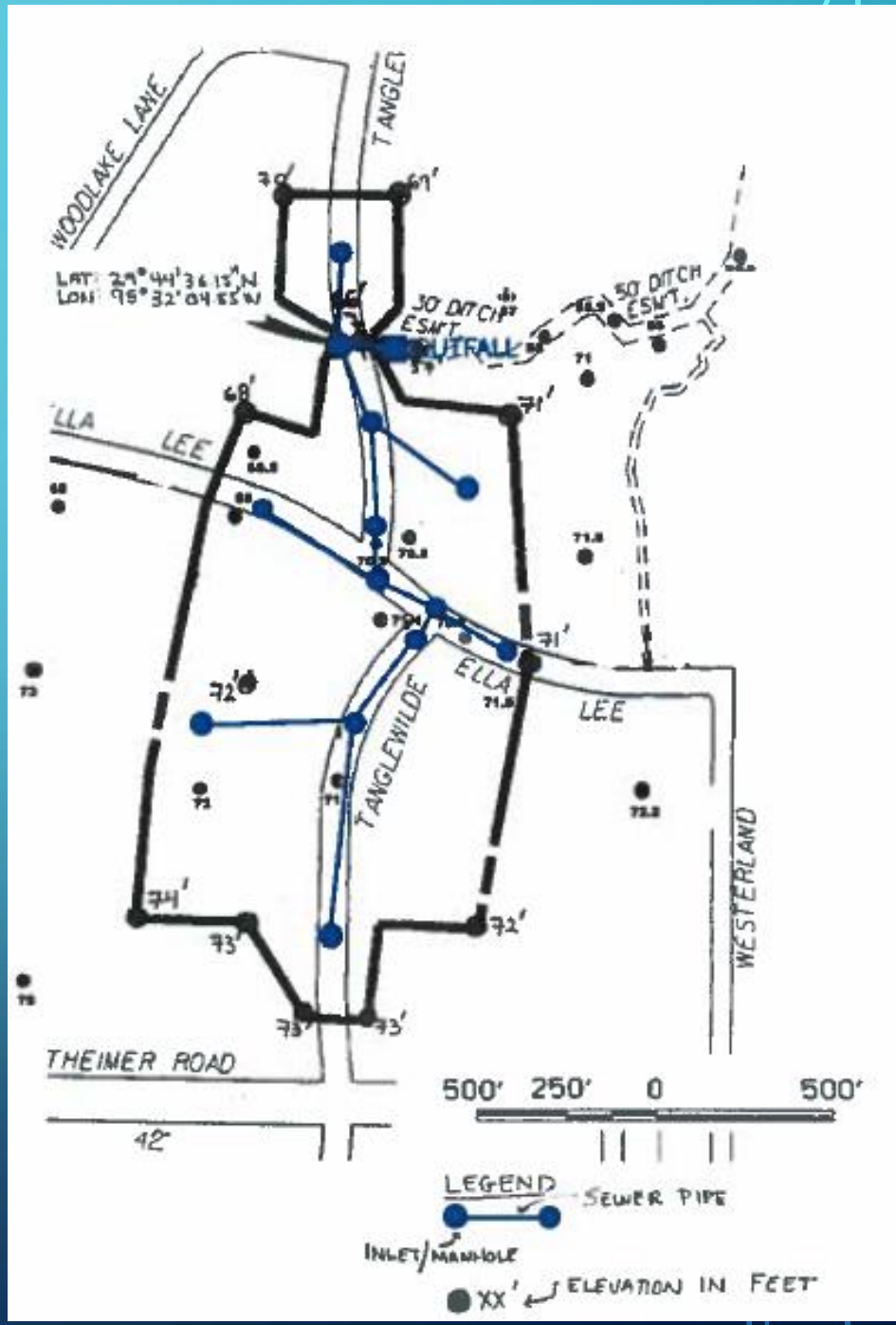
CE 3372 WATER SYSTEMS DESIGN

LESSON 19: STORM SEWER DESIGN EXAMPLE (TANGLEWILDE STORM SEWER)

