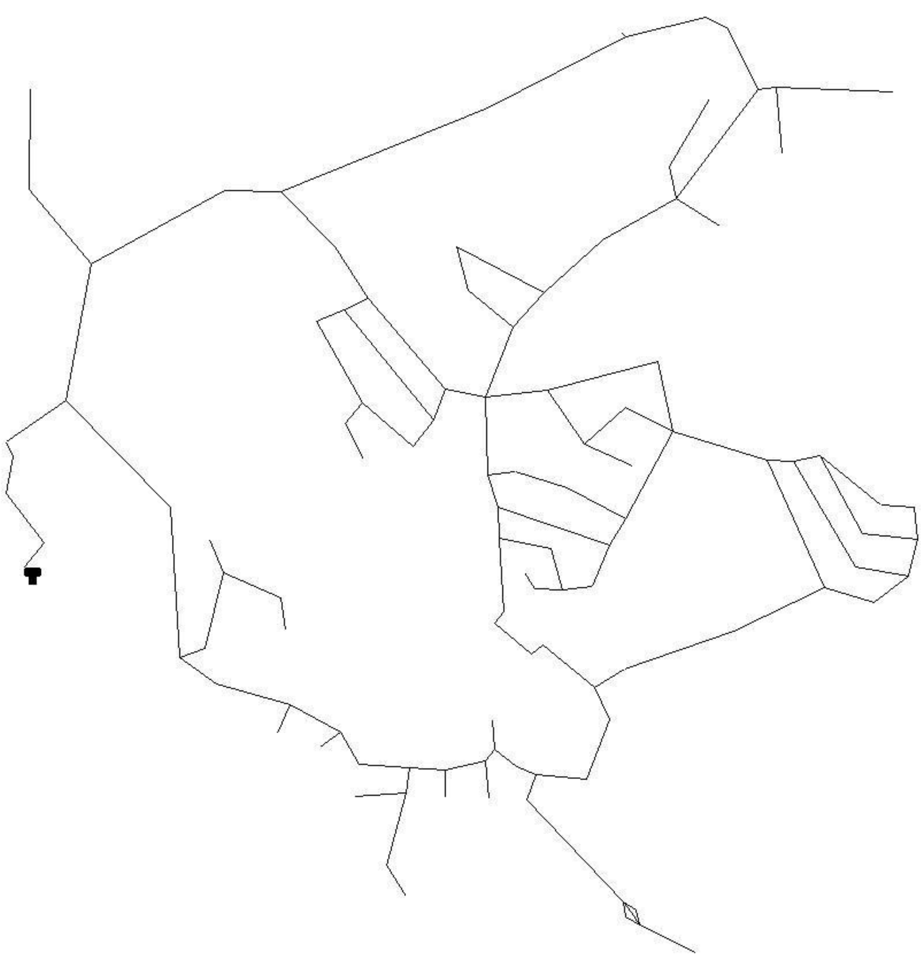
SYSTEM ID: CA1

NARRATIVE DESCRIPTION

The CA1 system is based on the Fairfield, CA water distribution system, which is a relatively small system with a single source. It serves 100,147. The system has an average demand of 0.62 MGD. The network was first used by Rossmann et al. (1996) as part of a study on numerical modelling methods and used a year later in a water quality study by Vasconcelos et al. (1997). It is based on a sampling campaign performed during 1993, observing chlorine residuals, decay, and wall uptake. At the time of samplings, most of the system was new, large diameter, asbestos cement pipes (8 and 12 inches). A general schematic of the system is shown below. The system has one tank and 11.1 miles of pipe.

NETWORK SCHEMATIC:



HISTORY OF THE NETWORK FILE

The CA1 system was originally used by Rossman et al. in 1996 as part of an article "Numerical Methods for Modeling Water Quality in Distribution Systems: A Comparison" which was published in 1996 in the *Journal of Water Resources Planning & Management*. It was used in a study by Vasconcelos et al. (1997) in an AWWA article titled "Kinetics of Chlorine Decay".

ORIGINAL REFERENCE:

Rossman, L.A. and Boulos, P.F., 1996. Numerical methods for modeling water quality in distribution systems: A comparison. *Journal of Water Resources planning and management*, *122*(2), pp.137-146.

ABSTRACT: A comparison is made between the formulation and computational performance of four numerical methods for modeling the transient behavior of water quality in drinking-water-distribution systems. Two are Eulerian-based (the finite-difference and discrete-volume methods) and two are Lagrangian-based (the time-driven and event-driven methods). The Eulerian approaches move water between fixed grid points or volume segments in pipes as time is advanced in uniform increments. The Lagrangian methods update conditions in variable-sized segments of water at either uniform time increments or only at times when a new segment reaches a downstream pipe junction. Each method is encoded into an existing distribution-system simulation model and run on several pipe networks of varying size under equal accuracy tolerances. Results show that the accuracies of the methods are comparable. The Lagrangian methods are more efficient for simulating chemical transport. For modeling water age, the time-driven Lagrangian method is the most-efficient while the Eulerian methods are more memory-efficient.

