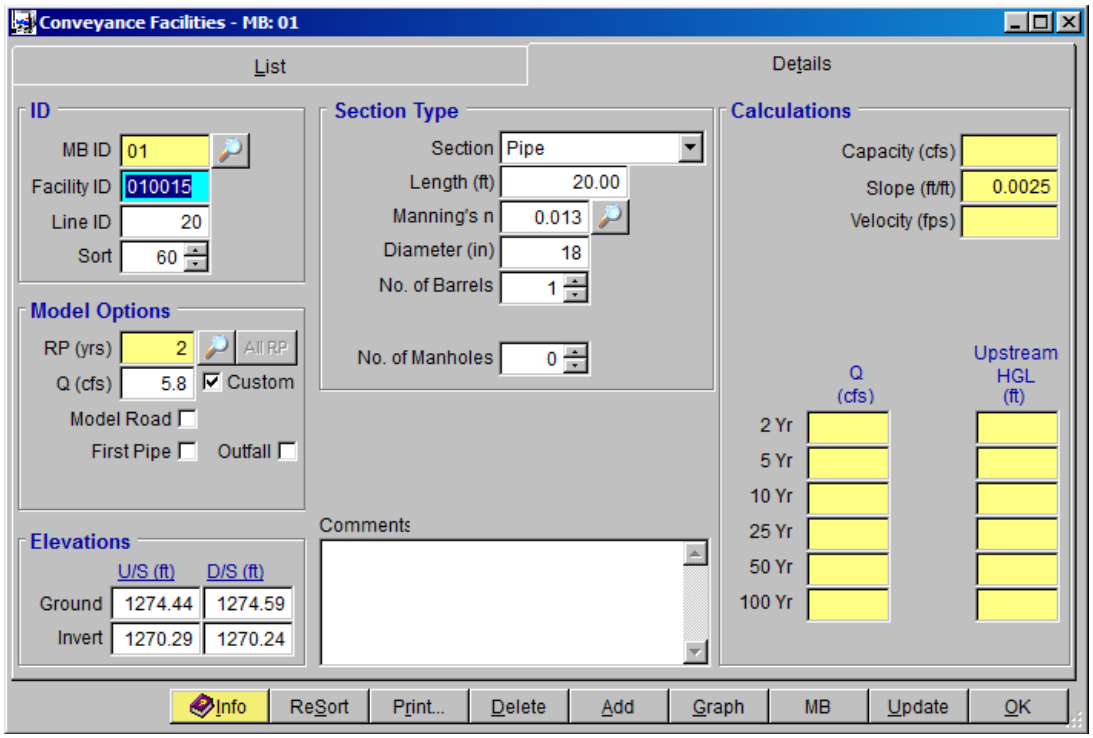
Elevations:

- **U/S Ground Elevation (ft)** *1274.44*
- **D/S Ground Elevation (ft)** *1274.59*
- **U/S Invert Elevation (ft)** *1270.29*
- **D/S Invert Elevation (ft)** *1270.24*

Section Type:

- **Section** *Pipe*
- **Length (ft)** *20.00*
- **Manning's n** *0.013*
- **Diameter (in)** *18*
- **No. of Barrels** *1*
- **No. of Manholes** *0*

After entering all the data for the sixth record (**Facility ID** *010015*), press ***'Save'.***



Click ***'Add'*** to enter the next record. Enter the following data for **Facility ID** *010010.*

ID:

- **Facility ID** *010010*
- **Line ID** *20*
- **Sort** *70*

Model Options:

- **RP (yrs)** 2
- **Custom** checkbox *Check*
- **Q (cfs)** *4.7*
- **Model Road** checkbox *Uncheck*
- **First Pipe** checkbox *Uncheck*
- **Outfall** checkbox *Uncheck*

Elevations:

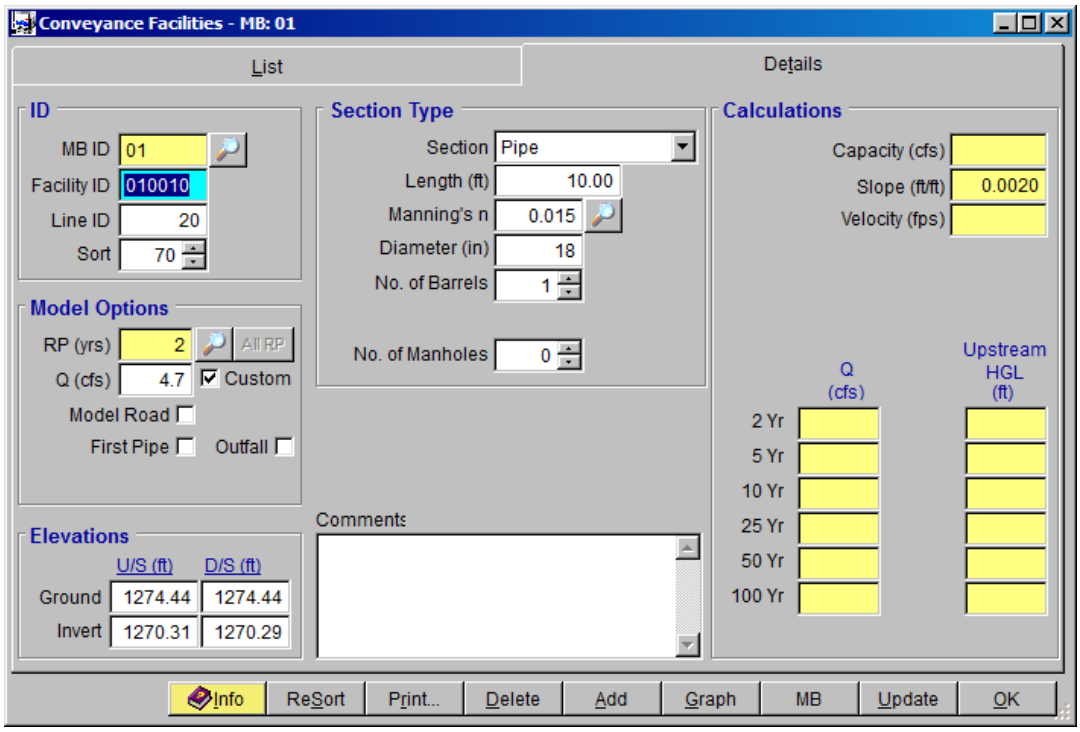
- **U/S Ground Elevation (ft)** *1274.44*
- **D/S Ground Elevation (ft)** *1274.44*
- **U/S Invert Elevation (ft)** *1270.31*
- **D/S Invert Elevation (ft)** *1270.29*

Section Type:

- **Section** *Pipe*

- **Length (ft)** *10.00*
- **Manning's n** *0.013*
- **Diameter (in)** *18*
- **No. of Barrels** *1*
- **No. of Manholes** *0*

After entering all the data for the seventh record (**Facility ID** *010010*), press ***'Save'.***



Click ***'Add'*** to enter the next and last record. Enter the following data for **Facility ID** *010005.*

ID:

- **Facility ID** *010005*
- **Line ID** *20*
- **Sort** *80*

Model Options:

- **RP (yrs)** 2
- **Custom** checkbox *Check*
- **Q (cfs)** *3.4*
- **Model Road** checkbox *Check*
- **First Pipe** checkbox *Check*
- **Outfall** checkbox *Uncheck*