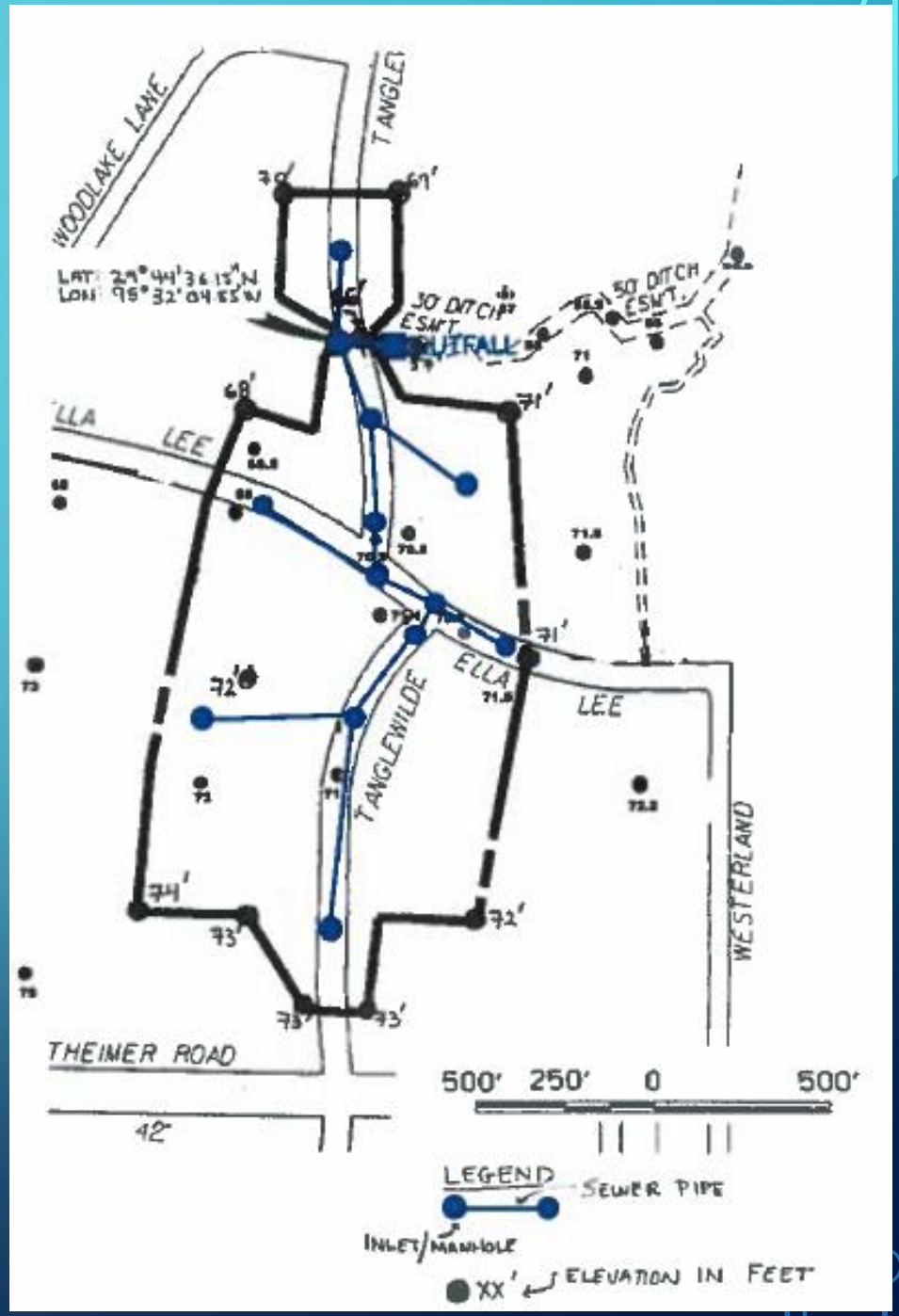
DESIGN STORM SEWER FOR TANGLEWILDE

- Method: Rational Equation Design Method to make initial design for subsequent hydraulics analysis
- Identical study area as ES-13



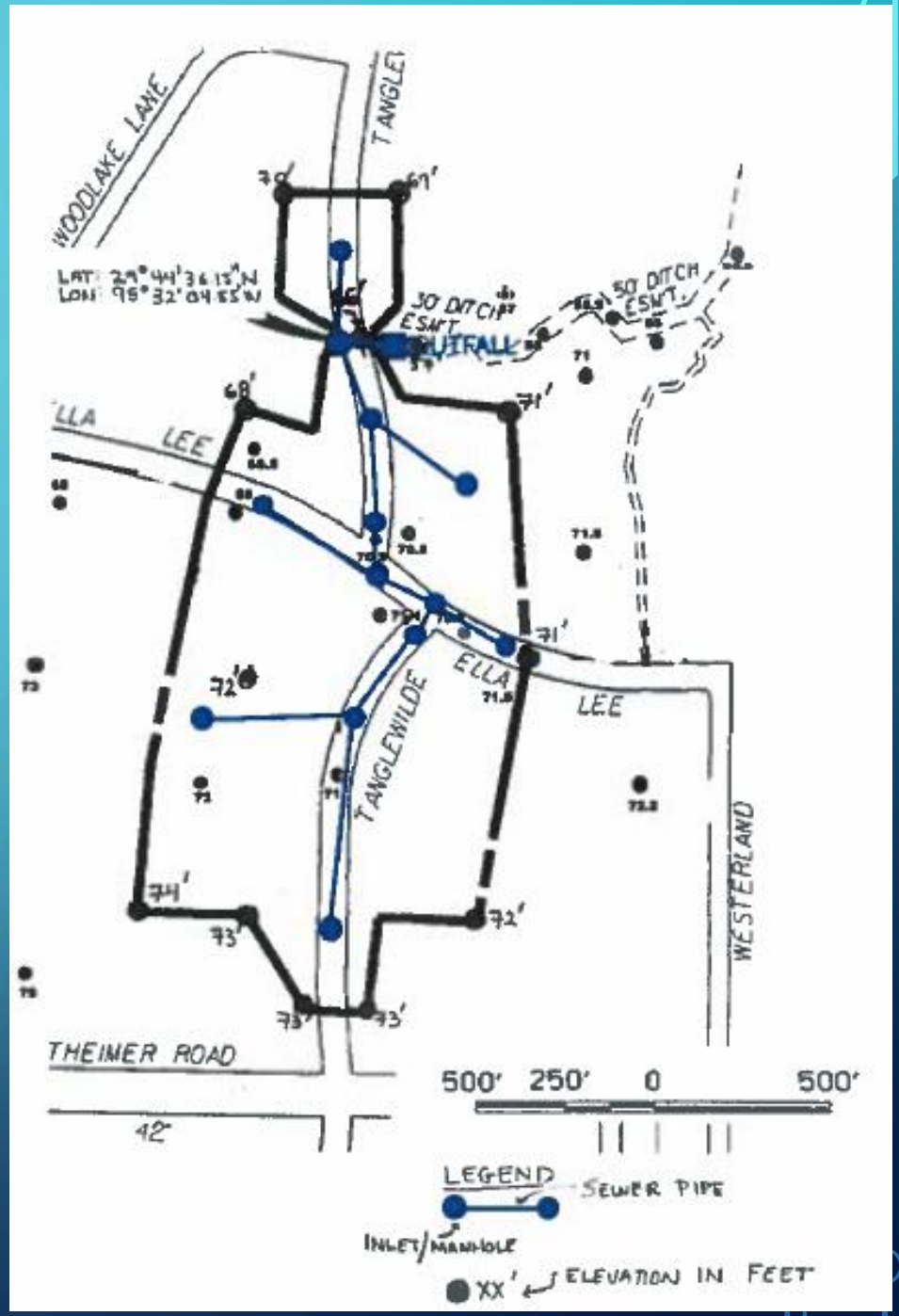
PREPARATION STEPS

- Apply (make) topographic map principles to identify drainage pattern(s)
- Identify the individual drainage areas based on the topographic map and sewer system layout.
- Determine the area of each contributing area, in acres. (ENGAUGE, PLANIMETER, etc)
- Determine the rational runoff coefficient for each area (TABLE LOOKUP)



