



DRAINAGE DESIGN MANAGEMENT SYSTEM FOR WINDOWS VERSION 5.6.0

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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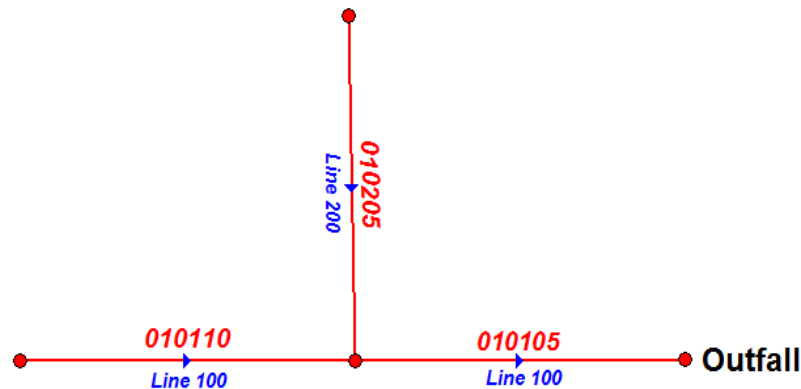
STORMPRO BACKWATER MODELING

DATE UPDATED: MAY 1, 2018

This tutorial provides a working example in the use of the **STORMPRO** Backwater Model. For this example, **KVLEXAMPLE7** 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:

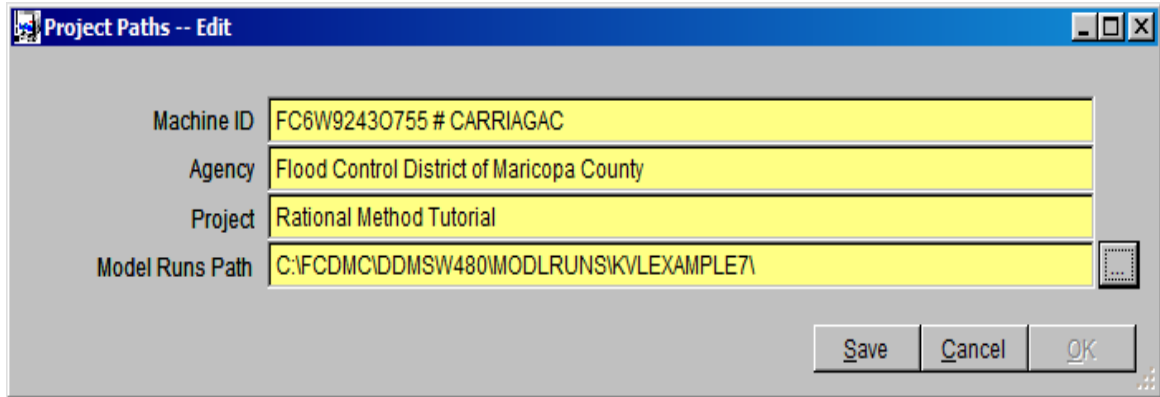
1. Establishing a folder for the model runs
2. Modifying the Conveyance Facilities
3. Establish the details for the Line IDs
4. Run Model



KvExample7 Pipe Network

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

For this example, a new folder (C:\FCDMC\DDMSW530\Modlrns\ kvlExample7) 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