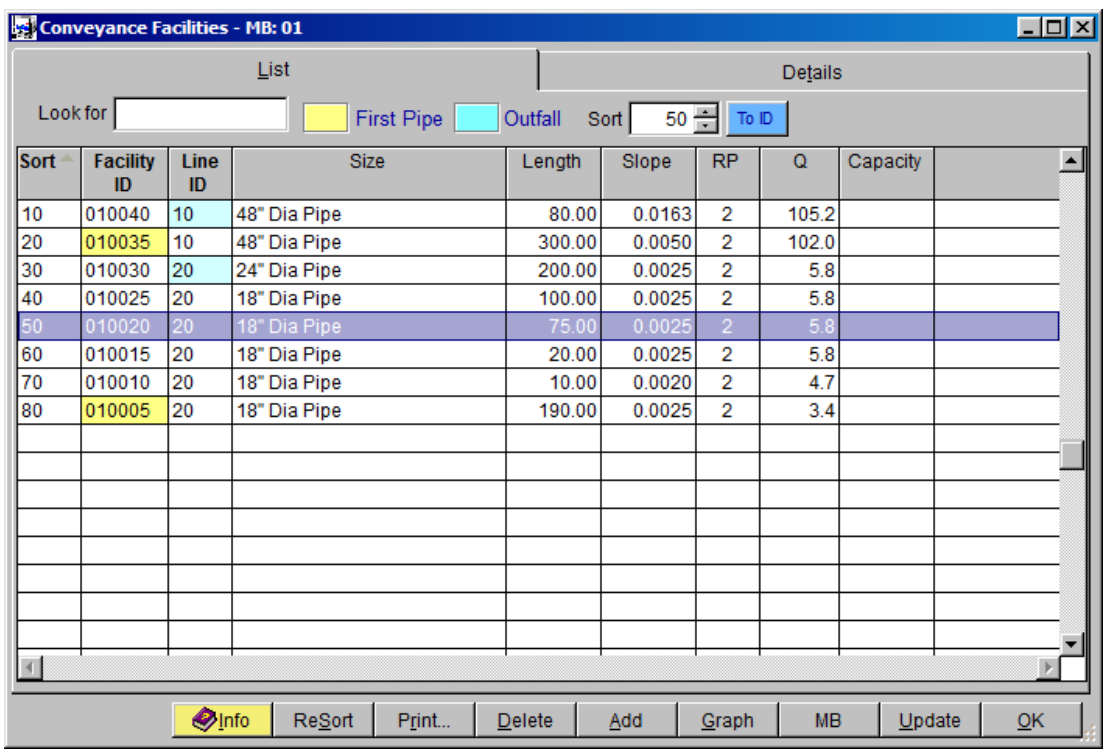
Elevations:

- **U/S Ground Elevation (ft)** *1274.96*
- **D/S Ground Elevation (ft)** *1274.44*
- **U/S Invert Elevation (ft)** *1270.79*
- **D/S Invert Elevation (ft)** *1270.31*

Section Type:

- **Section** *Pipe*
- **Length (ft)** *190.00*
- **Manning's n** *0.013*
- **Diameter (in)** *18*
- **No. of Barrels** *1*
- **Road ID** *PH-MJC-XSE-80*
- **No. of Manholes** *0*

After entering all the data for the last record (**Facility ID** *010005*), press ***'Save'.*** To view the list of Facilities Data entered, click the **List** tab.

