CE 3372 WATER SYSTEMS DESIGN

LESSON 18: INTRODUCTION TO SWMM FALL 2020

SWMM

- Storm Water Management Model
  - Originally by University of Florida in the 1970's
  - V1-4 are FORTRAN
  - V5 re-factored into C++
- The computation engine is mature
  - MIKE URBAN
  - SOBEK
  - XP-SWMM
  - Civil Storm

SWMM

- Started as a simplified hydraulic model, evolved into an integrated hydrology-hydraulics model
  - Pretty useful in urban settings
  - Used for BMP performance estimation
  - Used for LID performance estimation

DOWNLOAD AND INSTALL

- Google "EPA-SWMM" to find the software
- Download the self-extracting archive
- Download the user manual

TOUR OF THE INTERFACE

- Nodes and Links
- Outfall
- Sub-catchments and Rain gages
- Date/Time
- Hydraulics
- Hydrology

NODES

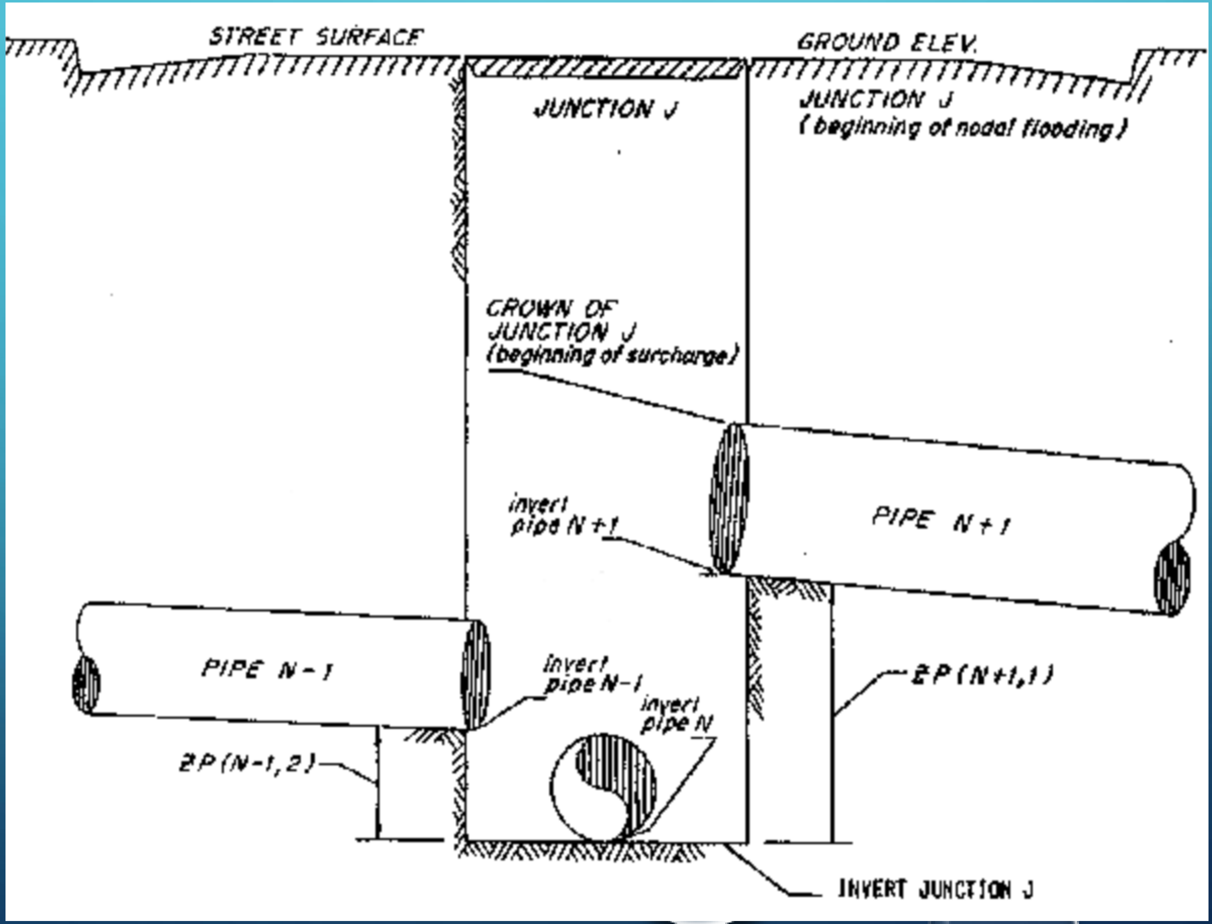
- Junction Nodes
- Storage Nodes
  - Invert Elevations
  - Flooding

