CE 3372 – Water Systems Design
Demand Estimation
Exercise Set 3

Exercise

1. Figure 4 is a layout of a hydraulic network model for the Somewhere USA subdivision. The blue line segments are pipes and are labeled (P1, P2, . . .). The blue circles are nodes and are labeled (N1, N2, . . .). The yellow polygons represent the lots assigned to each node; for example, node N2 supplies the six (6) lots located near the node.

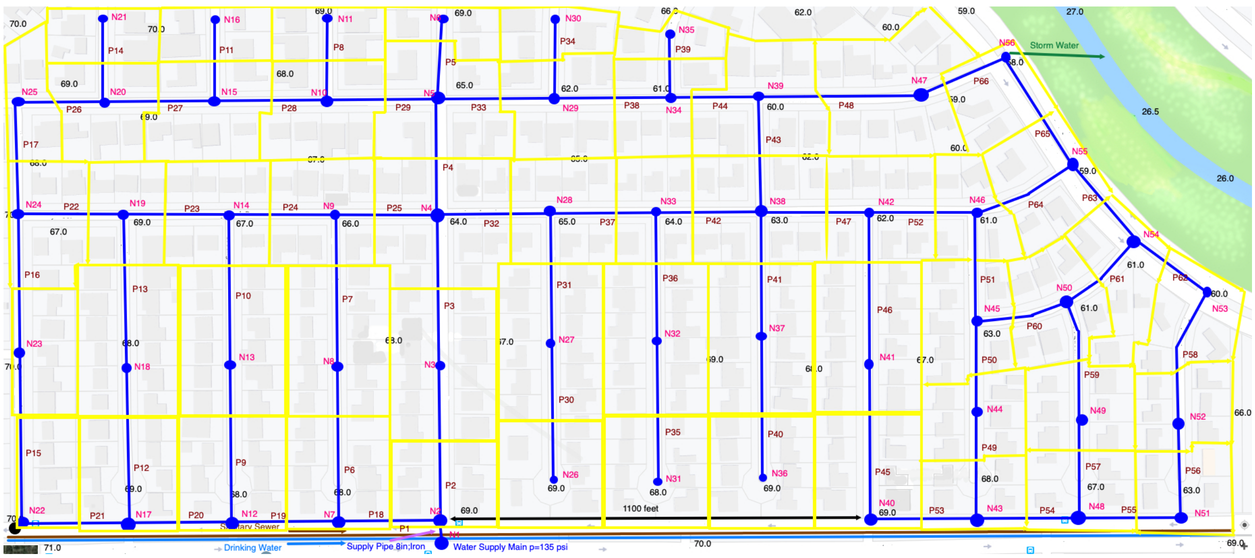

Figure 1: Hydraulic Model Network for Somewhere USA

a) Determine the number of lots served by each node, these will constitute the by-node service unit equivalent (SUE).

   This estimate is simply a matter of counting the ”houses” depicted in the drawing. I counted 355 lots - your values will be close (they should be the same, but I imagine there will be some variation but only a few lots)

b) Estimate the average daily demand (ADD), by-node, for distribution system using San Marcos, Texas water system design guidelines.

   This estmate uses guidance in Figure 2, which is 0.24 gpm/SUE

c) Estimate the maximum daily demand (MDD), by-node, for the distribution system using San Marcos, Texas water system design guidelines.

This estmate uses guidance in Figure 2, which is 0.70 gpm/SUE

d) Estimate the maximum daily demand (MDD) + fire flow, by-node for the distribution system using San Marcos, Texas water system design guidelines.

This estimate requires locating fire hydrants on the drawing (not supplied). For simplicity in planning apply the following parts of the San Marcos manual:

First consider flow per hydrant - it is unlikely the whole area will be on fire at once (unless it is in Los Angeles in January 2025) but a decent worst case would be 1000 gpm/hydrant (which should nicely oversize a system). The alternative is to find the ISO standards that are appliciable and use them, but the supplied information is pretty sparse for this application.

1.4 Water Design Demands

The developer's engineer is responsible for sizing all new waterlines within the development and submitting these sizing calculations to the City for acceptance. The developer's engineer will recommend one of the following 3 methods to City Staff for sizing. The final decision will be made by City Staff on which method shall be used.

a) Sizing of off-site waterlines shall conform to the Water Distribution System Master Plan, where applicable.
b) In other instances, computer modeling is the required method for sizing water lines.
c) The minimum requirement is for the design engineer to submit hand calculations justifying the size of the proposed waterlines.

The following criteria are to be used in sizing new waterlines.

