



DRAINAGE DESIGN MANAGEMENT SYSTEM FOR WINDOWS VERSION 5.3.0

TUTORIAL # 18 STORMPRO BACKWATER MODELING



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This document contains step-by-step tutorials for the Storm Drainage Hydraulics module of DDMSW for evaluating the hydraulic grade line.

STORMPRO BACKWATER MODELING

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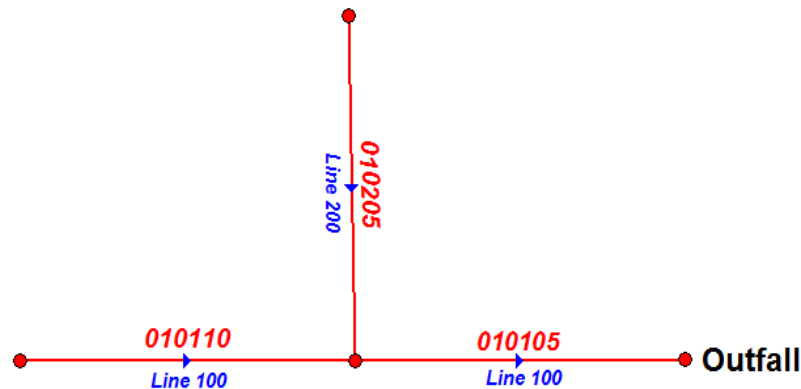
STORMPRO BACKWATER MODELING

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This tutorial provides a working example in the use of the **STORMPRO** Backwater Model. For this example, **KVEXAMPLE7** will be used. Before developing the backwater model, it is necessary to develop the hydrology using the Rational Method and enter the data for all conveyance facilities. The detailed procedure for the Rational Method and Conveyance Facilities for this tutorial is provided in **TUTORIALS FOR DDMSW HYDROLOGY MODELING – TUTORIAL 3 RATIONAL METHOD MODELING**. This tutorial starts after the **RATIONAL METHOD MODELING TUTORIAL** has been completed.

The specific requirements for running **STORMPRO** using the pipe network shown below include:

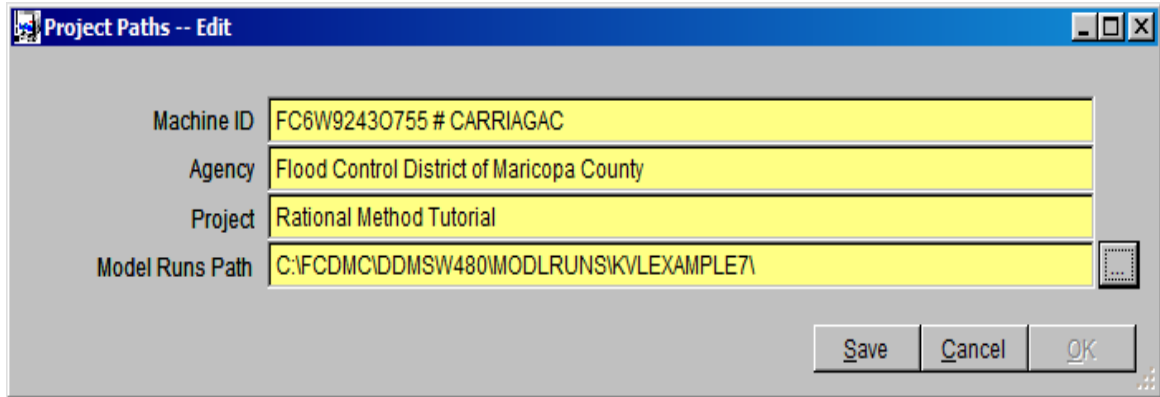
1. Establishing a folder for the model runs
2. Modifying the Conveyance Facilities
3. Establish the details for the Line IDs
4. Run Model



KvExample7 Pipe Network

1.0 CREATE A FOLDER FOR MODEL RUNS (FILE → PROJECT PATHS)

For this example, a new folder (C:\FCDMC\DDMSW530\Modlrns\ kvExample7) was created.