JUNCTION (NODE)

- Ordinary junction connects hydraulic elements (links)
- Junction attributes are:
  - Invert elevation (elevation of the bottom of the node)
  - Max elevation (elevation of top of node)
    - Set to land surface to plot profile grade line in SWMM
    - Set to land surface + added depth for dual (surface+subsurface drainage)
- When program runs, depth at the node is computed, but there is no storage (node has zero area)

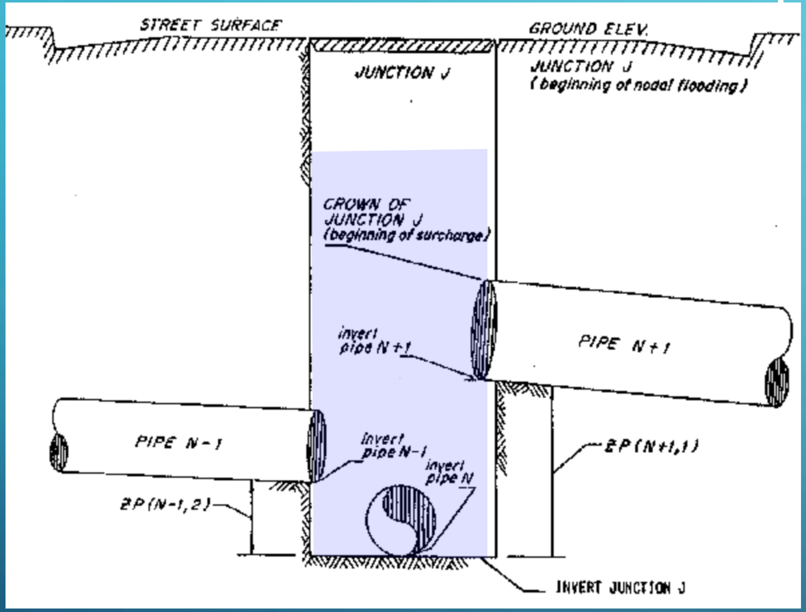
JUNCTION (NODE)

- Ordinary junction just connects pipes N-1, N, and N+1

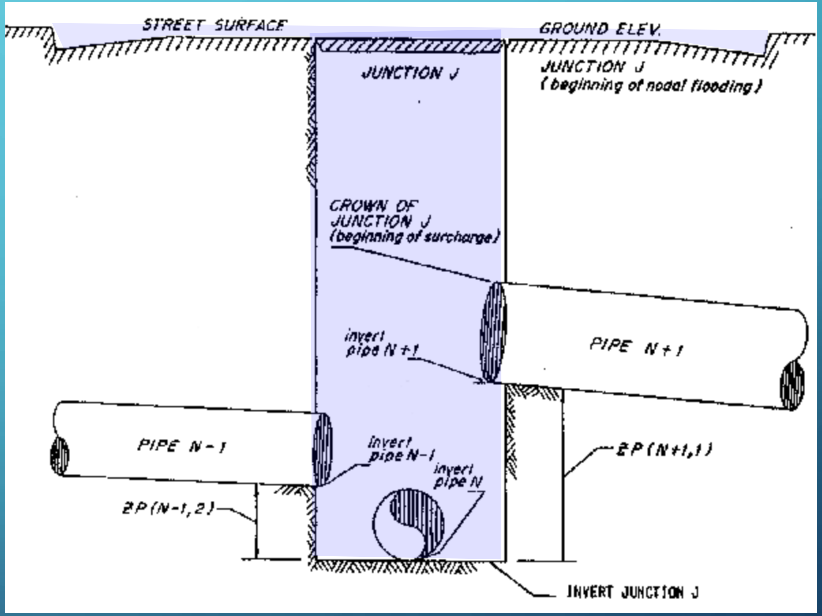


JUNCTION (NODE)