Table 1: Design Parameters

Hazen Williams Coefficient (PVC)	150
Hazen Williams Coefficient (DI)	130
Service Unit Equivalent (SUE)[1]	
Single-family residential	1.0 SUE per unit
Multi-family residential	0.66 SUE per unit
Average Day Demand	0.24 gal/min/SUE
Maximum Day Demand	0.70 gal/min/SUE
Peak Hour Demand	0.4 gal/min/SUE
Maximum Pressure	110 psi
Minimum Pressure[2]	35 psi
Note 1 *Refer to General Code of Ordinance Chapter 86 Article 5: DIVISION 4. - IMPACT FEE ORDINANCE OF THE SAN MARCOS CITY CODE for required SUE parameters.*	
Note 2 *Lines shall be sized to provide for either the peak hour demand plus a fire flow demand. Fire flows shall conform to Insurance Standards Office (ISO) standards. The fire marshal has identified minimum fire flow requirements based on type of construction for use in determining line sizing. In all instances, a minimum fire flow of 1000 gpm will be required for design purposes. When the City determines that a waterline needs to be larger than required to facilitate future services in the area, the City may require that a waterline may be oversized.*	

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Figure 2: Fire Flow guidelines - here we interpret as 1000 gpm/hydrant as a conservative value

Our next part is to determine the hydrant locations (for a demand estimate - actual locations are more complex). In the same manual a spacing specification states that all parts of the area should be within 500 feet of a hydrant (using a Manhattan distance definition, which is not the same as the usual cartesian distance we usually use).

1.10 Fire Hydrants

1.10.1 Spacing

Table 3: Fire Hydrant Spacing

Dwelling Type	Spacing (Feet)	Remarks
Single Family Residential Development or Single Family Duplex	500	Additional fire hydrants shall be installed as necessary, so that every portion of every building in the EJT will be within 500 feet of a standard city fire hydrant, measured along accessible approved roadways.
All Others	300	

1.10.2 Locations

The location of all public fire hydrants shall meet the following criteria:

- Fire hydrants shall be located as near to the street intersections as possible but out of the radius of curb turnouts, within 1.5' to 12' behind curb or projected future curb.
- Fire hydrant locations between street intersections shall be at the projection of a property line between owners.
- New fire hydrants shall be placed as close to the location of the existing fire hydrant to be replaced as possible.
- Rail lines, controlled access highways, divided roadways, fences and walls will inhibit laying the fire hose in the most direct route and must be considered as barriers when determining whether a structure is within 500 feet of a hydrant.
- Fire hydrants shall be located at all low points on transmission lines per detail 511-BH-SM.
- Fire hydrants shall not be installed within nine feet vertically or horizontally of any wastewater main, wastewater lateral, or wastewater service line regardless of construction.

Figure 3: Fire Hydrant spacing guidelines

Using the spacing guidelines (and some practical judgement on how hard it might be to drag a firehose 500 feet we can identify hydrant locations for the purpose of estimating demand.

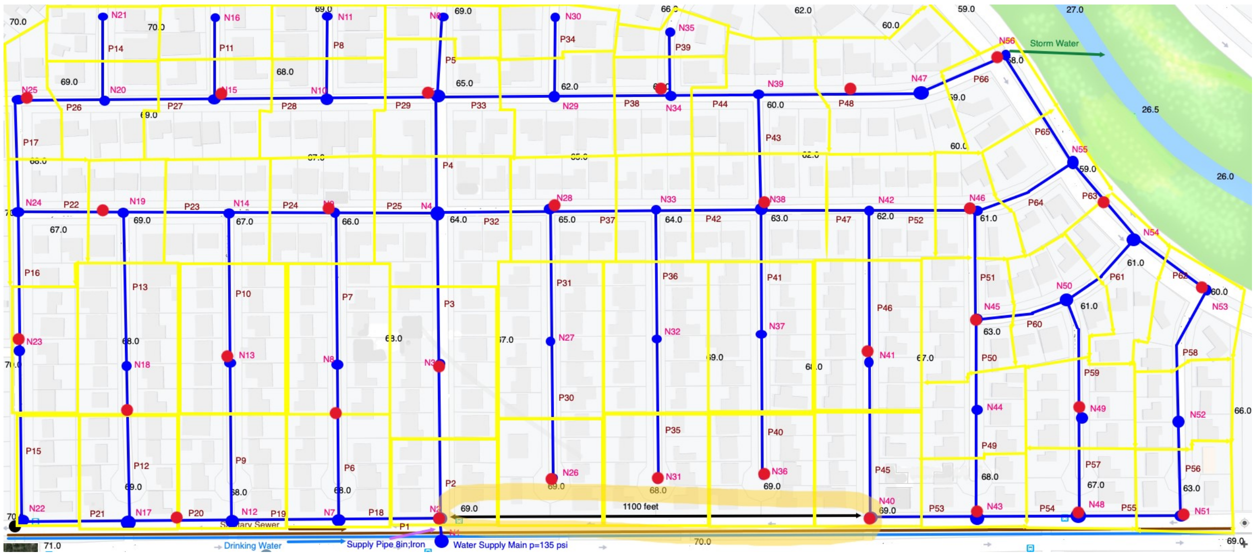

Figure 4: Hydrant locations (for fire flow estimation)