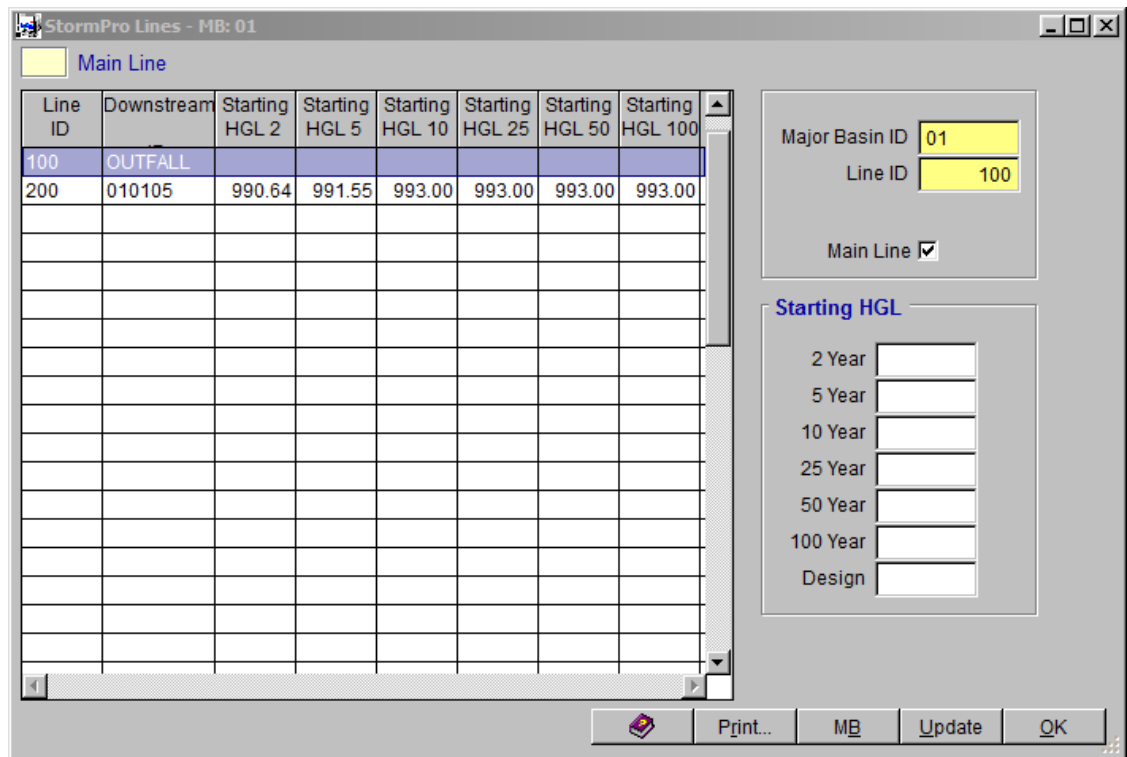
3.0 ESTABLISH LINE IDS (HYDRAULICS → STORMPRO BACKWATER → LINES)

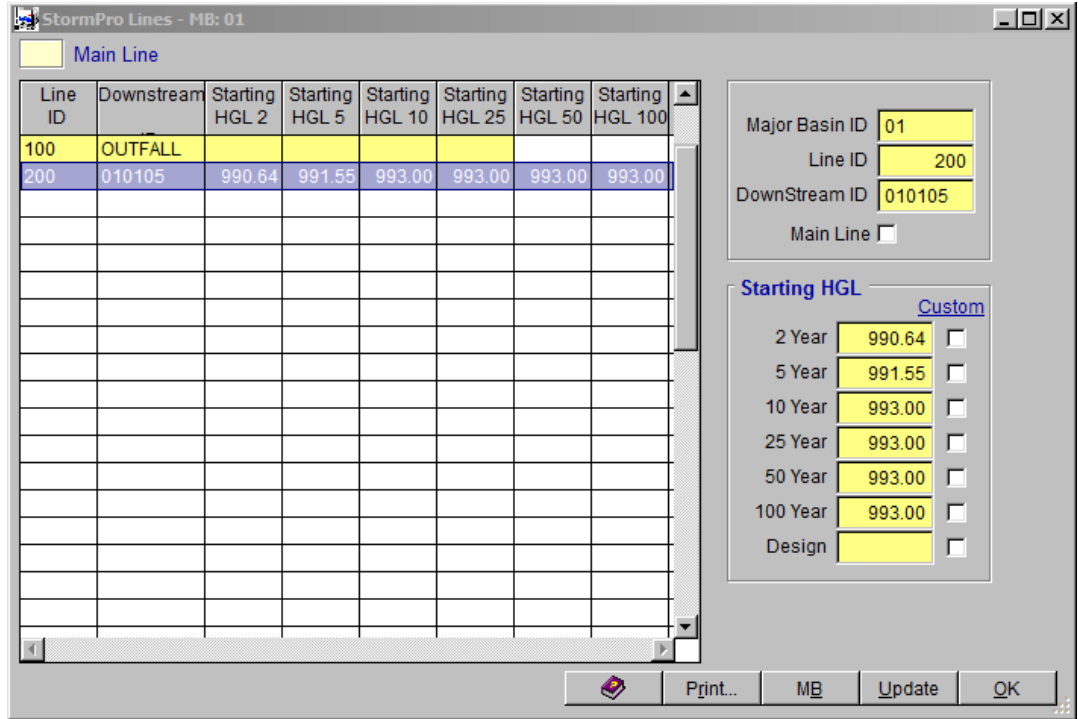
When first going into this form, there will be no data and there will not be an **Add** button. The data for the Lines is established when clicking the **Update** button. In this case a

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**.