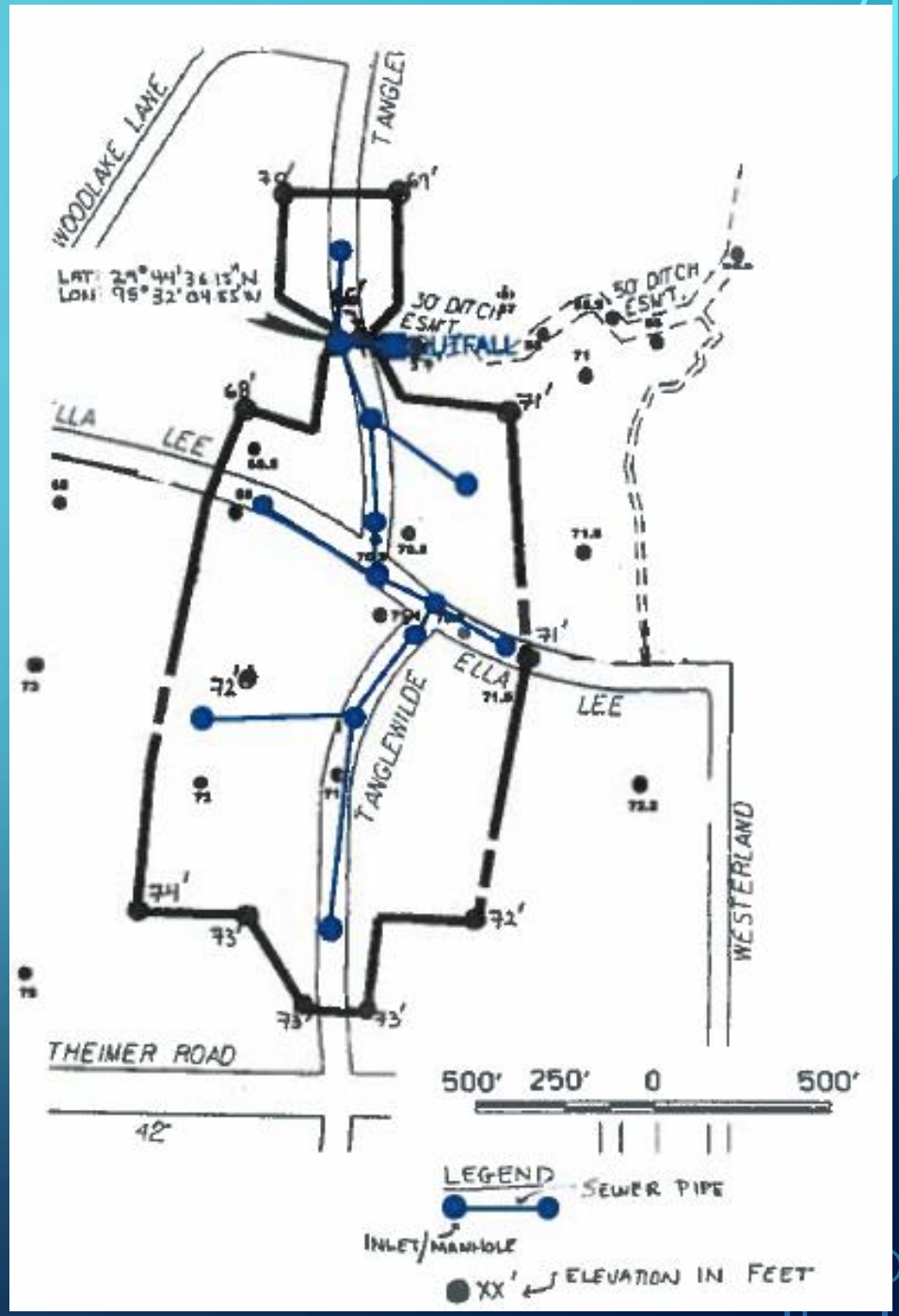
PREPARATION STEPS

- Determine inlet time for surface portion of drainage system.
- Determine rainfall intensity equation for Harris County.



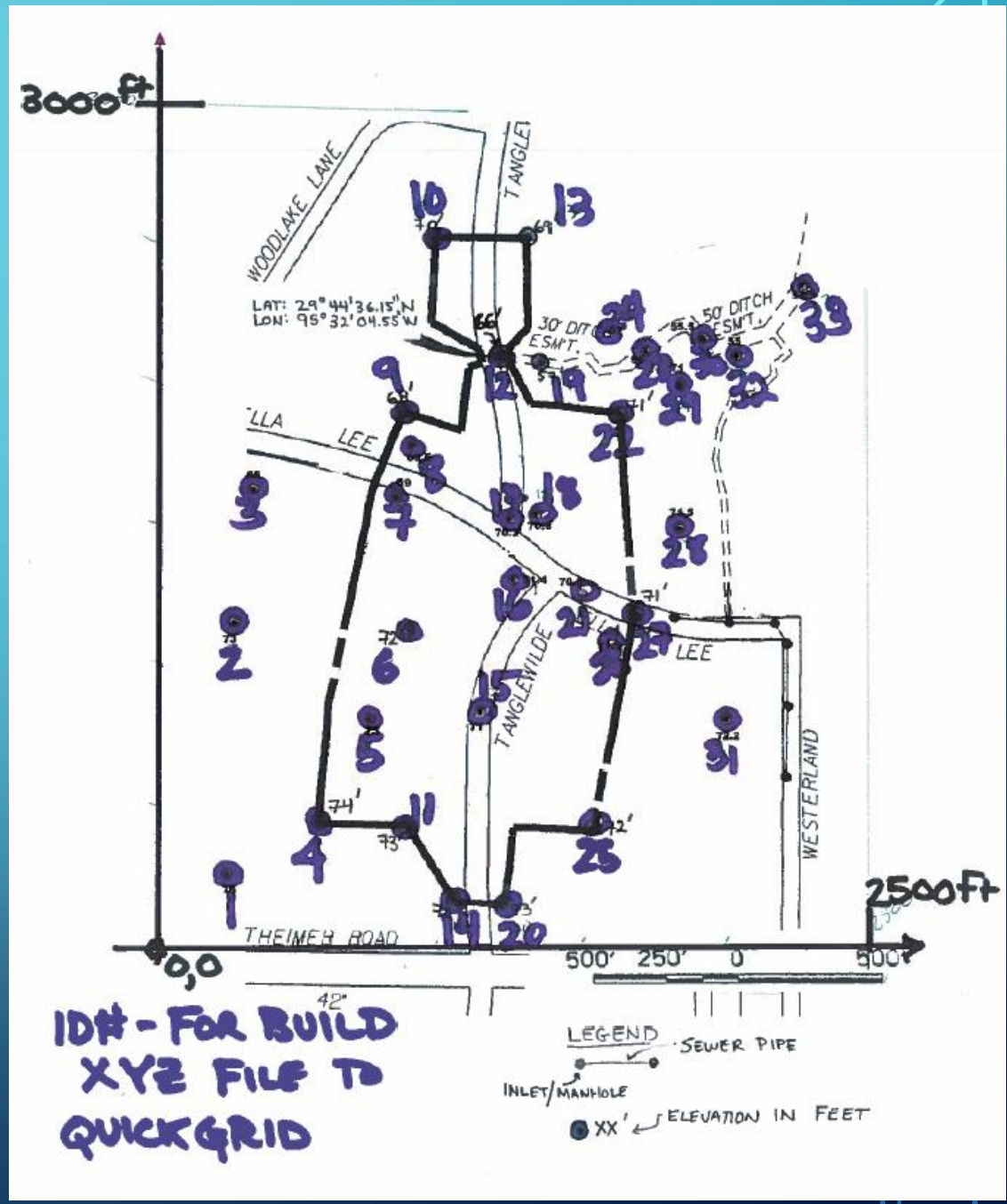
ANALYSIS STEPS

- Apply the intensity equation to the various surface drainage areas, and the accumulating area to size the conduits.
- Check invert elevations to fit into the useable vertical drop for the location
- Size the inlets using appropriate inlet hydraulics equations.