2.0 MODIFY CONVEYANCE FACILITIES (HYDRAULICS → CONVEYANCE FACILITIES)

In addition to the data previously entered (in the **RATIONAL METHOD MODELING TUTORIAL**) for the Conveyance Facilities, the following data needs to be entered:

Line ID: **STORMPRO** models each line separately starting with the lowest **Line ID**. It is important to enter the **Line ID**'s in the order that the model should run. This is to establish the starting water surface elevation for Lines entering another Line. In the above network, all conveyance facilities in the **Main Line** (that goes to an Outfall) are labeled **Line ID 100**. The upstream Line in this example is labeled **Line ID 200**.

Sort: For **STORMPRO** to run correctly, the **Facility ID**'s must be sorted in the order from Downstream to Upstream. Use the **Sort** field to force the correct order. **This is critical.**

Outfall: If a **Facility ID** is an Outfall, then check the **Outfall** checkbox. In this case, there are two outfalls. They are **Facility IDs 010105** and **010205** for **Line IDs 100** and **200** respectively.

D/S Pipe ID: If a **Facility ID** enters a downstream Line, then enter the **D/S Pipe ID**. In the case of **Facility ID 010205** for **Line ID 200**, enter **Pipe ID 010105** (of **Line ID 100**) as the **D/S Pipe ID**.

Manholes: Enter the number of manholes in each **Facility ID**.

Screen Captures for **Facility ID 010105** and **010205** are shown below.

Conveyance Facilities - MB: 01

List Details

ID

MB ID: 01
 Facility ID: 010105
 Line ID: 100
 Sort: 10

Section Type

Section: Pipe
 Length (ft): 1323.00
 Manning's n: 0.013
 Diameter (in): 54
 No. of Barrels: 1
 No. of Manholes: 0

Calculations

Capacity (cfs): 108.0
 Slope (ft/ft): 0.0030
 Velocity (fps): 6.8

Model Options

RP (yrs): 10 [All RP]
 Q (cfs): 145.9 [Custom]
 Model Road:
 First Pipe: Outfall:
 D/S Pipe ID: []

Elevations

	U/S (ft)	D/S (ft)
Ground	993.00	988.00
Invert	988.00	984.00

Comments: []

Info ReSort Print... Delete Add Graph MB Update OK

Conveyance Facilities - MB: 01

List Details

ID

MB ID: 01
 Facility ID: 010205
 Line ID: 200
 Sort: 30

Section Type

Section: Pipe
 Length (ft): 1318.00
 Manning's n: 0.013
 Diameter (in): 42
 No. of Barrels: 1
 Road ID: MC-RMAR
 No. of Manholes: 0

Calculations

Capacity (cfs): 51.8
 Slope (ft/ft): 0.0027
 Velocity (fps): 5.4

Model Options

RP (yrs): 10 [All RP]
 Q (cfs): 53.9 [Custom]
 Model Road:
 First Pipe: Outfall:
 D/S Pipe ID: 010105

Elevations

	U/S (ft)	D/S (ft)
Ground	996.00	993.00
Invert	992.00	988.50

Comments: []