- If flooding occurs, it is only considered when HGL is above node Max. Depth



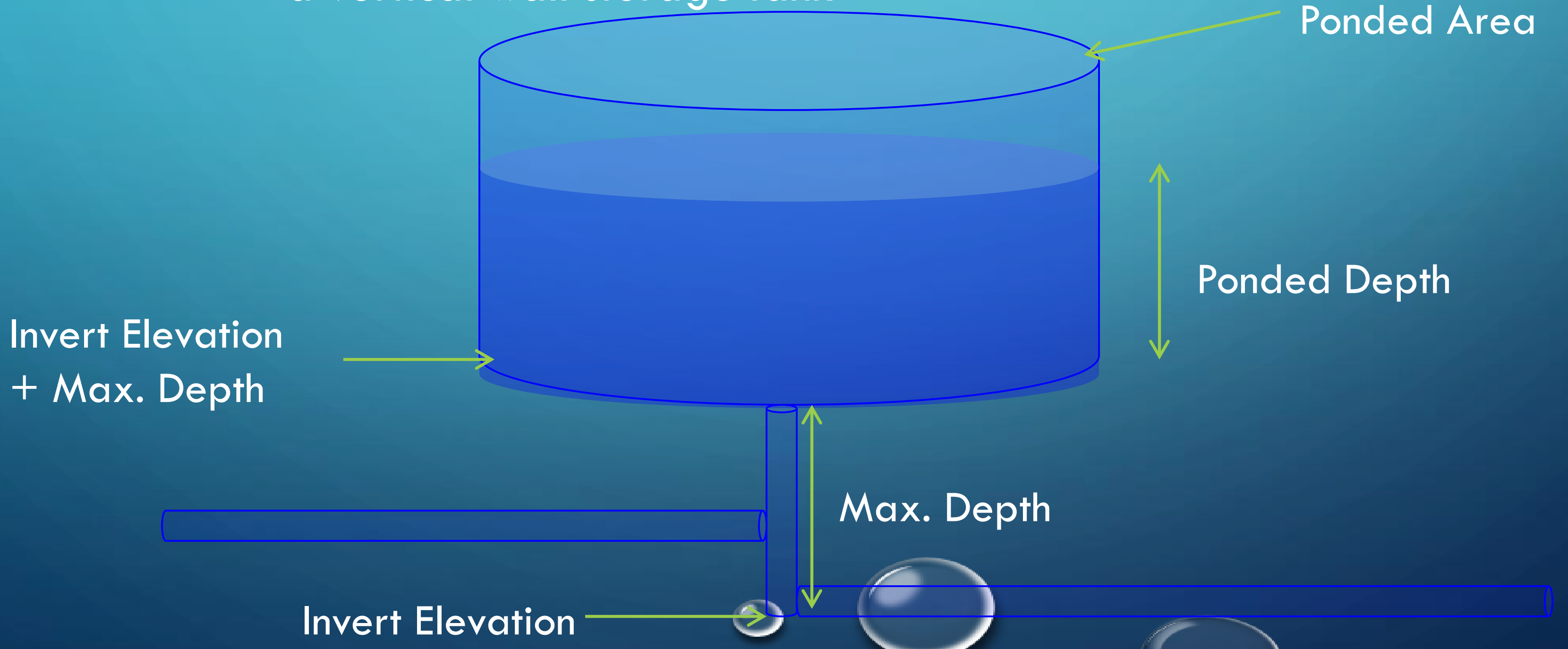
Node not flooded;
pipes are surcharged



Node flooded;
pipes are surcharged

JUNCTION (NODE)

- Flooded node attributes:
  - How deep is the flooding allowed (surcharge depth) above the top of the node
  - What is the ponded area during surcharge – treats the node as a vertical wall storage tank