TOPOGRAPHIC MAP

- Locate the elevations and construct an XY coordinate system.



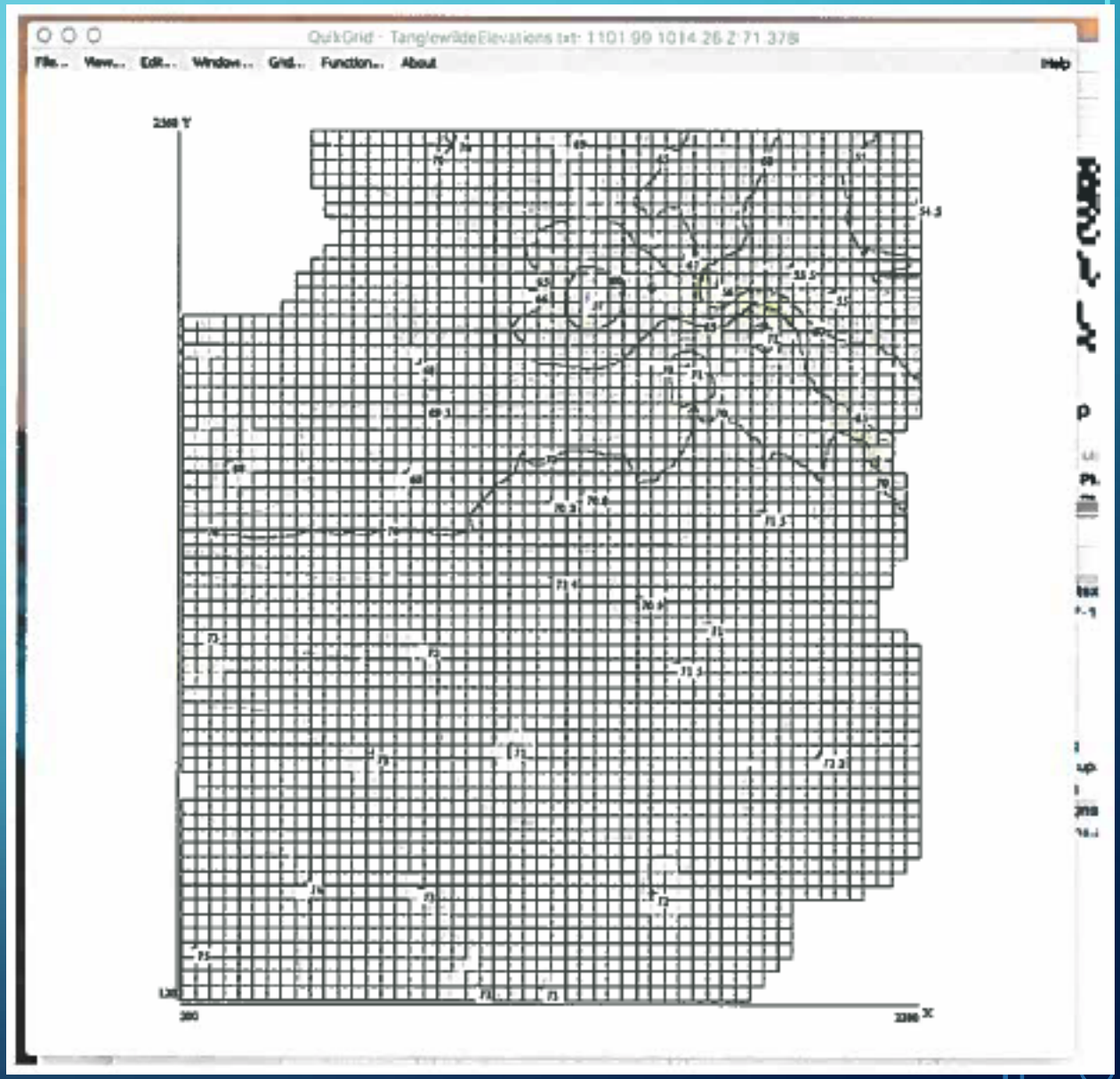
TOPOGRAPHIC MAP

- Use the XY-coordinate system and build an XYZ input file for topographic rendering.

	Tanglewilde Elevations								
ELEVATION SURVEY VALUES					METHOD(S)				
ID	X (FEET)	Y (FEET)	Z (FEET)		1) Use drawing and impose axes				
1	237.484279	263.09382	75		2) Locate X1,Y1				
2	260.879376	1158.93885	73		3) Locate X2,Y1				
3	332.144775	1633.90828	68		4) Locate X1, Y2				
4	554.122697	448.65323	74		5) Use G3DATA to capture x,y each point				
5	737.728288	815.072914	73		6) Manual enter z for each point based on collect order				
6	880.998109	1119.57212	72						
7	832.812956	1602.41018	69						
8	882.668563	1790.82685	69.5						
9	866.834237	1907.0222	68						
10	967.813595	2534.28453	70						
11	871.797496	430.252877	73						
12	1183.38082	2110.654	66						
13	1290.42541	2544.27839	69						
14	1028.15545	159.007068	73						
15	1126.33177	837.907403	71						
16	1240.80157	1310.25046	71.4						
17	1234.64451	1521.96078	70.2						
18	1328.54412	1542.51785	70.8						
19	1340.99381	2092.41894	57						
20	1218.73147	153.646749	73						
21	1484.9939	1253.19966	70.9						
22	1621.45072	1898.49764	71						
23	1706.6526	2130.76766	56						
24	1609.72694	2205.73866	67						
25	1527.34122	419.248873	72						
26	1595.18699	1067.19946	71.5						
27	1680.99234	1180.7081	71						
28	1829.31725	1490.36559	71.5						
29	1834.34173	2001.54801	71						
30	1912.21023	2177.02698	55.5						
31	1995.38308	808.61062	72.2						
32	2031.97563	2107.19589	55						
33	2266.97172	2359.96526	54.5						