Info ReSort Print... Delete Add Graph MB Update OK

3.0 ESTABLISH LINE IDS (HYDRAULICS → STORMPRO BACKWATER → LINES)

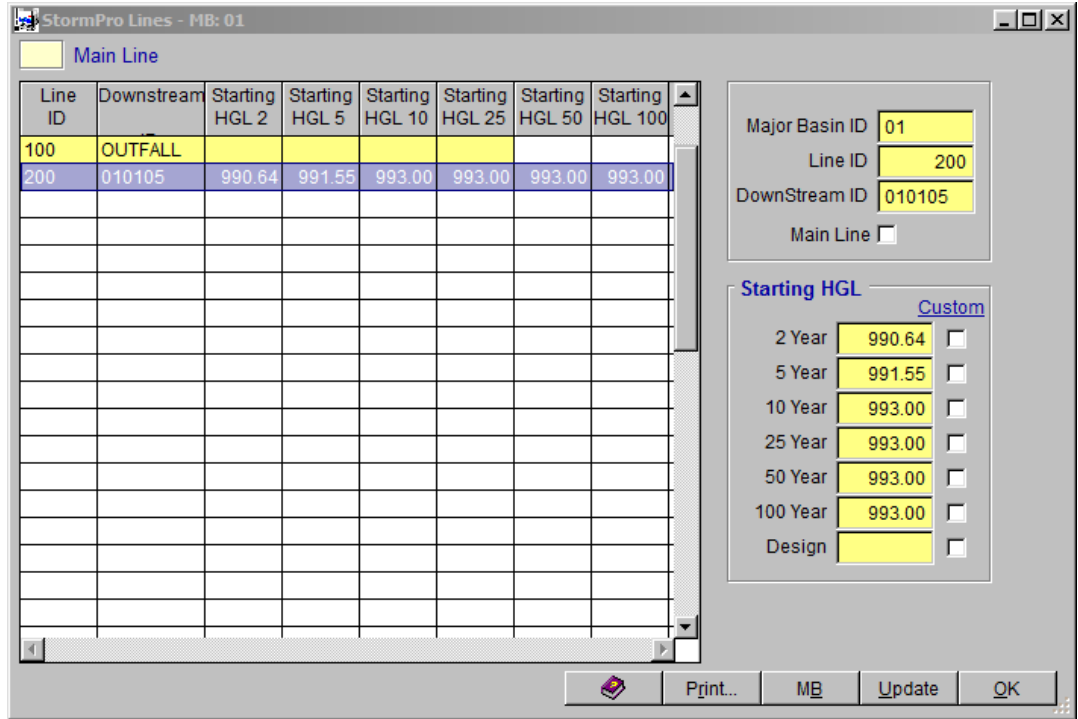
When first going into this form, there will be no data and there will not be an **Add** button. The data for the Lines is established when clicking the **Update** button. In this

case a warning will be given that there is no **Downstream ID** for **Line ID 100** (because it is an **Outfall**). For this **Line ID 100**, check **Main Line**. It is important to note that if the Conveyance Facilities are modified, then the **STORMPRO** Lines should be updated before running a **STORMPRO** Model.

For a **Main Line**, the Starting Hydraulic Grade Line for each return period can be entered. If left blank, the model uses the formula $(D_c + D)/2$, where D_c is the critical depth and D is the height of the **Facility ID**.

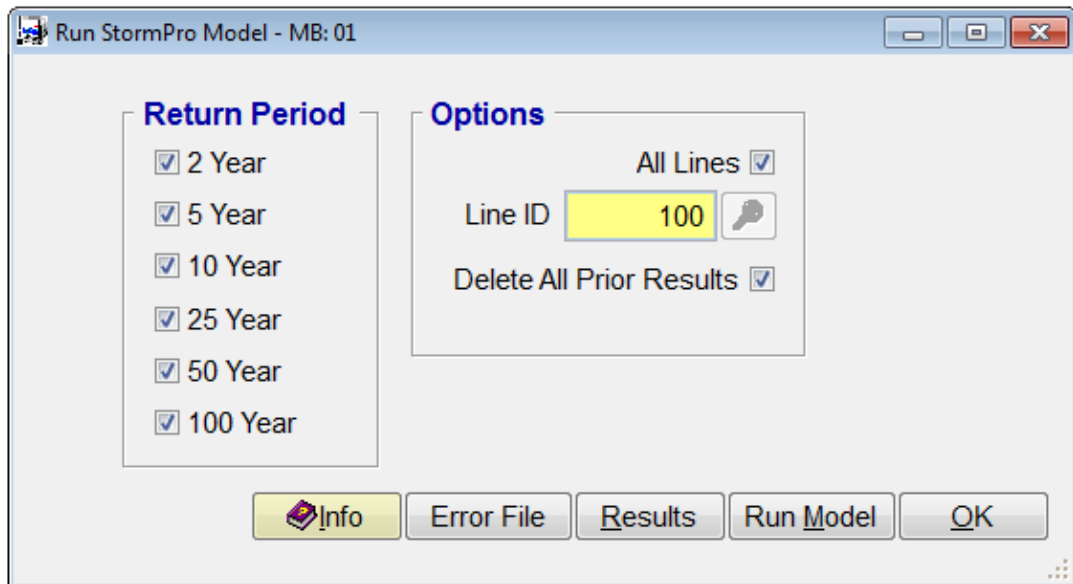
For Lines that are not a Main Line, a Starting Hydraulic Grade Line can be entered by checking the appropriate **Custom** for each return period. If left blank, the model establishes the value from the modeled Line that this Line enters.

