SYSTEM ID: EPANET Net 3

NARRATIVE DESCRIPTION

The EPANET Net 3 system is based on the North Marin Water District (NMWD) in Novato, CA. NMWD serves a population of around 64,000 people over an area of about 100 mi^2. The system has an average demand of 4.9 MGD. The network was used by Clark et al., (1994) as part of a water quality study of the system (one of the very first in the country) and employed a relatively new computer program developed by Lew Rossman with EPA called EPANET(1994). A general schematic of the system is shown below. The system had two raw water sources (represented by the square reservoirs in the schematic), two pump stations at the water sources, and three elevated storage tanks. The first of these sources is the North Marin Aqueduct which conveys water from the Russian river. It supplies water continuously while the second source, Stafford Lake, is used only during dry periods.

NETWORK SCHEMATIC:

HISTORY OF THE NETWORK FILE

The network was first published by Clark et al (1994), since then it has been frequently used for water quality, chlorine residual, and disinfection byproduct formation modelling in literature. The original citation and abstract are listed below.

ORIGINAL REFERENCE:

Clark, Robert M., Lewis A. Rossman, and Larry J. Wymer. (1995). Modeling distribution system water quality: Regulatory implications. *Journal of water resources planning and management*, 121(6), 423-428. DOI: 10.1061/(ASCE)0733-9496(1995)121:6(423).

ABSTRACT: Passage of the Safe Drinking Water Act in 1974 and its Amendments in 1986 (SDWAA) is changing the way water is treated and delivered in the United States. Under the SDWAA the U.S. Environmental Protection Agency (EPA) is required to regulate chemical contaminants and pathogenic microorganisms in drinking water. Emphasis has shifted from a primary concern with treated drinking water to attainment of standards at the point of consumption. Two regulations promulgated under the SDWAA, the Surface Water Treatment Rule (SWTR) and the Total Coliform Rule (TCR) specify treatment and monitoring requirements that must be met by all public water suppliers. This paper will examine the effect of various system variables on chlorine residual propagation. A recently proposed model (EPANET) will be utilized to examine the extent of fluid velocity and pipe radius on chlorine demand. The effect of these variables on the maintenance of chlorine residuals will be demonstrated. It will be shown that the same variables that affect the propagation of chlorine residual levels can potentially affect disinfection efficacy and the formation of disinfection byproducts.

ADDITIONAL REFERENCES:

Rossman, L, L A. EPANET USERS MANUAL. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-94/057 (NTIS PB94-165610), 1994.

ADDITIONAL CITATIONS:

The original publication of Clark et. al., (1994) and by inference the EPANET Net 3 system has been cited by 46 additional authors. These may be accessed by moving your cursor over the following link while simultaneously depressing the CTRL key on your keyboard: 46 Citations. The additional publication by Clark et al., (1995) has been cited by 122 additional authors which may be accessed here: 122 Citations

AVAILABLE INFORMATION

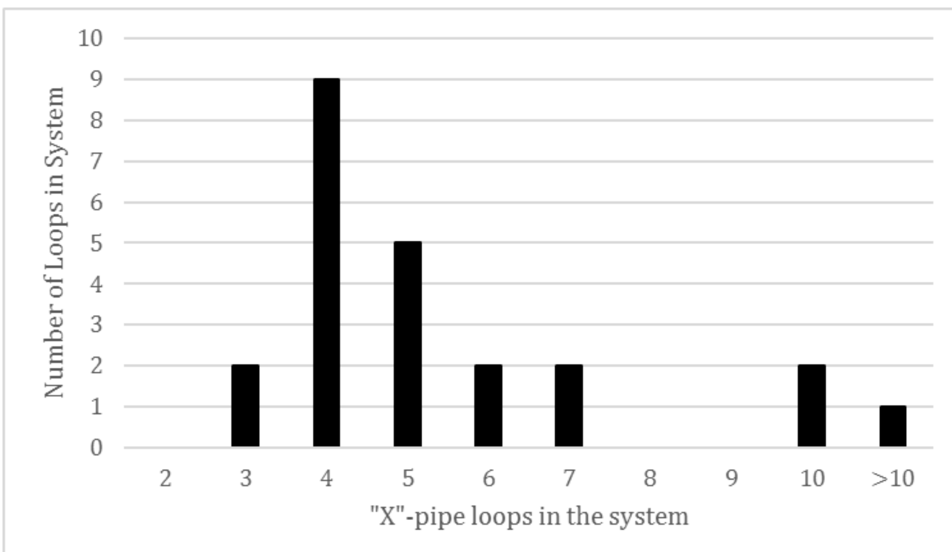
Physical attributes	Yes
Schematic diagram	Yes
Network geometry data	Yes
GIS data file	No
Background map	No
Elevation data	Yes
Pipe data	Yes
Pipe material	No
Pipe age	No
Pipe pressure class	No
Nominal or actual diameters	Nominal
Pump data	Yes
Useful horsepower	No
Pump operating curves	Yes
Tank data	Yes
Elevation data	Yes
Stage storage curves	No
Water quality information	No
Valve data	NA
PRV/FCV data	
Isolation valve data	
Hydrant data	
Demand data	Yes
Total system demand	Yes
Nodal demand data	Yes
Temporal data demands	Yes
System leakage	No
Hydraulic data	No
Hydraulically calibrated model	
Field hydraulic calibration data	
Water quality data	No
Disinfection method	
Chlorine residual data	
Booster station data	
Fluoride/Chloride field data	
Water quality calibrated model	
Operational data	Yes
SCADA datasets	No
Operational rules	Yes