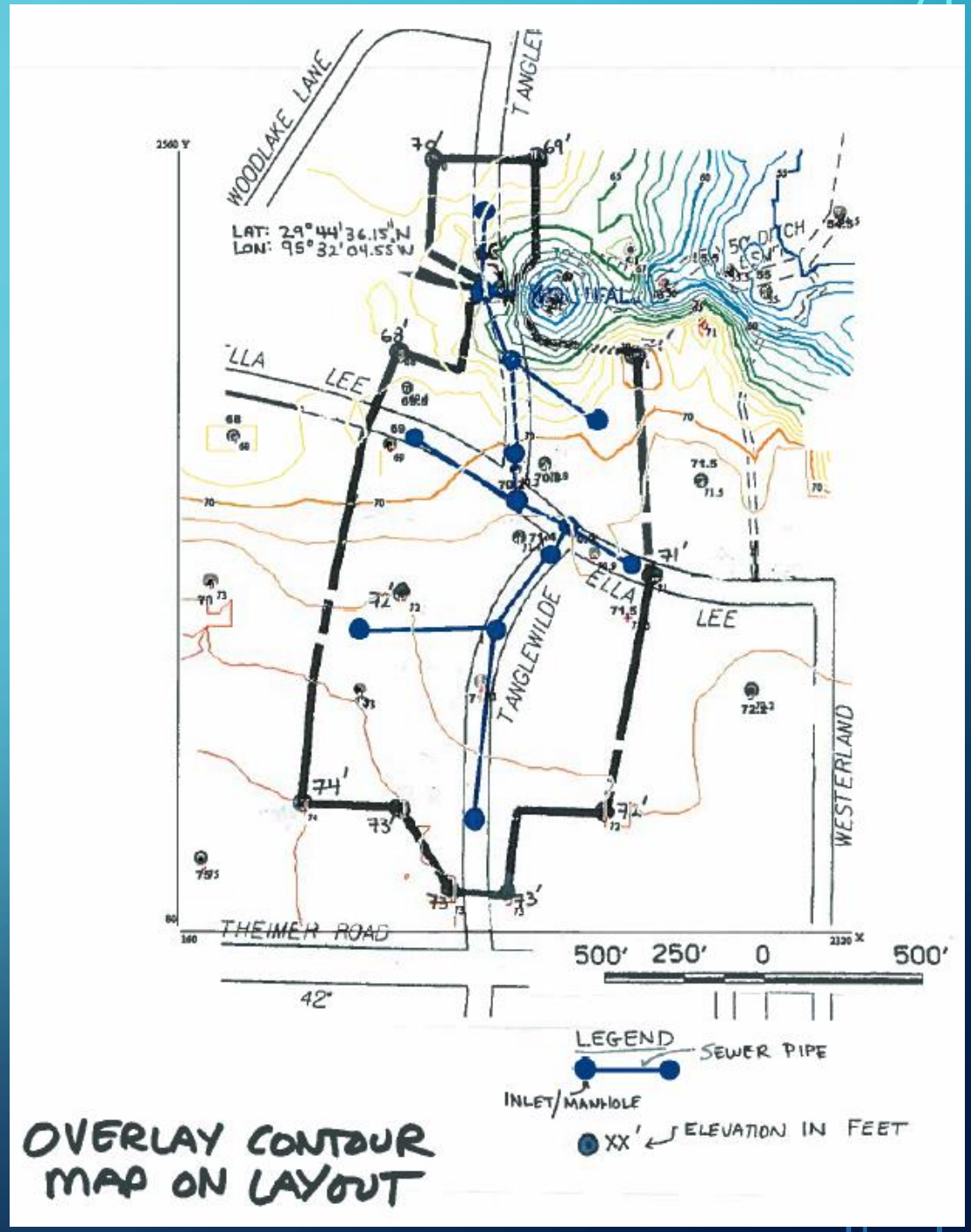
TOPOGRAPHIC MAP

- Render a topographic map using appropriate tools
  - By-hand; Excel, R-script
  - QuickGrid, Surfer, etc.
  - Arc GIS, qGIS, etc.
- Adjust settings to build an overlay



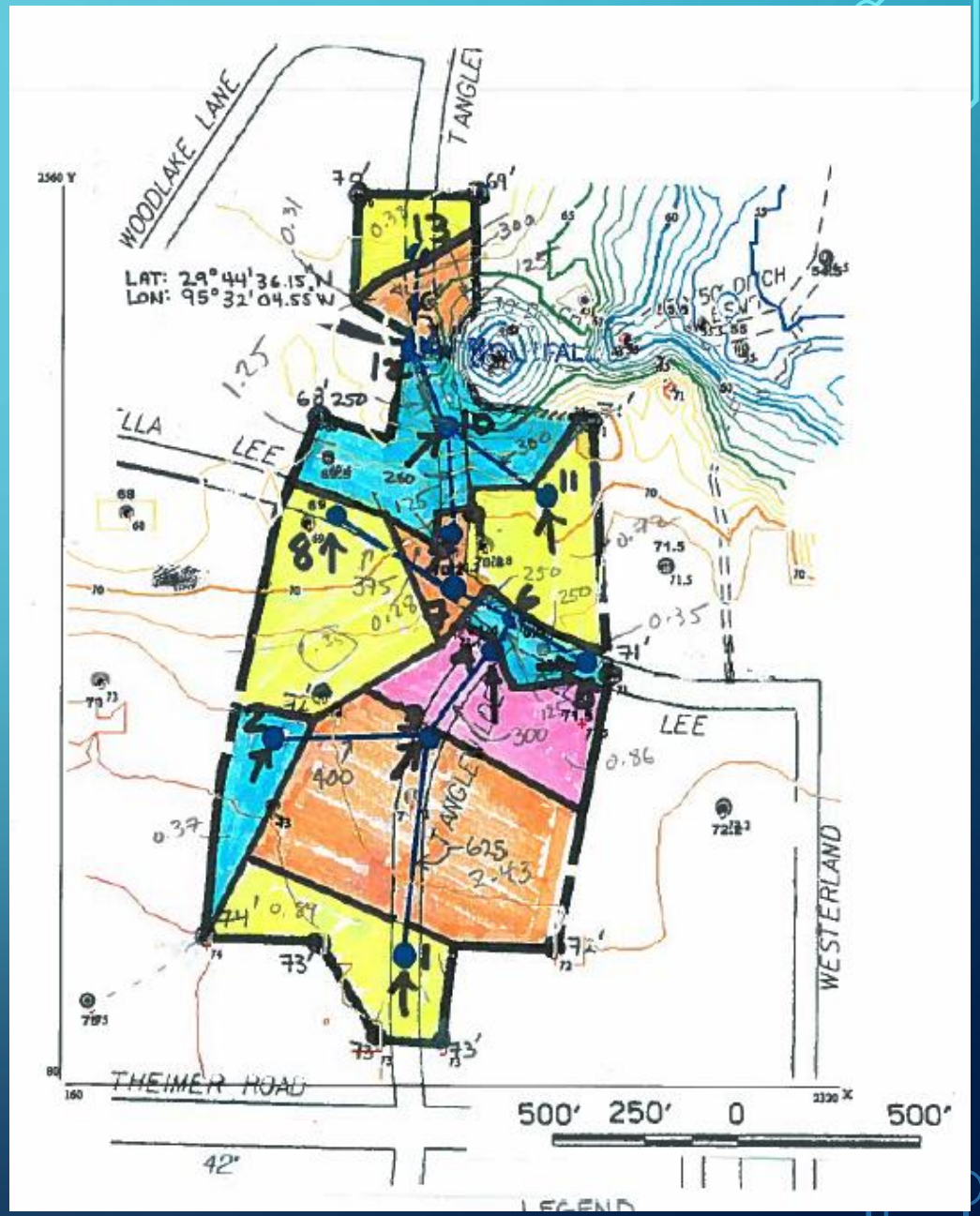
TOPOGRAPHIC MAP

- Overlay the map – use known data locations (in XY) to reference the overlay to the sewer drawing