Line ID	Downstream	Starting HGL 2	Starting HGL 5	Starting HGL 10	Starting HGL 25	Starting HGL 50	Starting HGL 100
100	OUTFALL						
200	010105	990.64	991.55	993.00	993.00	993.00	993.00



This is a view after the model has been run (**Starting HGL** is automatically loaded from results).

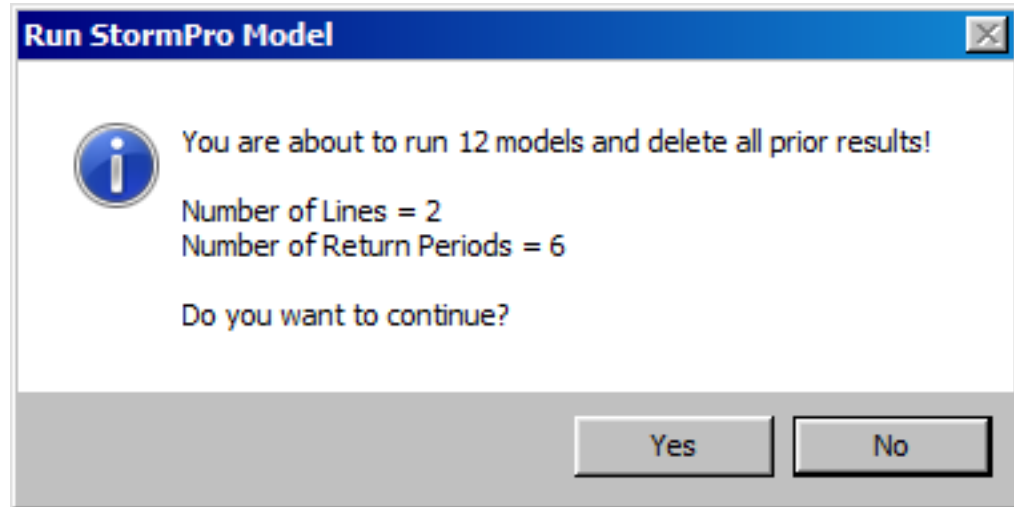
4.0 RUN MODEL (HYDRAULICS → STORMPRO BACKWATER → MODEL)



Options when running a **STORMPRO** Model include **Return Period**, **Line ID** and Delete Prior Results. If **All Lines** is checked, then **STORMPRO** will model all the selected return

periods for **Line 100** then model all the selected return periods for **Line 200** (in that order).

Click **Run Model** to run the model. Click **Yes** to continue.