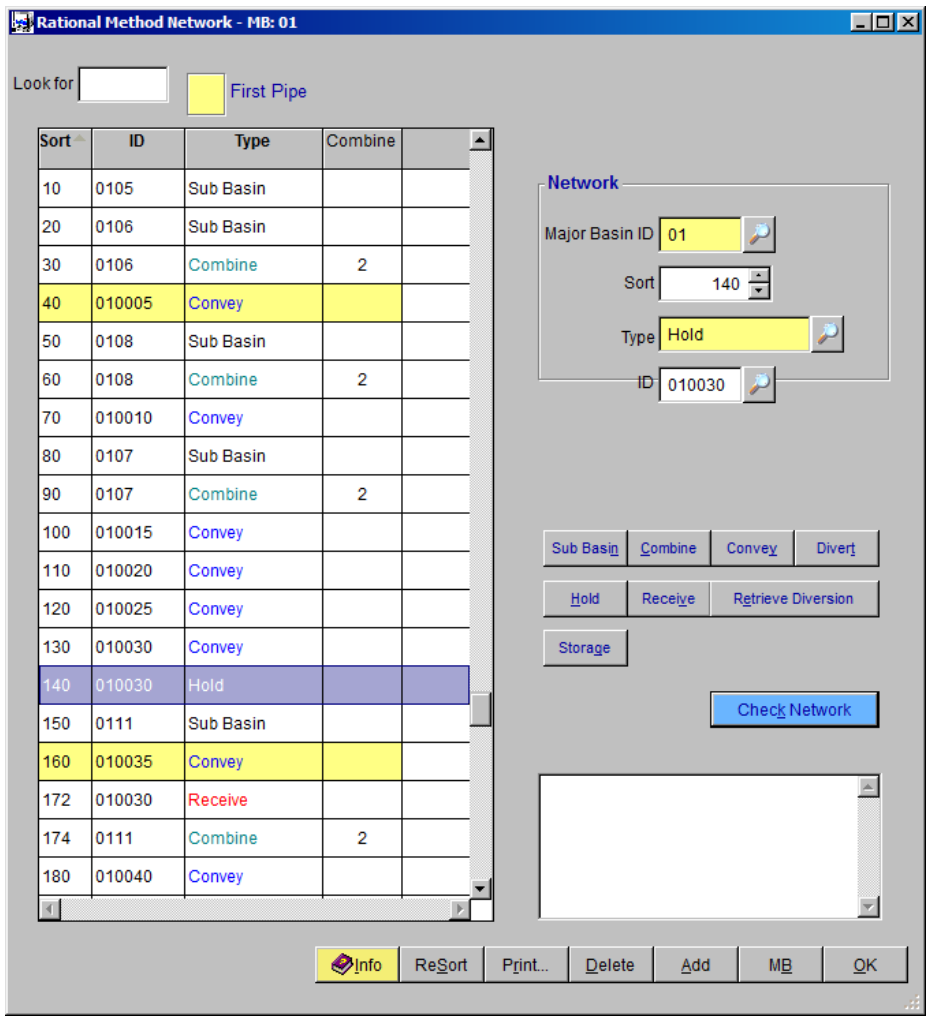


Sort	Facility ID	Line ID	Size	Length	Slope	RP	Q	Capacity
10	010040	10	48" Dia Pipe	80.00	0.0163	2	105.2	
20	010035	10	48" Dia Pipe	300.00	0.0050	2	102.0	
30	010030	20	24" Dia Pipe	200.00	0.0025	2	5.8	
40	010025	20	18" Dia Pipe	100.00	0.0025	2	5.8	
50	010020	20	18" Dia Pipe	75.00	0.0025	2	5.8	
60	010015	20	18" Dia Pipe	20.00	0.0025	2	5.8	
70	010010	20	18" Dia Pipe	10.00	0.0020	2	4.7	
80	010005	20	18" Dia Pipe	190.00	0.0025	2	3.4	

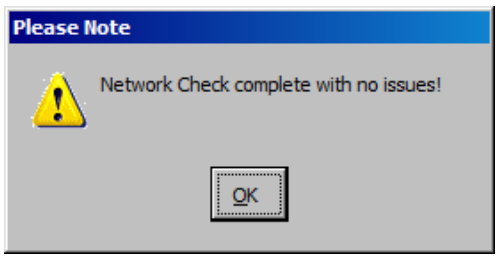
Click ***'OK'*** to close the **CONVEYANCE FACILITIES** form now that the Conveyance Facilities Data have now been developed.

9.0 BUILD THE MODEL NETWORK

Prior to running the Storm Drain system created from the Section 8.0, it is essential to build the model network to define the interconnectivity of the piping / conduit system. To build the model network, open the **RATIONAL METHOD NETWORK** form (***Hydrology ➔ Rational Method ➔ Network***). To start, press the ***'Add'*** button. Build the model network as shown below. The procedure for building a model network for Rational Method is presented in another tutorial document called, ***"Developing a New Project Using Rational Method".***



Once the model network is built (like the one shown above), click the ***'Check Network'*** button for the program to verify if the model network that was built is complete or has issues.