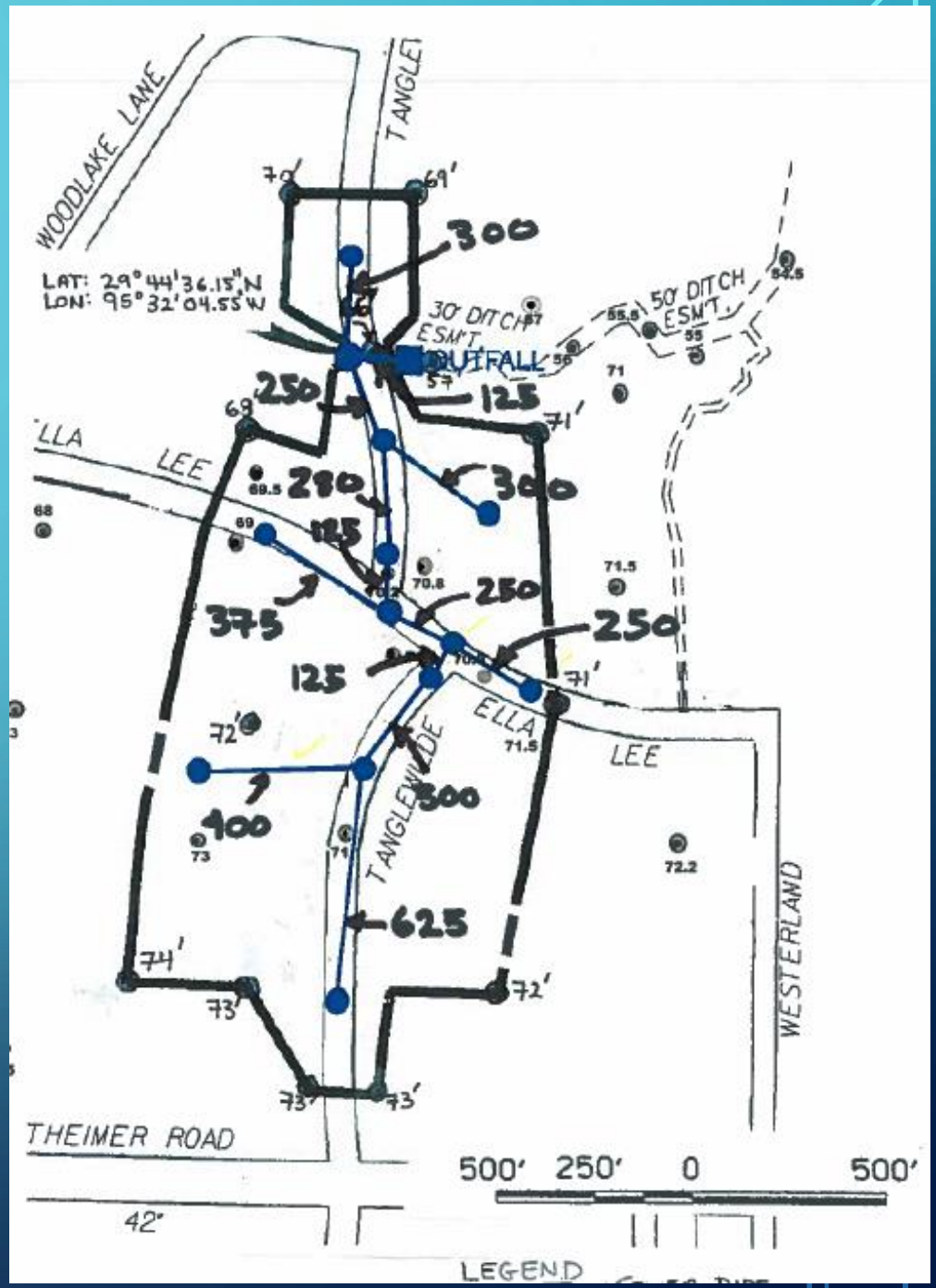
DETERMINE DRAINAGE AREAS

- Identify the individual drainage areas using the topographic rendering and the project layout drawing.
- We will assume that drainage from outside the project area is collected elsewhere
  - The figure to the right is intended as a guide to the method – the areas listed are not topographically justified; that is left as an exercise!



DETERMINE PIPE DISTANCES

- Identify the pipes to be sized in the drainage network
- Measure the pipe lengths