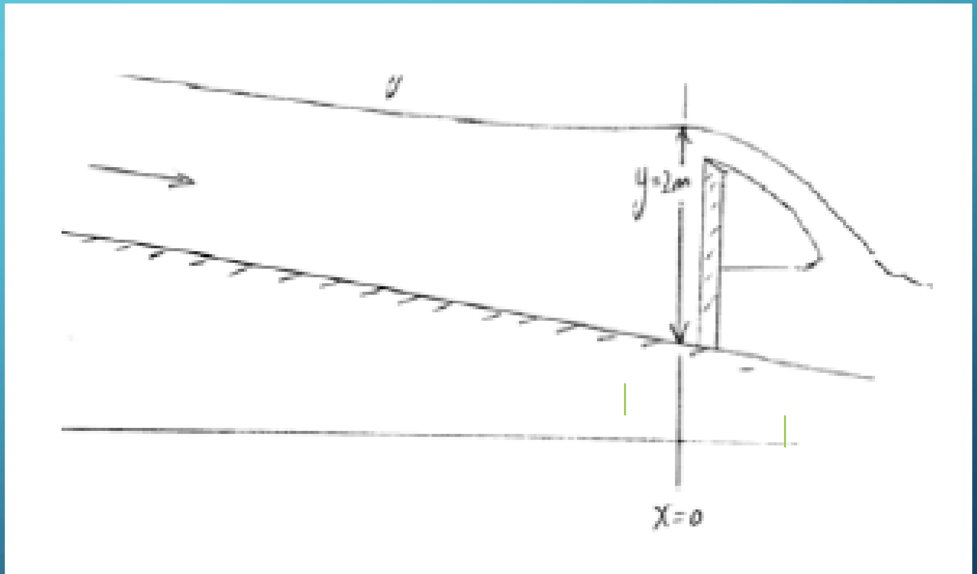


EXAMPLE 1 : RECTANGULAR CHANNEL

- Steady flow over a weir; depth at the weir is 2.0 meters.

  Determine the water surface profile for a distance 2000 meters upstream using SWMM.

Sketch:



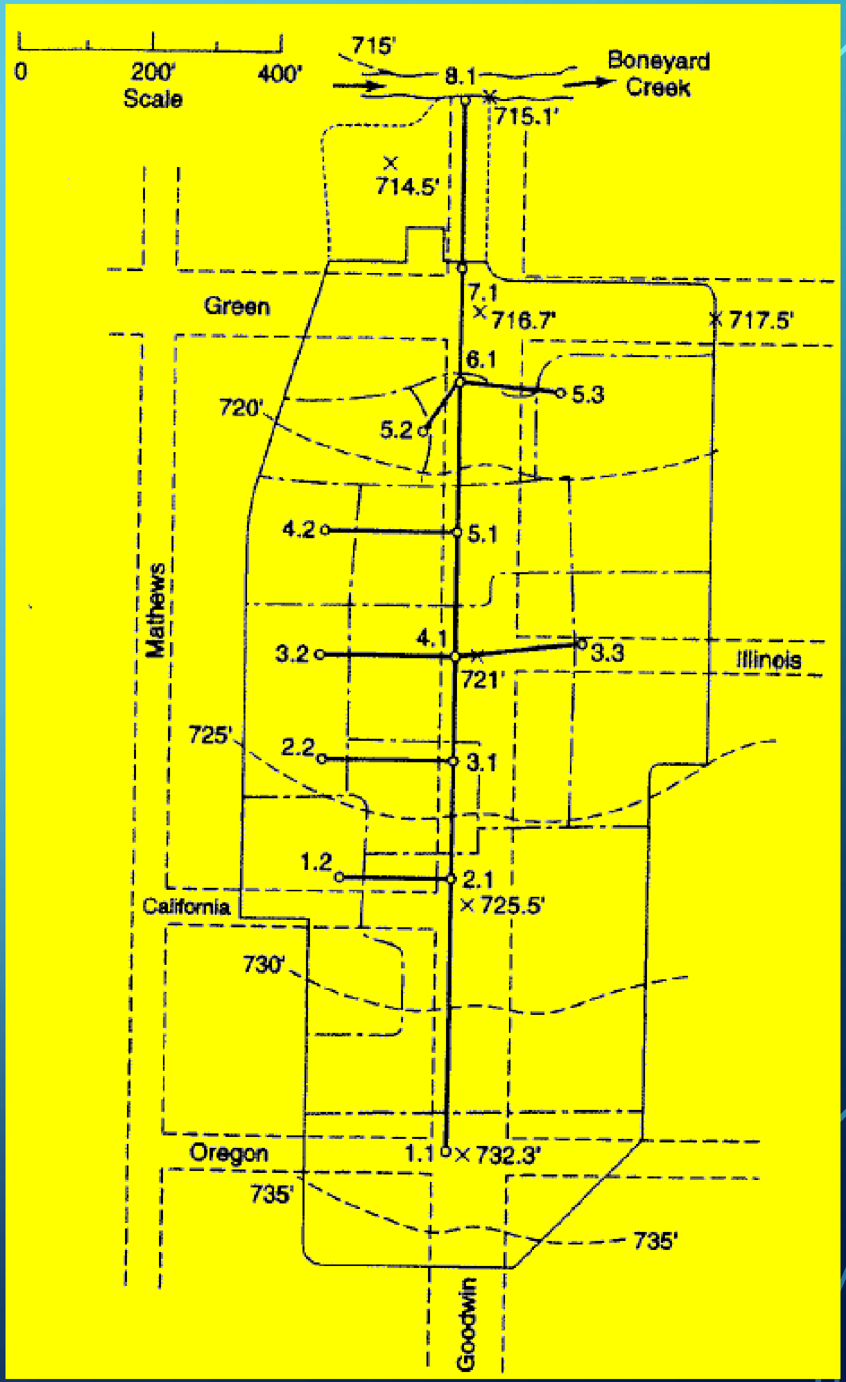
- Hydraulic Data:
  - Rectangular B = 1 m
  - Steady flow Q = 2.5 CMS
  - S_o = 0.001
  - n = 0.025
  - Δx = 200 meters
  - Outfall boundary == fixed