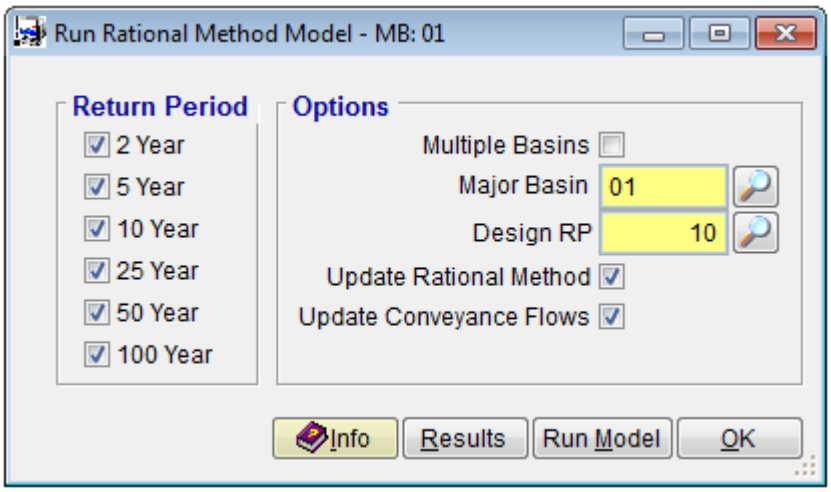


10.0 RUN THE MODEL

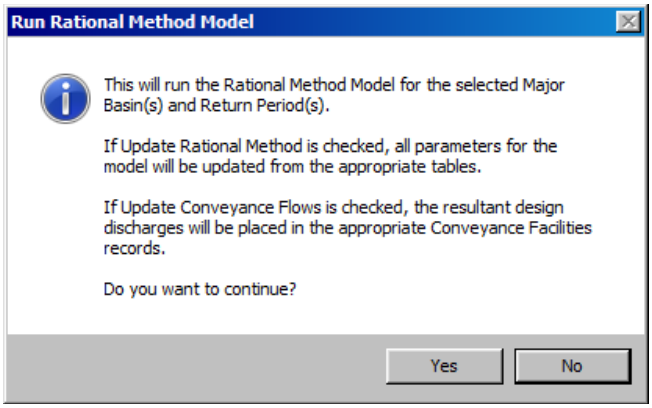
To run the model, open the **RUN RATIONAL METHOD MODEL** form and make the following changes on the form:

(a) Check all the **Return Periods** (i.e., ***2 Year, 5 Year, 10 Year, 25 Year, 50 Year,*** and ***100 Year***);
(b) Check the ***'Update Rational Method'*** checkbox.
(c) Check the ***'Update Conveyance Flows'*** checkbox.

Click the ***'Run Model'*** button.



Click ***'OK'*** to continue.

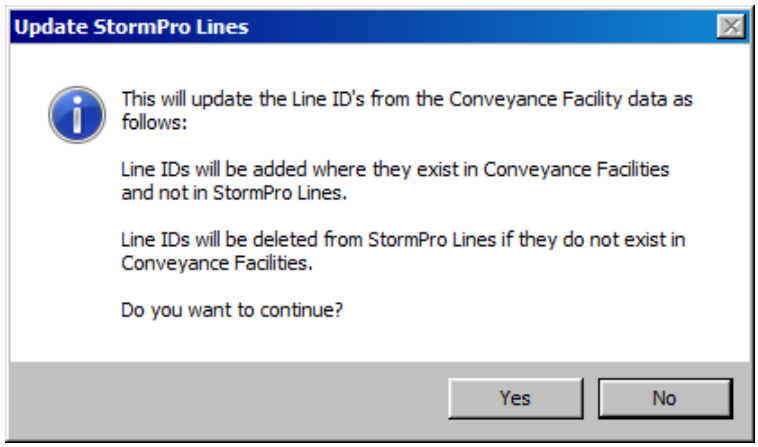


After the model is run, click ***'OK'*** to close and exit the form.

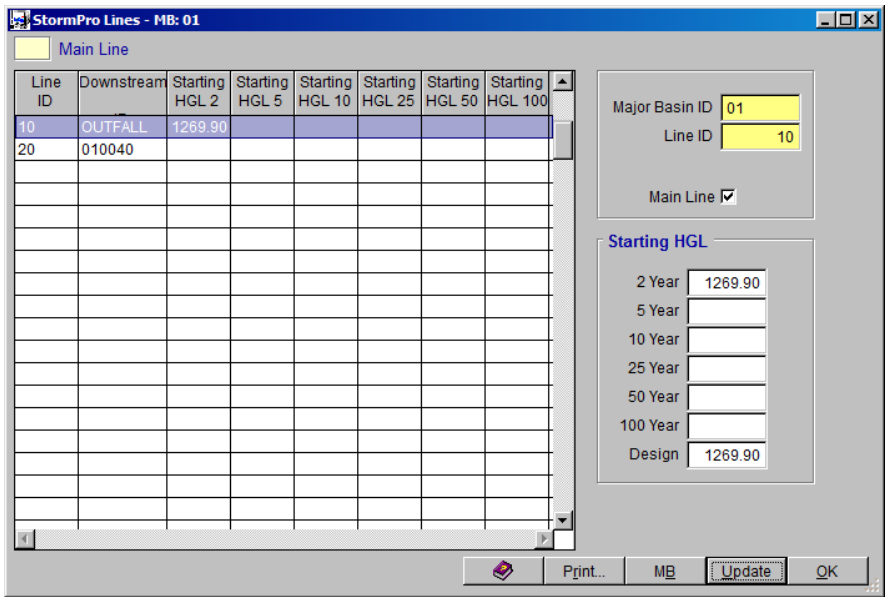
11.0 ESTABLISH DATA FOR THE STORMPRO LINES