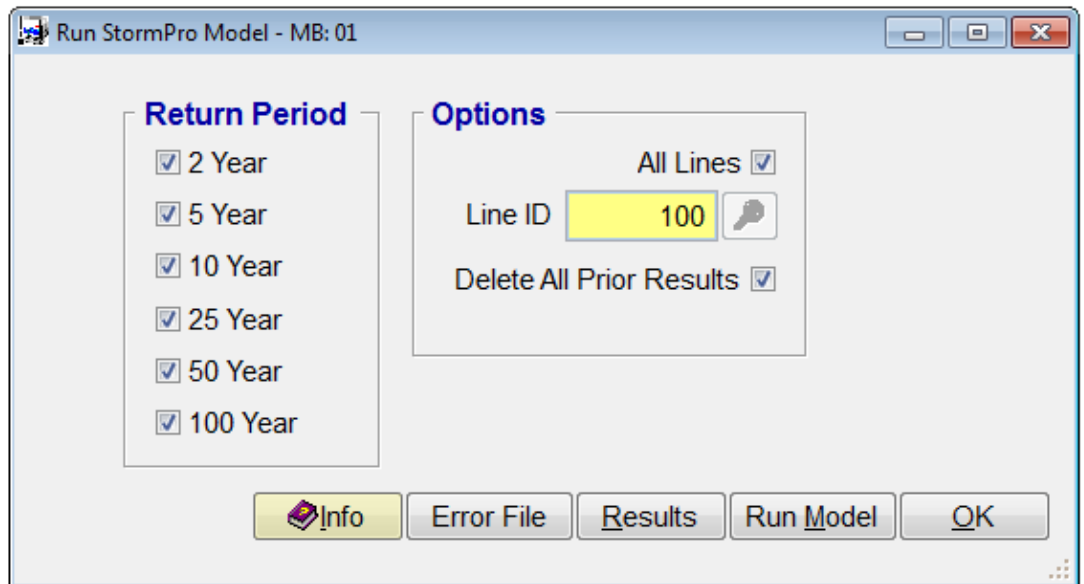
For Lines that are not a Main Line, a Starting Hydraulic Grade Line can be entered by checking the appropriate **Custom** for each return period. If left blank, the model establishes the value from the modeled Line that this Line enters.





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

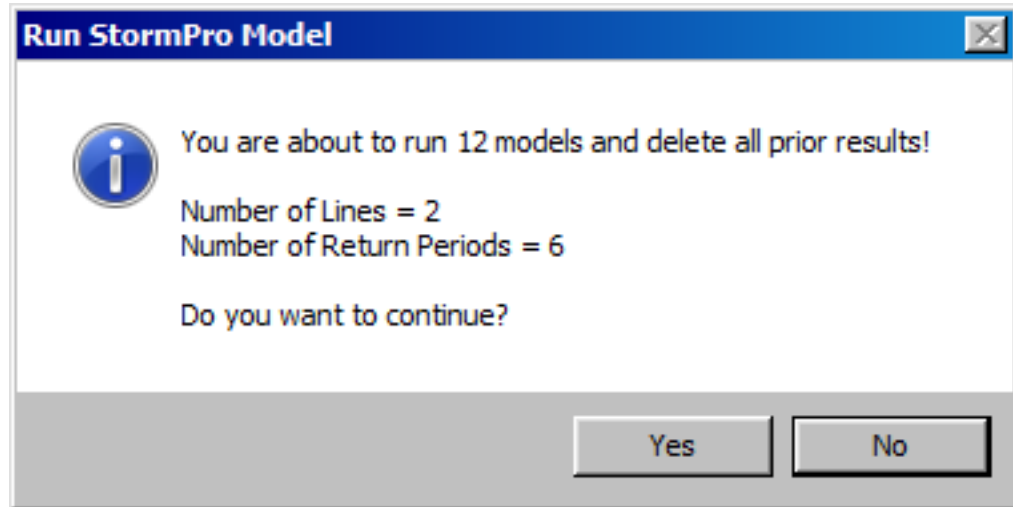
4.0 RUN MODEL (HYDRAULICS → STORMPRO BACKWATER → MODEL)