ADDITIONAL REFERENCE:

Vasconcelos, J.J., Rossman, L.A., Grayman, W.M., Boulos, P.F. and Clark, R.M., 1997. Kinetics of chlorine decay. *Journal-American Water Works Association*, *89*(7), pp.54-65. https://doi.org/10.1002/j.1551-8833.1997.tb08259.x

ADDITIONAL CITATIONS:

The original publication of Rossman et al. (1996) and by inference the CA1 system have been cited by 254 additional authors. These may be accessed by moving your cursor over the following link while simultaneously depressing the CTRL key on your keyboard: 254 Citations. The paper by Vasconcelos et al. (1997) has been referenced by 305 authors. Those may be accessed at this link: 305 Citations.

AVAILABLE INFORMATION

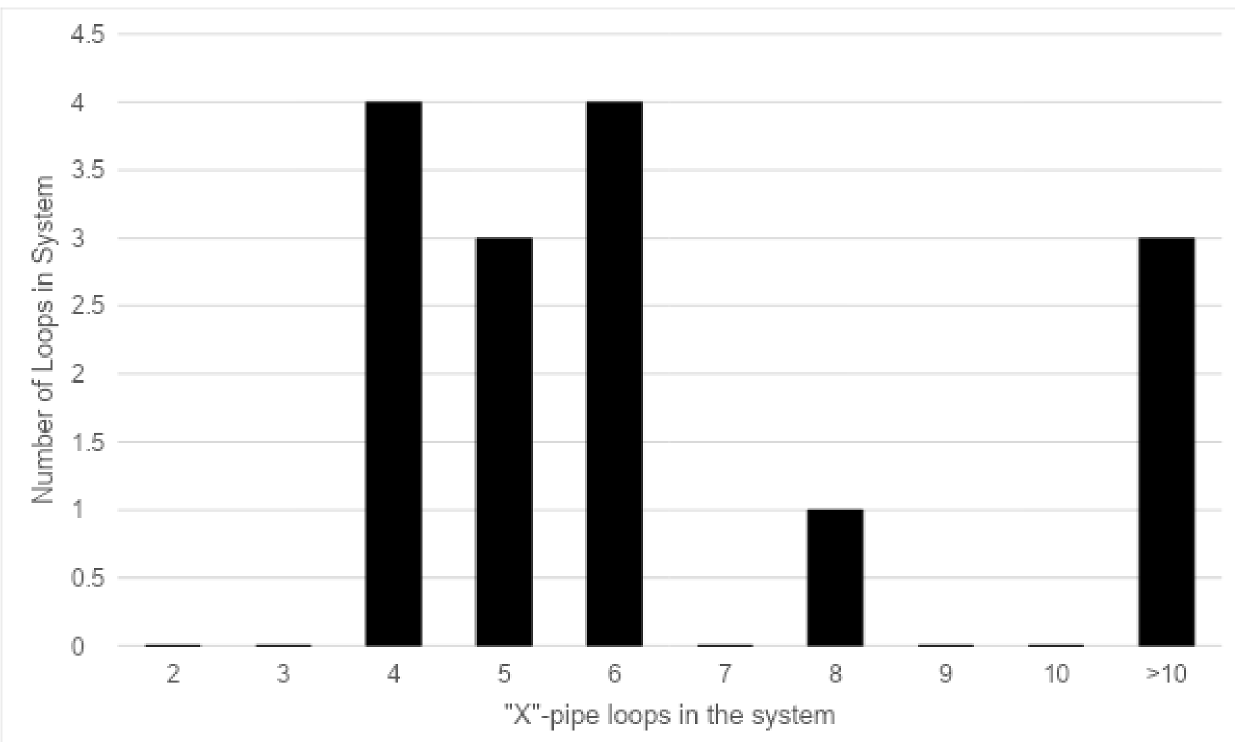
Physical attributes	Yes
Schematic diagram	Yes
Network geometry data	Yes
GIS data file	No
Background map	No
Elevation data	Yes
Pipe data	Yes
Pipe material	No
Pipe age	No
Pipe pressure class	No
Nominal or actual diameters	Nominal
Pump data	NA
Useful horsepower	
Pump operating curves	
Tank data	Yes
Elevation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

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 CA1 system is provided below. Using this information, Hoagland et al., classified this system as being a GRIDDED system.