To establish the starting water surface elevation (boundary condition) for **Line ID** *10* (the Main Line), open the **STORMPRO LINES** form (***Hydraulics ➔StormPro Backwater ➔Lines***). This starting water surface elevation is used to establish the hydraulic grade line (HGL) for the entire drainage system. If left blank, the value will default to (D+Dc)/2, where D is the depth of the facility, and Dc is the critical depth.

On the **STORMPRO LINES** form, press the ***'Update'*** button to start. On the **UPDATE STORMPRO LINES** form, click ***'Yes'*** to continue.



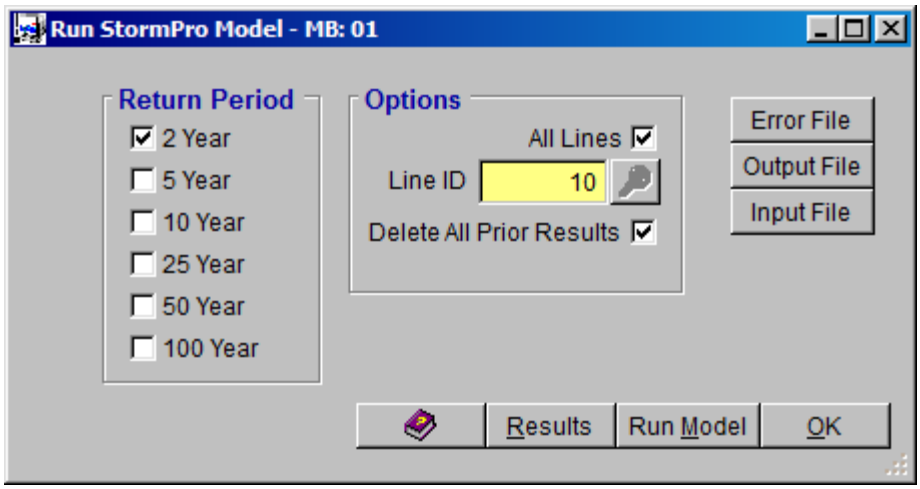
For **Line ID** *10*, check that it is a **'Main Line'** and enter *1269.90* for the starting water surface elevation. Do not enter any starting water surface elevation for **Line ID** *20* (**Lateral Line**) as this will be established in the Model Run.



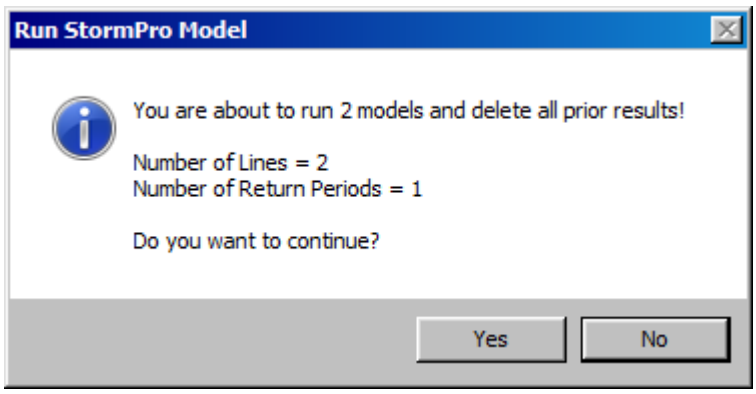
Click '***OK***' to close the form.