EXAMPLE 2 : FLOW IN A SEWER

- Discharge in a 3 mile long, 60-inch RCP sewer is 50 MGD. What is the flow depth if the entire sewer is on a 0.1% slope and the downstream boundary (outfall) is a normal depth condition?
  - Hydraulic Data:
    - Circular: 60-inches (5 feet)
    - Steady flow Q = 50 million gallons per day (MGD)
    - S_o = 0.001
    - n = 0.015
    - Δx = 2640 feet (use 6 links)
    - Outfall boundary == normal

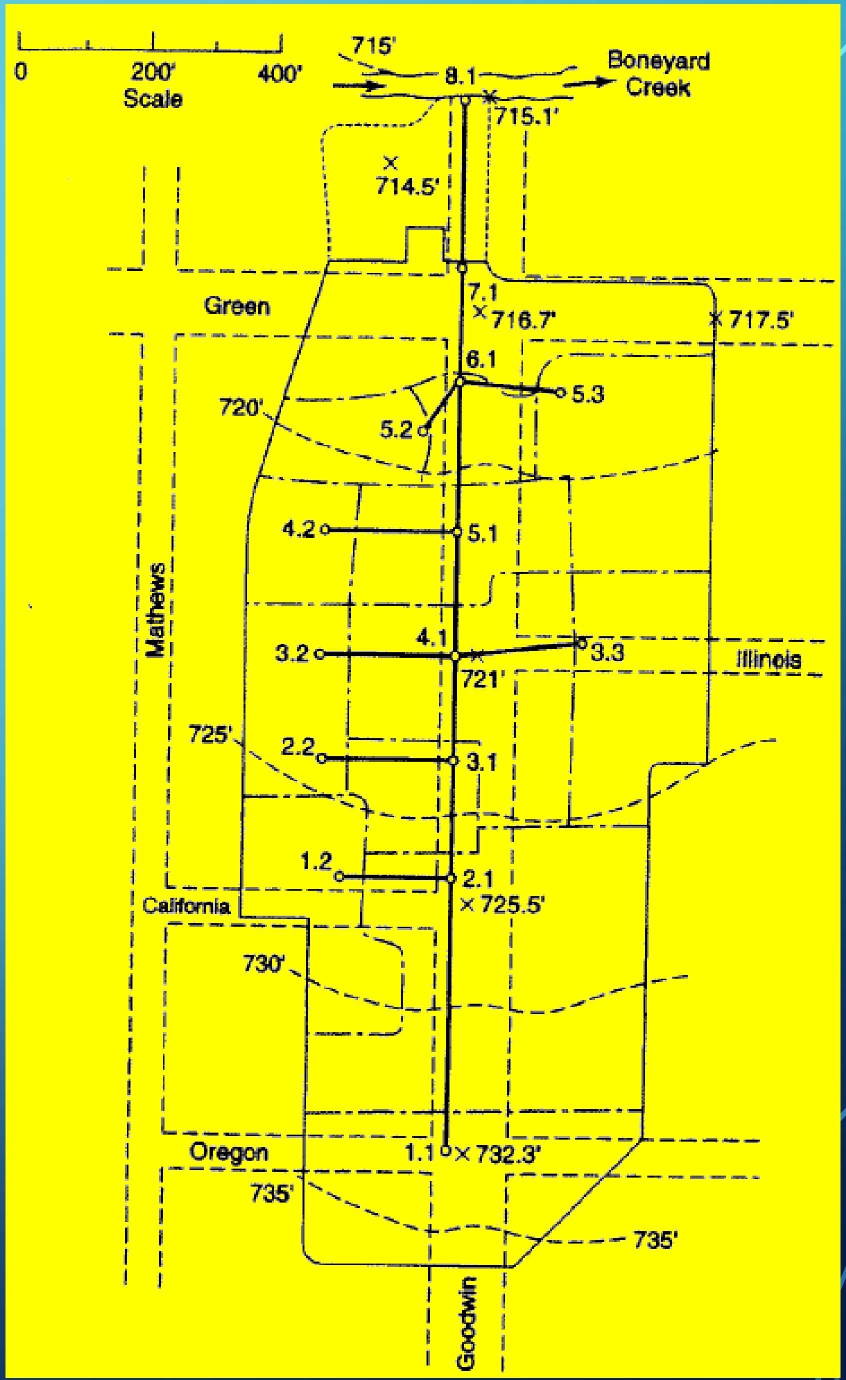
DESIGN STORM SEWER FOR GOODWIN STREET

- "Rational Method Storm Sewer Design" in Mays, L. W. (2008) Water Resources Engineering. Pearson-Prentice Hall (pp. 613-635)
- Method: Rational Equation Design Method
  to make initial design for subsequent hydraulics analysis