# Total Pipes:	126
# Branch Pipes:	37
Ratio (Branch Pipes / Total Pipes):	0.294



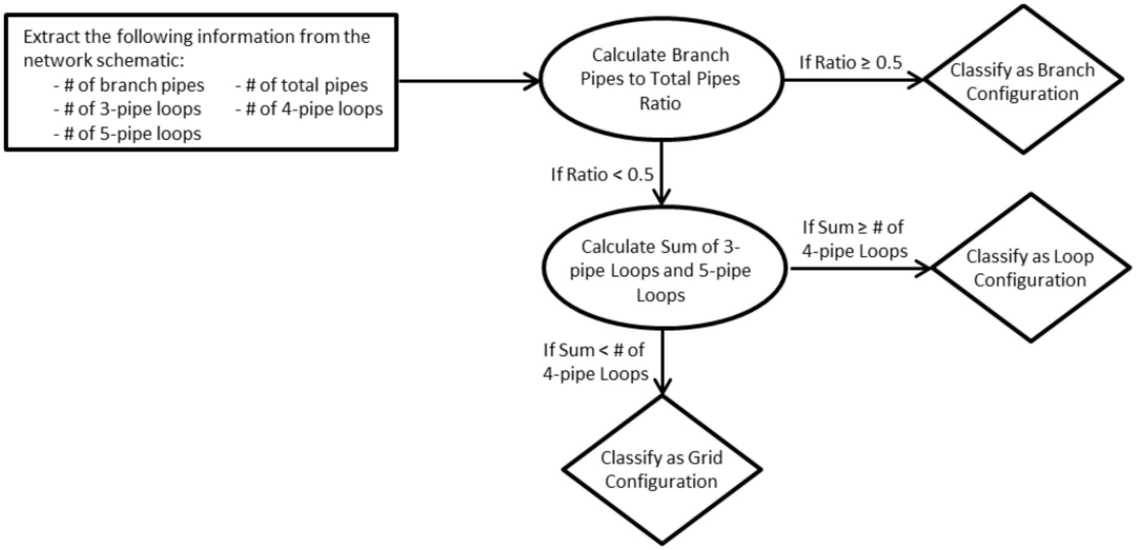


Figure 3.4. Classification Algorithm (Hoagland et al., 2015)

Hoagland, Steven & Schal, Stacey & Ormsbee, Lindell & Bryson, Lindsey. (2015). Classification of Water Distribution Systems for Research Applications. 696-702. 10.1061/9780784479162.06

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 system yields the following statics and associated classification:

Parameter	**Value**
Edges	126
Pipes	126
Nodes	112
Average Diameter	10.2
Reduced Nodes	40
Reduced Edges	54
Branched Edges	35
Branched Index	0.4
Meshed Connectedness	0.1
Reduced Meshed Connectedness	0.2
Link Density	0
Average Node Degree	2.3
Hwang & Lansey Classification	Distribution Dense-Grid

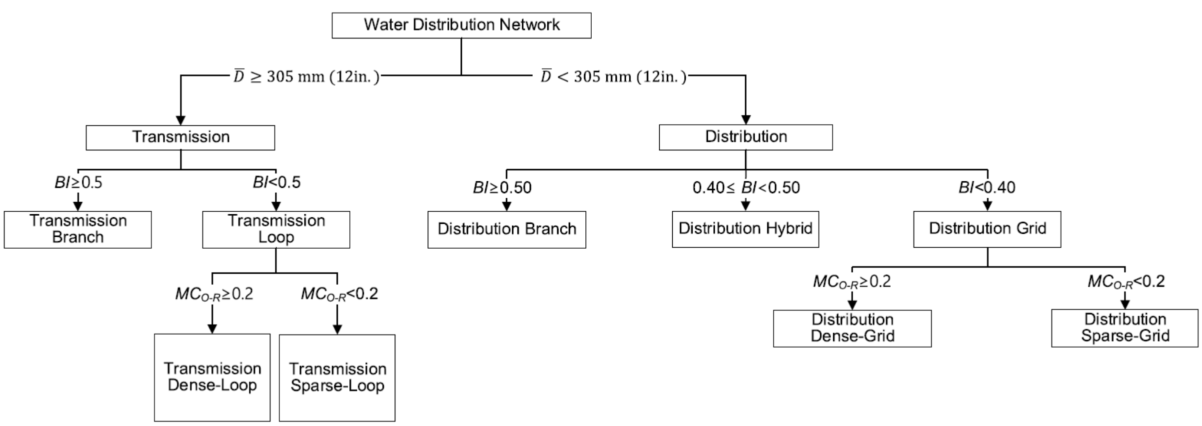


Figure 7. Water Distribution System Classification Flowchart (Hwang & Lansey, 2017)

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	1
Pumps	0
Water Sources	0

NETWORK CHARACTERISTICS:

# Total Pipes:	126
# Junctions	111
# Reservoirs	0
# Tanks	1
# Regulating Valves	0
# Isolation Values	Unknown
# Hydrants	Unknown
Elevation Data	YES

PIPE DATA:

Diameter (in)	Length (ft)
6	1,598
8	25,885
12	29,420
16	1,830

PUMP DATA:

Pump Horsepower	NO
Pump Curves:	NO

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	X	Feet
Tank Volume		
PRVs		
WTP		
WTP Capacity		
Pump Data		