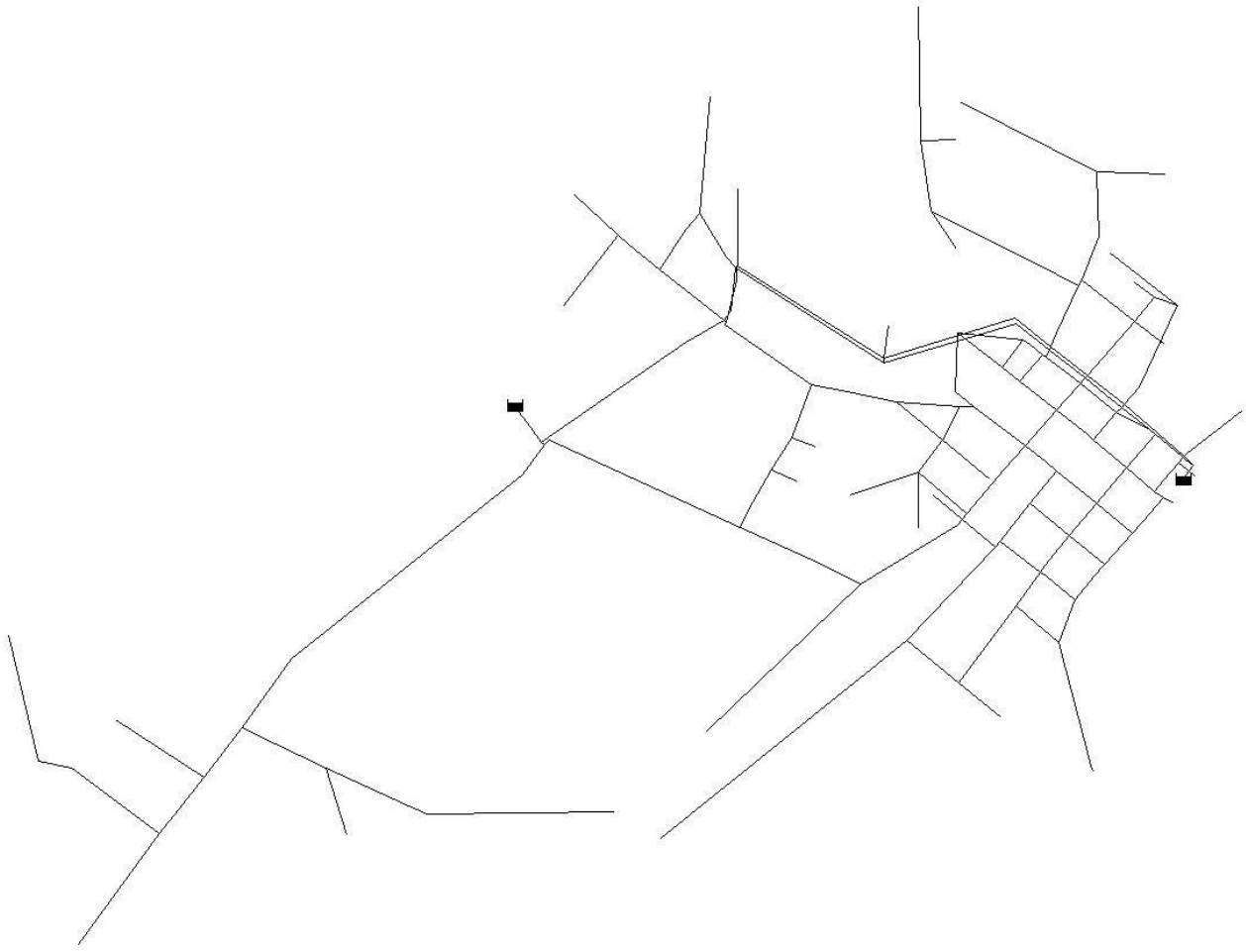
SYSTEM ID: KY V20

NARRATIVE DESCRIPTION

The KY V20 system is based on a real-world water distribution system in Kentucky. It serves 5,935 customers and sells water for $9.36 per 1,000 gallons. The system has an average demand of 0.266 MGD. The network was used by Hernandez & Ormsbee (2021) as part of a classification study. A general schematic of the system is shown below. The system has two reservoirs and 14.8 miles of pipe. Water loss within the system is estimated to be 20%.

NETWORK SCHEMATIC:



HISTORY OF THE NETWORK FILE

The KY V20 system was originally created by Erika Hernandez Hernandez in 2018 as part of an article “Segment-Based Assessment of Consequences of Failure on Water Distribution Systems” which was published in 2021 in the *Journal of Water Resources Planning & Management*.