The few hydrants not colocated with a node would be either assigned to the nearest node or distributed to the two nearest nodes. I choose the later approach.

e) Estimate the peak hourly demand (PHD), by-node, for the distribution system using San Marcos, Texas water system design guidelines.

   This estmate uses guidance in Figure 2, which is 0.40 gpm/SUE

Use your estimates to produce a completed version of Table 1. Save the table (in a file) – you will need it later in another homework problem.

Table 1: Node Demands for Somewhere USA Distribution System

Node	SUE	ADD	MDD	Fire	Fire+MDD	PHD
N1	0					
N2	6	1.44	4.2	1000	1004.2	2.4
N3	12	2.88	8.4	1000	1008.4	4.8
N4	10	2.4	7		7	4.0
N5	5	1.2	3.5	1000	1003.5	2.0
N6	3	0.72	2.1		2.1	1.2
N7	7	1.68	4.9	500	504.9	2.8
N8	12	2.88	8.4	500	508.4	4.8
N9	7	1.68	4.9	1000	1004.9	2.8
N10	6	1.44	4.2		4.2	2.4
N11	4	0.96	2.8		2.8	1.6
N12	8	1.92	5.6		5.6	3.2
N13	12	2.88	8.4	1000	1008.4	4.8
N14	7	1.68	4.9		4.9	2.8
N15	6	1.44	4.2	1000	1004.2	2.4
N16	4	0.96	2.8		2.8	1.6
N17	8	1.92	5.6	1000	1005.6	3.2
N18	12	2.88	8.4	500	508.4	4.8
N19	5	1.2	3.5	1000	1003.5	2.0
N20	5	1.2	3.5		3.5	2.0
N21	4	0.96	2.8		2.8	1.6
N22	4	0.96	2.8		2.8	1.6
N23	5	1.2	3.5	1000	1003.5	2.0
N24	5	1.2	3.5		3.5	2.0
N25	3	0.72	2.1	1000	1002.1	1.2
N26	6	1.44	4.2	1000	1004.2	2.4
N27	12	2.88	8.4		8.4	4.8
N28	7	1.68	4.9	1000	1004.9	2.8
N29	5	1.2	3.5		3.5	2.0
N30	3	0.72	2.1		2.1	1.2
N31	8	1.92	5.6	1000	1005.6	3.2
N32	12	2.88	8.4		8.4	4.8
N33	5	1.2	3.5		3.5	2.0
N34	5	1.2	3.5	1000	1003.5	2.0
N35	2	0.48	1.4		1.4	0.8

Table 2: Node Demands for Somewhere USA Distribution System (Continued)

Node	SUE	ADD	MDD	Fire	Fire+MDD	PHD
N36	8	1.92	5.6	1000	1005.6	3.2
N37	12	2.88	8.4		8.4	4.8
N38	8	1.92	5.6	1000	1005.6	3.2
N39	7	1.68	4.9	500	504.9	2.8
N40	8	1.92	5.6	1000	1005.6	3.2
N41	12	2.88	8.4	1000	1008.4	4.8
N42	7	1.68	4.9		4.9	2.8
N43	4	0.96	2.8	1000	1002.8	1.6
N44	6	1.44	4.2		4.2	2.4
N45	7	1.68	4.9	1000	1004.9	2.8
N46	4	0.96	2.8	1000	1002.8	1.6
N47	9	2.16	6.3	500	506.3	3.6
N48	4	0.96	2.8	1000	1002.8	1.6
N49	6	1.44	4.2	1000	1004.2	2.4
N50	6	1.44	4.2		4.2	2.4
N51	4	0.96	2.8	1000	1002.8	1.6
N52	6	1.44	4.2		4.2	2.4
N53	3	0.72	2.1	1000	1002.1	1.2
N54	4	0.96	2.8	500	502.8	1.6
N55	3	0.72	2.1	500	502.1	1.2
N56	2	0.48	1.4	1000	1001.4	0.8
Totals:	355	85.2	248.5	29500	29748.5	142