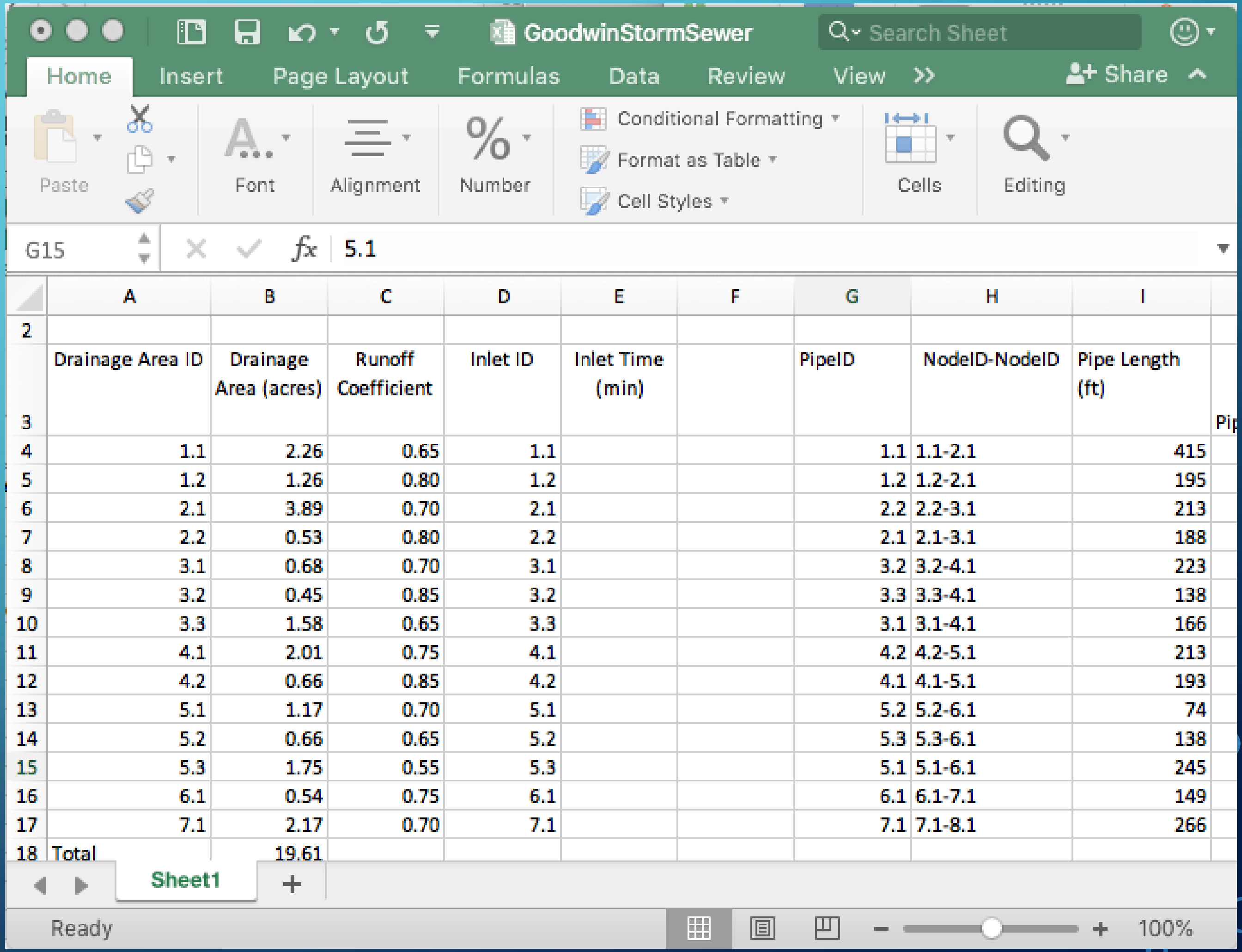
PREPARATION STEPS

- Identify the individual drainage areas.
- Determine the area of each contributing area, in acres. (ENGAUGE, PLANIMETER, etc)
- Determine the rational runoff coefficient for each area (TABLE LOOKUP)



GATHER THE INFORMATION INTO A SPREADSHEET

- Build a sheet with the information
- Note the naming convention (a bit awkward, but faithful to the original example)



	A	B	C	D	E	F	G	H	I
2									
3	Drainage Area ID	Drainage Area (acres)	Runoff Coefficient	Inlet ID	Inlet Time (min)		PipeID	NodeID-NodeID	Pipe Length (ft)
4	1.1	2.26	0.65	1.1			1.1	1.1-2.1	415
5	1.2	1.26	0.80	1.2			1.2	1.2-2.1	195
6	2.1	3.89	0.70	2.1			2.2	2.2-3.1	213
7	2.2	0.53	0.80	2.2			2.1	2.1-3.1	188
8	3.1	0.68	0.70	3.1			3.2	3.2-4.1	223
9	3.2	0.45	0.85	3.2			3.3	3.3-4.1	138
10	3.3	1.58	0.65	3.3			3.1	3.1-4.1	166
11	4.1	2.01	0.75	4.1			4.2	4.2-5.1	213
12	4.2	0.66	0.85	4.2			4.1	4.1-5.1	193
13	5.1	1.17	0.70	5.1			5.2	5.2-6.1	74
14	5.2	0.66	0.65	5.2			5.3	5.3-6.1	138