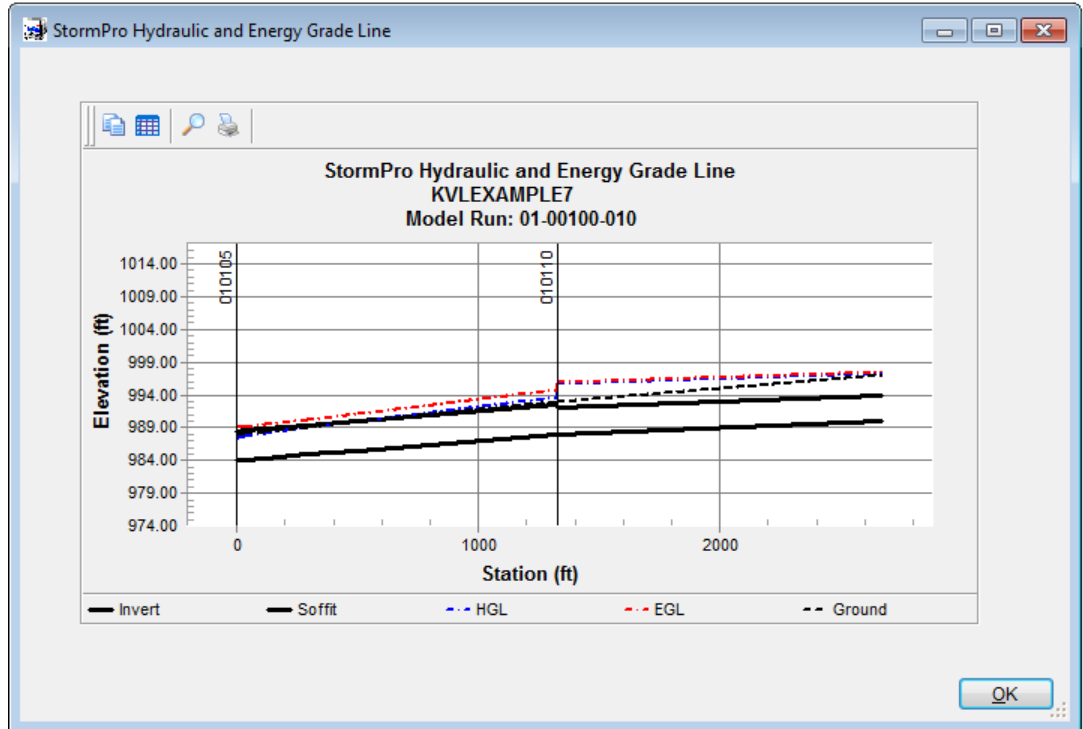


Click **Results** to view the model results.

The "StormPro Results - MB: 01" window shows a "List" tab with a table of results. A blue box highlights "Equivalent Box Section". The table has columns for Line ID, RP, ID, Size, Station, Flow, Velocity, Inv, HGL, GE, and HGL>GE.

Line ID	RP	ID	Size	Station	Flow	Velocity	Inv	HGL	GE	HGL>GE
100	10	010105	54" Dia Pipe	0.00	145.9	10.85	984.00	987.55	988.00	
100	10	010105	54" Dia Pipe	7.12	145.9	10.35	984.02	987.75	988.03	
100	10	010105	54" Dia Pipe	37.64	145.9	9.86	984.11	988.06	988.14	
100	10	010105	54" Dia Pipe	115.14	145.9	9.40	984.35	988.58	988.44	0.14
100	10	010105	54" Dia Pipe	213.66	145.9	9.17	984.65	989.15	988.81	0.34
100	10	010105	54" Dia Pipe	1323.00	145.9	9.17	988.00	995.25	993.00	2.25
100	10	010110	48" Dia Pipe	1328.00	51.4	4.09	988.00	997.74	993.01	4.73
100	10	010110	48" Dia Pipe	2671.00	51.4	4.09	990.00	999.45	997.00	2.45

Click **Graph** to view the graph of the model results.



To view another line and/or return period, click the **View** button.

Options include selecting the **Line ID**, **Return Period**, **File Type** and an option to graph the Energy Grade Line (**Graph EGL**). When selecting a **File Type** the following options are available:

Results will select the data from the **STORMPRO RESULTS** filtered for the selected **Line ID** and **Return Period**.

HGL>GE will select the data from the **STORMPRO RESULTS** filtered for the selected **Line ID, Return Period** and sections where the hydraulic grade line is above the ground elevation.

Input, Output and *Warning* will open the model Input, Output and Warning files, respectively (See below for examples of the Input File, Output File, and Warning File).

INPUT FILE:

```

JU
F1      Flood Control District of Maricopa County
F2      File: 01-00100-010.SPI
F3      Major Basin: 01 - Line ID: 100 - RP: 10
SO      0.00 984.00 2
}
JX      1323.00 988.00 2      .013
}
JX      1328.00 988.00 1 1      .000      94.5      988.00      90.0      0      0.000
}
JX      2671.00 990.00 1      .013
}
JH      2671.00 990.00 1      0.00
}
JD      1 4      4.00
JD      2 4      4.50
}
}      51.4
  
```

OUTPUT FILE:

Flood Control District of Maricopa County															
File: 01-00100-010.SPI															
Major Basin: 01 - Line ID: 100 - RP: 10															
STATION	INVERT	DEPTH	N.S.	Q	VEL	VEL	ENERGY	SUPER	CRITICAL		HGT/	BASE/	ZL	NO	AUBPR
I L/ELEM	ELEV	OF FLOW	ELEV		HEAD	GRD.EL.	ELEV	DEPTH		NORM DEPTH	DIA	ID NO.	ZR	PIER	
I	0.00	984.00	3.55	987.55	145.9	10.85	1.83	989.38	0.00	3.55	4.50	0.00	0.00	0	0.00
I	7.12	0.00302					0.00566	0.04			4.50		0.00		
I	7.12	984.02	3.73	987.75	145.9	10.35	1.66	989.42	0.00	3.55	4.50	0.00	0.00	0	0.00
I	30.52	0.00302					0.00518	0.16			4.50		0.00		
I	37.64	984.11	3.95	988.06	145.9	9.86	1.51	989.57	0.00	3.55	4.50	0.00	0.00	0	0.00
I	77.50	0.00302					0.00486	0.38			4.50		0.00		
I	115.14	984.35	4.23	988.58	145.9	9.40	1.37	989.95	0.00	3.55	4.50	0.00	0.00	0	0.00
I	98.52	0.00302					0.00510	0.50			4.50		0.00		
I	213.66	984.65	4.50	989.15	145.9	9.17	1.31	990.45	0.00	3.55	4.50	0.00	0.00	0	0.00
I	1109.34	0.00302					0.00547	6.07			4.50		0.00		
I	1323.00	988.00	7.25	995.25	145.9	9.17	1.31	996.56	0.00	3.55	4.50	0.00	0.00	0	0.00
I	JUNCT STR	0.00000					0.00393	0.02					0.00		
I	1328.00	988.00	9.74	997.74	51.4	4.09	0.26	998.00	0.00	2.15	4.00	0.00	0.00	0	0.00
I	1343.00	0.00149					0.00128	1.72			3.04		0.00		
I	2671.00	990.00	9.45	999.45	51.4	4.09	0.26	999.71	0.00	2.15	4.00	0.00	0.00	0	0.00

WARNING FILE

```

T1 Flood Control District of Maricopa County
T2 File: 01-00100-010.SPI
T3 Major Basin: 01 - Line ID: 100 - RP: 10
S0 0.00 984.00 2
R 1328.00 988.00 2 .013 0 0.000
JX 1328.00 988.00 1 1 .000 94.5 988.00 90.0 0 0.000
R 2671.00 990.00 1 .013 0 0.000
SH 2671.00 990.00 1 0.00

```

CARD	SECT	CHN	NO OF	AVE PIER	HEIGHT	WATER SURFACE PROFILE		CHANNEL DEFINITION LISTING										PAGE			
						1	BASE	ZL	ZR	INU	V(1)	V(2)	V(3)	V(4)	V(5)	V(6)	V(7)		V(8)	V(9)	V(10)
CODE	NO	TYPE	PIERS	WIDTH	DIAMETER	WIDTH			DROP												
CD	1	4			4.00															1	
CD	2	4			4.50																
LEADING LINE NO 1 IS - Flood Control District of Maricopa County																					
LEADING LINE NO 2 IS - File: 01-00100-010.SPI																					
LEADING LINE NO 3 IS - Major Basin: 01 - Line ID: 100 - RP: 10																					
ELEMENT NO	1	IS A	SYSTEM OUTLET																		
		U/S DATA		STATION		INVERT	SECT													W S ELEV	
				0.00		984.00	2														0.00
ELEMENT NO	2	IS A	REACH																		
		U/S DATA		STATION		INVERT	SECT														
				1328.00		988.00	2														
ELEMENT NO	3	IS A	JUNCTION																		
		U/S DATA		STATION		INVERT	SECT	LAT-1	LAT-2	N	Q3	Q4	INVERT-3	INVERT-4	PHI 3	PHI 4					
				1328.00		988.00	1	1	0	0.014	94.5	0.0	988.00	0.00	90.00	0.00					
THE ABOVE ELEMENT CONTAINED AN INVERT ELEV WHICH WAS NOT GREATER THAN THE PREVIOUS INVERT ELEV -WARNING																					
THE ABOVE ELEMENT CONTAINED AN INVERT ELEV WHICH WAS NOT GREATER THAN THE PREVIOUS INVERT ELEV -WARNING																					
ELEMENT NO	4	IS A	REACH																		
		U/S DATA		STATION		INVERT	SECT														
				2671.00		990.00	1														
ELEMENT NO	5	IS A	SYSTEM HEADWORKS																		
		U/S DATA		STATION		INVERT	SECT														
				2671.00		990.00	1														