12.0 RUN STORMPRO

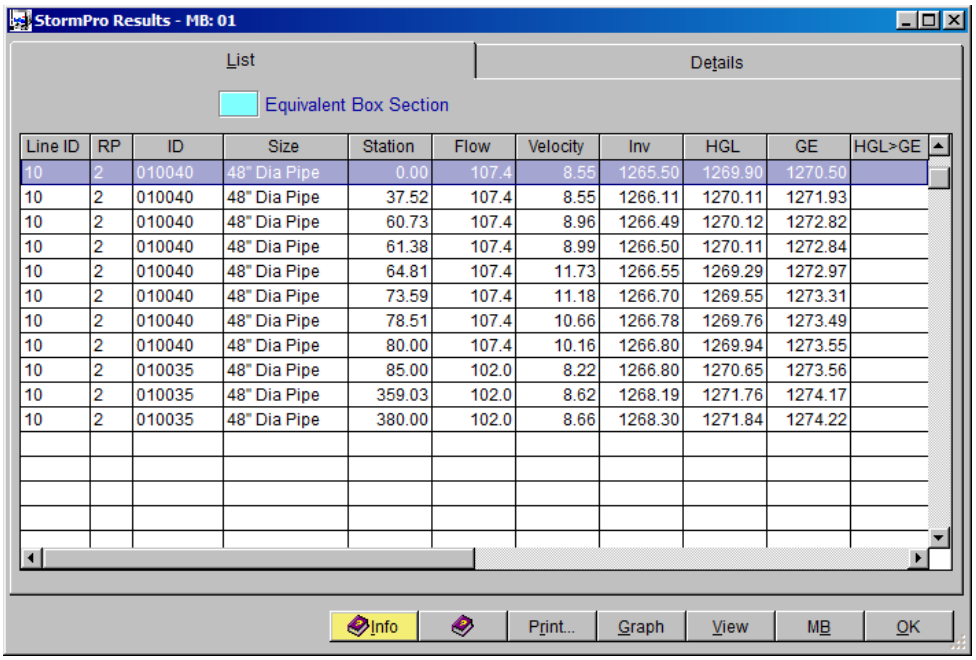
To run the model, open the **RUN STORMPRO MODEL** form (***Hydraulics ➔ StormPro Backwater ➔Model***). Select the **2 Year** Return Period, check **All Lines** and **Delete All Prior Results** checkboxes. Click ***'Save'*** to save the data entered and press ***'Run Model'***.



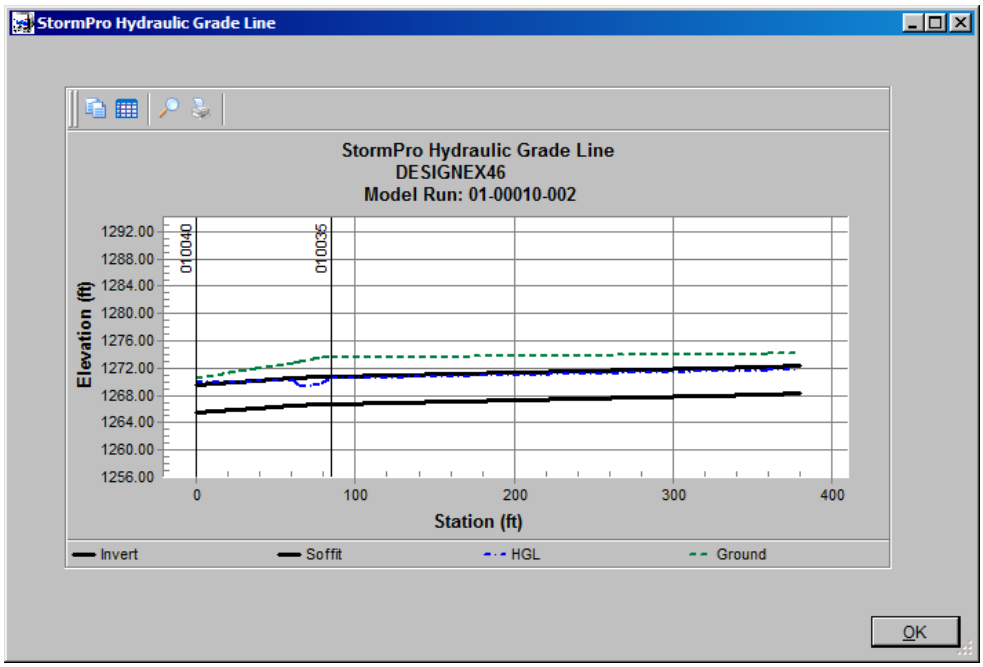
Click ***'Yes'*** to continue.