15	5.3	1.75	0.55	5.3			5.1	5.1-6.1	245
16	6.1	0.54	0.75	6.1			6.1	6.1-7.1	149
17	7.1	2.17	0.70	7.1			7.1	7.1-8.1	266
18	Total	19.61							

ESTIMATE PIPE SLOPES

- Use the node elevations and topographic map to estimate pipe slopes
- Populate the spreadsheet

Drainage Area ID	Drainage Area (acres)	Runoff Coefficient	Inlet ID	Inlet Time (min)	PipeID	NodeID-NodeID	Pipe Length (ft)	Pipe Slope
1.1	2.26	0.65	1.1	11	1.1	1.1-2.1	415	0.0200
1.2	1.26	0.80	1.2	9.2	1.2	1.2-2.1	195	0.0041
2.1	3.89	0.70	2.1	13.7	2.2	2.2-3.1	213	0.0180
2.2	0.53	0.80	2.2	5.2	2.1	2.1-3.1	188	0.0245
3.1	0.68	0.70	3.1	8.7	3.2	3.2-4.1	223	0.0175
3.2	0.45	0.85	3.2	5.9	3.3	3.3-4.1	138	0.0300
3.3	1.58	0.65	3.3	11.8	3.1	3.1-4.1	166	0.0104
4.1	2.01	0.75	4.1	9.5	4.2	4.2-5.1	213	0.0026
4.2	0.66	0.85	4.2	6.2	4.1	4.1-5.1	193	0.0041
5.1	1.17	0.70	5.1	10.3	5.2	5.2-6.1	74	0.0250
5.2	0.66	0.65	5.2	11.8	5.3	5.3-6.1	138	0.0060
5.3	1.75	0.55	5.3	17.6	5.1	5.1-6.1	245	0.0028
6.1	0.54	0.75	6.1	7.3	6.1	6.1-7.1	149	0.0030
7.1	2.17	0.70	7.1	14.5	7.1	7.1-8.1	266	0.0030
Total	19.61