SYSTEM CLASSIFICATION:

PIPE/LOOP HISTOGRAM:

Hoagland et al. (2015) designed a network classification algorithm for use in classifying water distribution systems as either “branched,” “looped,” or “gridded” based on the observed frequency of network loops with different numbers of distinct pipe segments. The frequency distribution for the Net 3 system is provided below. Using this information, Hoagland et al., classified this system as being a GRIDDED system.

# Total Pipes:	121
# Branch Pipes:	32
Ratio (Branch Pipes / Total Pipes):	0.264



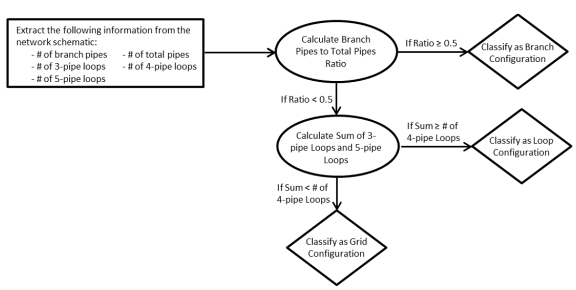


Figure 3.4. Classification Algorithm (Hoagland et al., 2015)

Hoagland, Steven & Schal, Stacey & Ormsbee, Lindell & Bryson, Lindsey. (2015). Classification of Water Distribution Systems for Research Applications. 696-702. 10.1061/9780784479162.064.

NETWORK STRUCTURE METRICS:

Building on the work of Hoagland et al., (2015), Hwang & Lansey (2017) created an expanded classification system that allows for further classification of a system as being either a transmission or distribution branched, looped, gridded, or hybrid system. Their algorithm streamlines the classification system by removing unnecessary nodes that do not contribute to the structure of the system while still retaining their use as intermediate points for demand data entry. A full description of the algorithm can be found in the cited reference.

Application of the Hwang and Lansey classification algorithm to the EPANET Net 3 system yields the following statics and associated classification:

Parameter	Value
Edges	119
Pipes	117
Nodes	97
Average Diameter	17.9
Reduced Nodes	50
Reduced Edges	72
Branched Edges	24
Branched Index	0.3
Meshed Connectedness	0.1
Reduced Meshed Connectedness	0.24
Link Density	0
Average Node Degree	2.5
Hwang & Lansey Classification	Transmission Dense-Loop

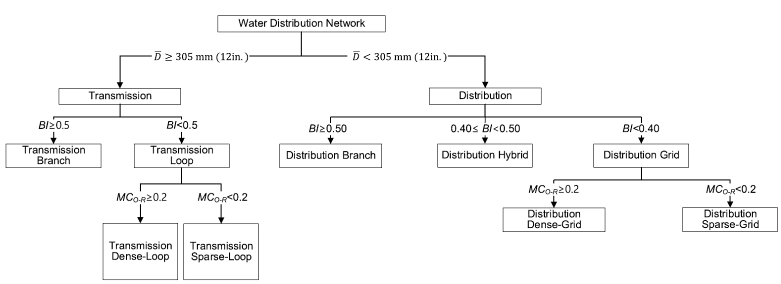


Figure 7. Water Distribution System Classification Flowchart (Hwang & Lansey, 2017)

Hwang H. & Lansey, K. (2015) "Water distribution system classification using system characteristics and graph theory metrics." *Journal of water resource planning and management* 143(12) https://doi.org/10.1061/(ASCE)WR.1943-5452.0000850

DETAILED DATA SUMMARIES

PHYSICAL ASSETS:

Asset Type:	# of Assets
Master Meters	0
Tanks	3
Pumps	2
Water Sources	2

NETWORK CHARACTERISTICS:

# Total Pipes:	121
# Junctions	91
# Reservoirs	2
# Tanks	3
# Regulating Valves	Unknown
# Isolation Values	Unknown
# Hydrants	Unknown
Elevation Data	YES

PIPE DATA:

Diameter (in)	Length (ft)
8	35985
10	3860
12	66287
14	2690
16	19915
18	14200
20	785
24	12101
30	59532
99	297

PUMP DATA:

Pump Horsepower	NO

Pump Curves:	YES

DATA FILE ATTRIBUTES:

ATTRIBUTE		UNITS
Pipe Length & Diameter	X	Feet & inches
Pipe Age		
Node Elevation	X	Feet
Node Demand	X	GPM
Valves		
Hydrants		
Tank Levels		
Tank Volume		
PRVs		
WTP		
WTP Capacity		
Pump Data		