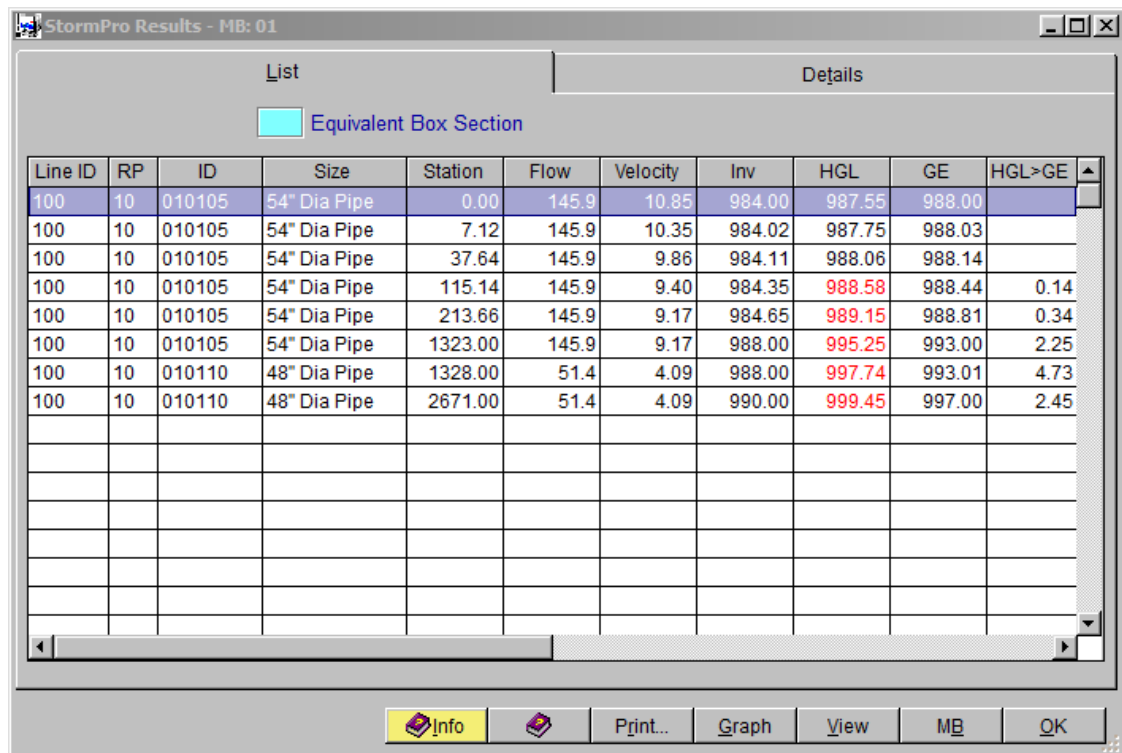
Options when running a **STORMPRO** Model include **Return Period**, **Line ID** and Delete Prior Results. If **All Lines** is checked, then **STORMPRO** will model all the selected return

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.