TABULATE PREPARATORY RESULTS

NODE-ARC DATA FROM ACROBAT

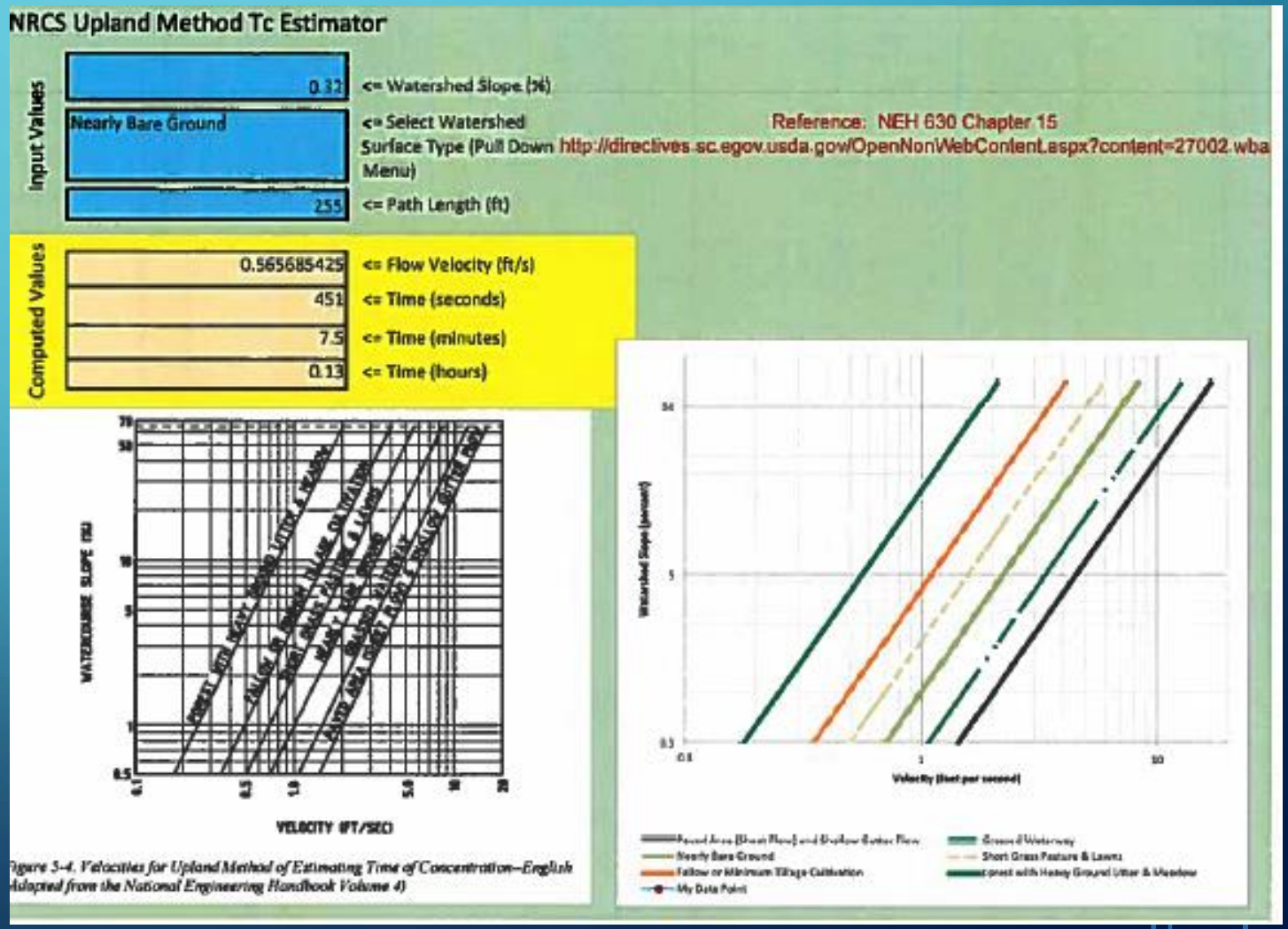
Node	Area (sq.in)	Area (sq. ft.)	Area (acres)		Overland Flow Distance (feet)	NRCS Upland Velocity (ft/sec)			Average Slope		
1	0.890	152920.962	3.511		391.051				Drop	2	feet
2	0.370	63573.883	1.459		252.139				Distance	625	feet
3	2.430	417525.773	9.585		646.162				Slope	0.0032	Dimensionless
4	0.860	147766.323	3.392		384.404				Slope	0.32	% Slope
5	0.350	60137.457	1.381		245.229						
6	0.000	0.000	0.000		0.000						
7	0.000	0.000	0.000		0.000						
8	1.350	231958.763	5.325		481.621						
9	0.280	48109.966	1.104		219.340						
10	1.250	214776.632	4.931		463.440						
11	0.720	123711.340	2.840		351.726						
12	0.310	53264.605	1.223		230.791						
13	0.380	65292.096	1.499		255.523						
14	--	--	36.250	Outfall							

USER UPLAND t_c ENTER NEXT SHEET

Pipe	Node_1	Node_2	Length
1	1	3	625
2	2	3	400
3	3	4	300
4	4	6	125
5	5	6	250
6	6	7	250
7	7	9	125
8	8	7	375
9	9	10	280
10	11	10	300
11	10	12	250
12	13	12	300
13	12	14	125

DETERMINE INLET TIMES

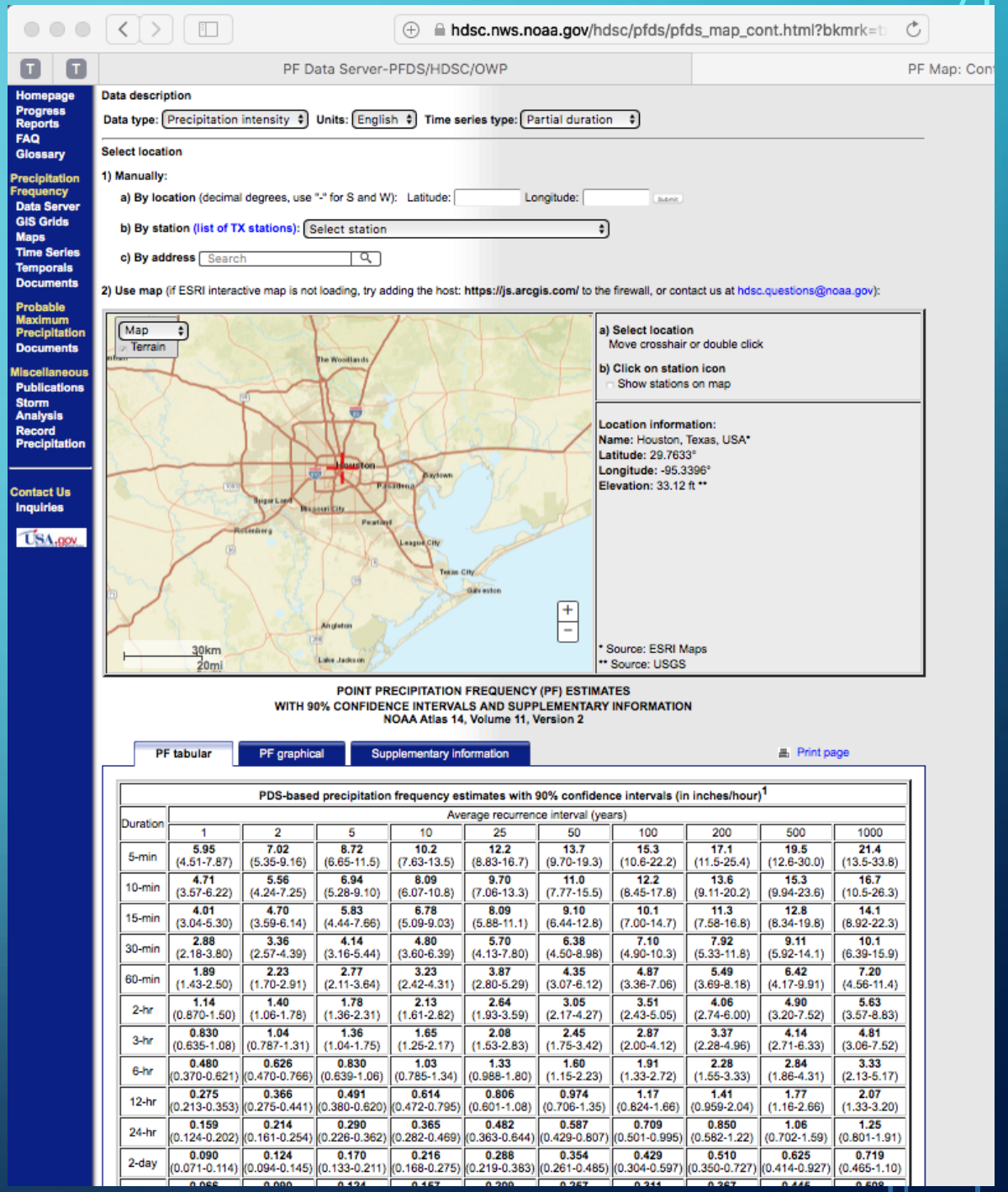
- Declare a travel distance on a drainage area to an inlet
- Determine slope along that path
- Apply a Tc estimation method
- Repeat for each inlet