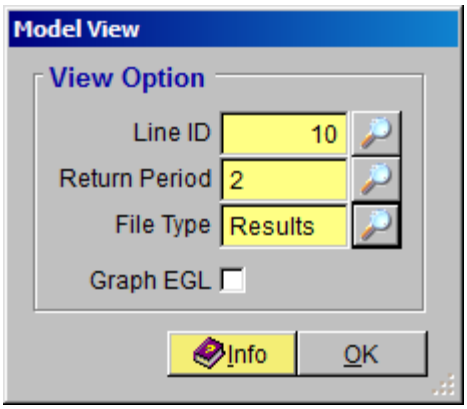
Once the model run is complete, model results viewed by clicking the ***'Results'*** button and can be graphed by clicking the ***'Graph'*** on the **STORMPRO RESULTS** form.



Line ID	RP	ID	Size	Station	Flow	Velocity	Inv	HGL	GE	HGL>GE
10	2	010040	48" Dia Pipe	0.00	107.4	8.55	1265.50	1269.90	1270.50	
10	2	010040	48" Dia Pipe	37.52	107.4	8.55	1266.11	1270.11	1271.93	
10	2	010040	48" Dia Pipe	60.73	107.4	8.96	1266.49	1270.12	1272.82	
10	2	010040	48" Dia Pipe	61.38	107.4	8.99	1266.50	1270.11	1272.84	
10	2	010040	48" Dia Pipe	64.81	107.4	11.73	1266.55	1269.29	1272.97	
10	2	010040	48" Dia Pipe	73.59	107.4	11.18	1266.70	1269.55	1273.31	
10	2	010040	48" Dia Pipe	78.51	107.4	10.66	1266.78	1269.76	1273.49	
10	2	010040	48" Dia Pipe	80.00	107.4	10.16	1266.80	1269.94	1273.55	
10	2	010035	48" Dia Pipe	85.00	102.0	8.22	1266.80	1270.65	1273.56	
10	2	010035	48" Dia Pipe	359.03	102.0	8.62	1268.19	1271.76	1274.17	
10	2	010035	48" Dia Pipe	380.00	102.0	8.66	1268.30	1271.84	1274.22	



To see more detailed results, the model output file can be viewed by clicking ***'View'***, and selecting ***'Output'*** for the File Type.

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\FCDMC\DDMSW482\MODLRUNS\DESIGNEX46\01-00010-002.SPO
** WARNING NO. 2 ** - WATER SURFACE ELEVATION GIVEN IS LESS THAN OR EQUALS INVERT ELEVATION IN HDWKDS, W.S.ELEV = INV + DC
1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        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Note that there is a Hydraulic Jump at Station 61.38 and also that the depth of flow after the Hydraulic Jump is significantly lower than the Normal depth resulting in extremely high velocities.

13.0 COMPARISON OF RESULTS

The differences in HGL and EGL between the Manual method and the StormPro Model are tabulated below.

ID	Q	HGL		EGL		Comments
		Manual	StormPro	Manual	StormPro	
010040	105.20	1271.52	1268.91	1272.61	1272.63	Hydraulic Jump
010035	102.00	1273.07	1269.30	1274.09	1296.30	Super Critical Flow
010030	5.80	1271.69	1270.31	1271.74	1270.64	
010025	5.80	1272.10	1270.98	1272.27	1271.37	
010020	5.80	1272.36	1271.43	1272.53	1271.66	
010015	5.80	1272.47	1271.50	1272.64	1271.72	
010010	4.70	1272.55	1271.70	1272.66	1271.82	
010005	3.40	1272.74	1271.17	1272.80	1272.62	