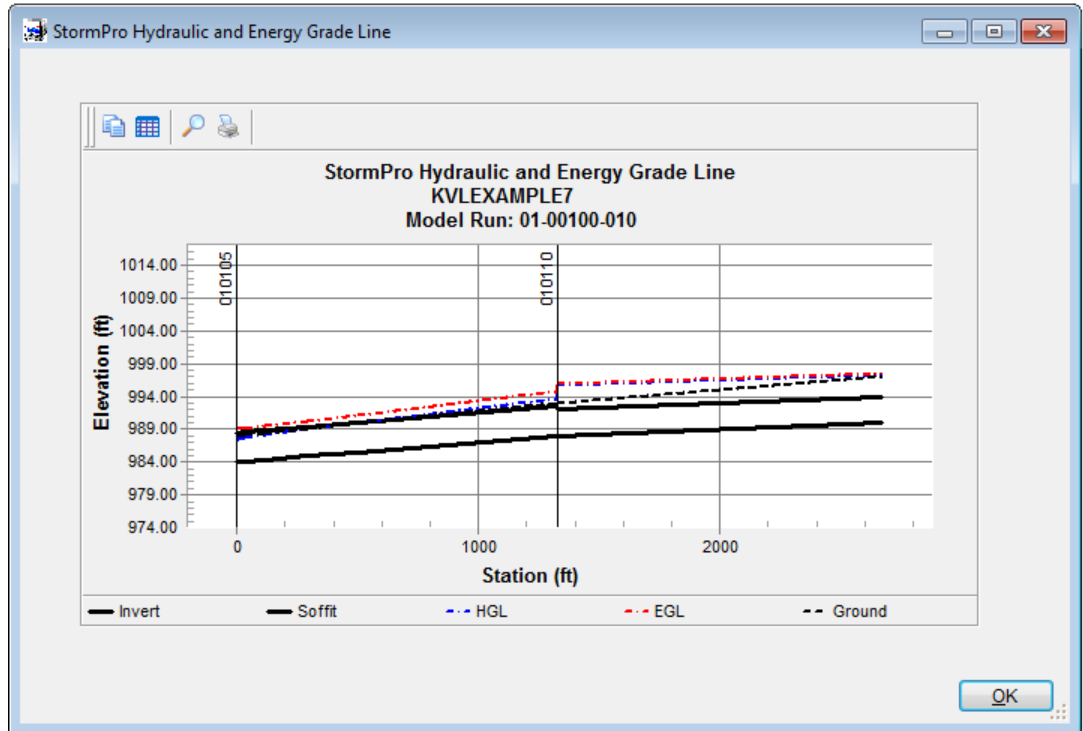


Click **Results** to view the model results.

A screenshot of the "StormPro Results - MB: 01" window. The window has a "List" tab selected and a "Details" tab. Below the tabs, there is a legend for "Equivalent Box Section" with a light blue square. A table displays the results for Line ID 100, showing columns for RP, ID, Size, Station, Flow, Velocity, Inv, HGL, GE, and HGL>GE. The data rows show increasing stationing and corresponding changes in flow, velocity, and water levels. The bottom of the window features a toolbar with buttons for Info, Print..., Graph, View, MB, and OK.

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:

```

JV
F1      Flood Control District of Maricopa County
F2      File: 01-00100-010.SPI
F3      Major Basin: 01 - Line ID: 100 - RP: 10
S0      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
}
SD      1 4      4.00
SD      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	V.S.	Q	VEL	VEL	ENERGY	SUPER	CRITICAL		HGT/	BASE/	ZL	NO
L/ELEM	ELEV	OF FLOW	ELEV			HEAD	GRD.EL.	ELEV	DEPTH	NORM DEPTH	DIA	ID NO.	ZR	PIER
	SO					SF AVE	HF							
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						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						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						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						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						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
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      1323.00 988.00 2 .013
JK     1328.00 988.00 1 1 .000 94.5 988.00 90.0 0 0.000
R      2671.00 990.00 1 .013
SH     2671.00 990.00 1 0.00
SP
WATER SURFACE PROFILE - CHANNEL DEFINITION LISTING
I CARD SECT CHN NO OF AVE PIER HEIGHT 1 BASE ZL ZR INU Y(1) Y(2) Y(3) Y(4) Y(5) Y(6) Y(7) Y(8) Y(9) Y(10) PAGE 1
CODE NO TYPE PERS WIDTH DIAMETER WIDTH DROP
CD 1 4 4.00
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 ELEU
0.00 984.00 2 0.00
ELEMENT NO 2 IS A REACH
U/S DATA STATION INVERT SECT N RADIUS ANGLE ANG_PT MAN_H IHINDRL CHINDRL
1323.00 988.00 2 0.013 0.00 0.00 0.00 0 0 0.000
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 ELEU WHICH WAS NOT GREATER THAN THE PREVIOUS INVERT ELEU -WARNING
THE ABOVE ELEMENT CONTAINED AN INVERT ELEU WHICH WAS NOT GREATER THAN THE PREVIOUS INVERT ELEU -WARNING
ELEMENT NO 4 IS A REACH
U/S DATA STATION INVERT SECT N RADIUS ANGLE ANG_PT MAN_H IHINDRL CHINDRL
2671.00 990.00 1 0.013 0.00 0.00 0.00 0 0 0.000
ELEMENT NO 5 IS A SYSTEM HEADWORKS
U/S DATA STATION INVERT SECT W S ELEU
2671.00 990.00 1 0.00

```