DEVELOP AN INTENSITY EQUATION

- Locate the region on NOAA Atlas 14, Vol. 11 PFDS.
- Download the .CSV table
- Use solver to fit

$$I = \frac{B}{(T_c + D)^E}$$

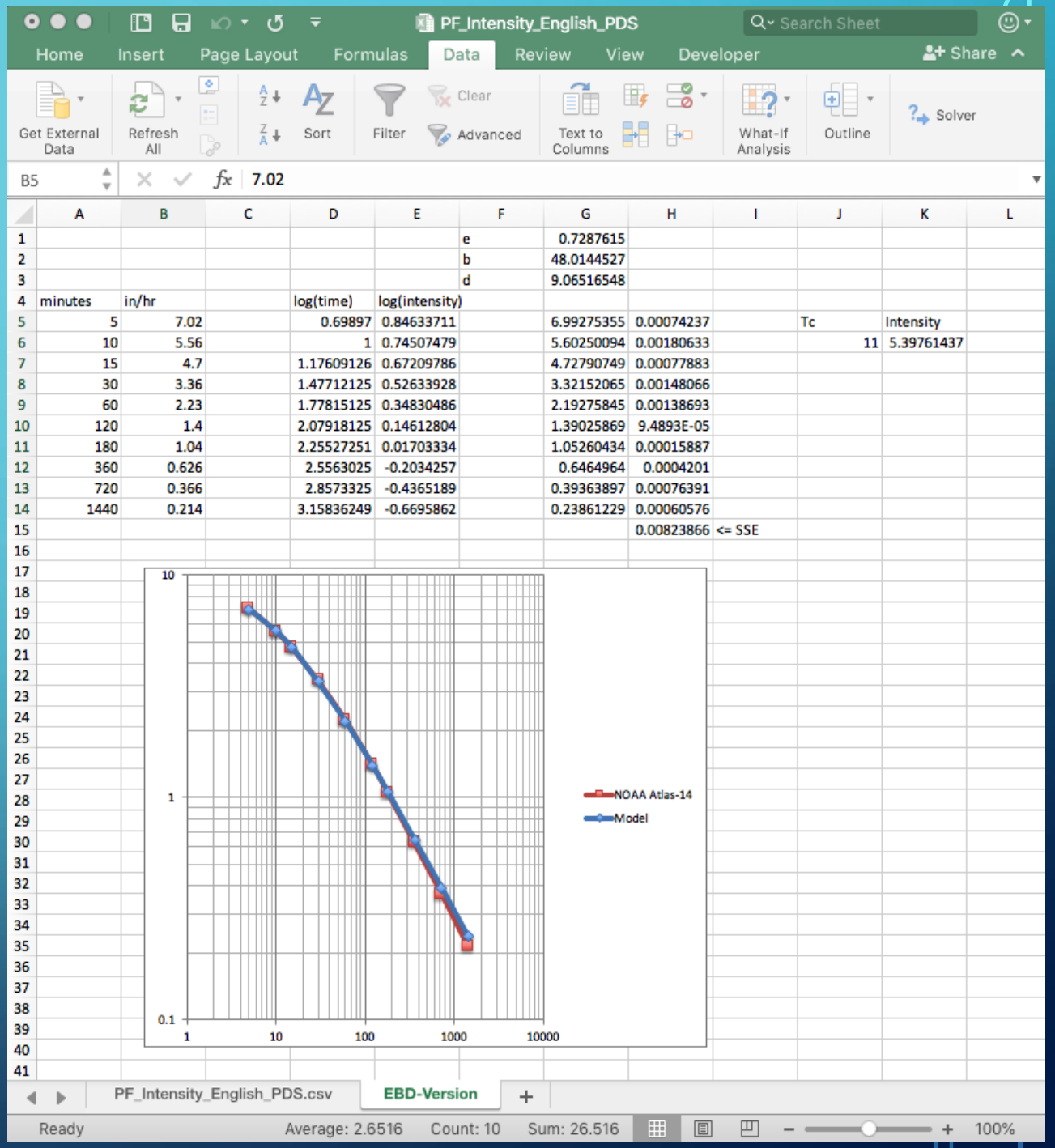


DEVELOP AN INTENSITY EQUATION

- Solver results for (2-yr ARI)

$$I = \frac{48.01}{(T_c + 9.06)^{0.73}}$$

- Use the above equation in the subsequent analysis
- Note: The exercise requests a design for 5-yr ARI, so readers will have to conduct the fitting exercise on the 5-yr column from NOAA Atlas 14!



	A	B	C	D	E	F	G	H	I	J	K	L
1						e	0.7287615					
2						b	48.0144527					
3						d	9.06516548					
4	minutes	in/hr		log(time)	log(intensity)							
5	5	7.02		0.69897	0.84633711		6.99275355	0.00074237		Tc	Intensity	
6	10	5.56		1	0.74507479		5.60250094	0.00180633		11	5.39761437	
7	15	4.7		1.17609126	0.67209786		4.72790749	0.00077883				
8	30	3.36		1.47712125	0.52633928		3.32152065	0.00148066				
9	60	2.23		1.77815125	0.34830486		2.19275845	0.00138693				
10	120	1.4		2.07918125	0.14612804		1.39025869	9.4893E-05				
11	180	1.04		2.25527251	0.01703334		1.05260434	0.00015887				
12	360	0.626		2.5563025	-0.2034257		0.6464964	0.0004201				
13	720	0.366		2.8573325	-0.4365189		0.39363897	0.00076391				
14	1440	0.214		3.15836249	-0.6695862		0.23861229	0.00060576				
15								0.00823866	<= SSE			

ANALYSIS

- Apply the intensity equation as needed