ORIGINAL REFERENCE:

Hernandez Hernandez, Erika, and Ormsbee, Lindell. "Segment-Based Assessment of Consequences of Failure on Water Distribution Systems." Journal of Water Resources Planning and Management 147.4 (2021): 04021009. 10.1061/(ASCE)WR.1943-5452.0001340

ABSTRACT: This paper presents an assessment methodology that considers the impact of actual valve locations in a water distribution system in creating discrete isolated groups of pipes or segments when evaluating the performance of the network under a failure condition. The layout of the distribution network used as a case study and the location of the isolation valves are based on a survey of the real system instead of being artificially generated. In addition to evaluating the performance of the system under typical conditions with metrics based on loss of connectivity and the reduction in demand satisfaction, the assessment also includes a consideration for fire flow requirements that has not been widely used in combination with a segment-based reliability assessment.

ADDITIONAL CITATIONS:

The original publication of Hernandez et. al. (2021) and by inference the KY V20 system have been cited by 2 additional authors. These may be accessed by moving your cursor over the following link while simultaneously depressing the CTRL key on your keyboard: 2 Citations

AVAILABLE INFORMATION

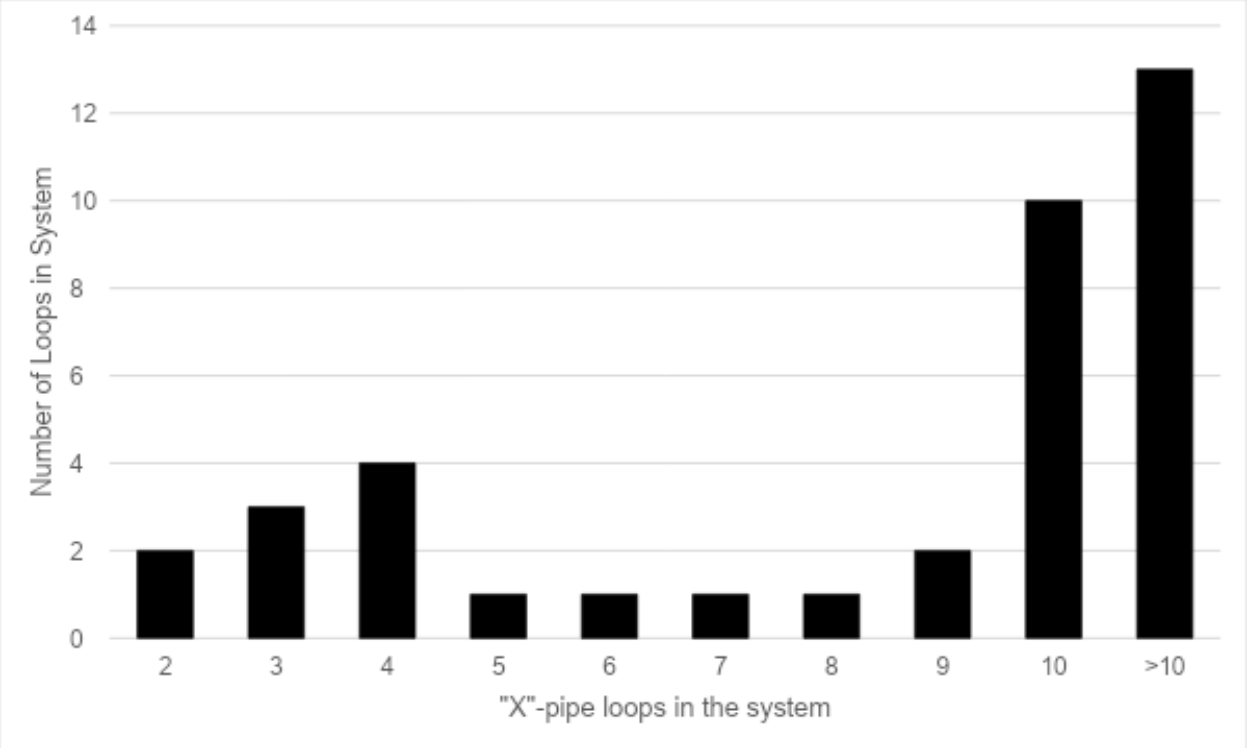
Physical attributes	Yes
Schematic diagram	Yes
Network geometry data	Yes
GIS data file	Yes
Background map	Yes
Elevation data	Yes
Pipe data	Yes
Pipe material	No
Pipe age	No
Pipe pressure class	No
Nominal or actual diameters	Nominal
Pump data	NA
Useful horsepower	
Pump operating curves	
Tank data	NA
Elevation data	
Stage storage curves	
Water quality information	
Valve data	Yes
PRV/FCV data	No
Isolation valve data	Yes
Hydrant data	No
Demand data	Yes
Total system demand	Yes
Nodal demand data	Yes
Temporal data demands	No
System leakage	Yes
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	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 KY V20 system is provided below. Using this information, Hoagland et al., classified this system as being a GRIDDED system.

# Total Pipes:	297
# Branch Pipes:	70
Ratio (Branch Pipes / Total Pipes):	0.24



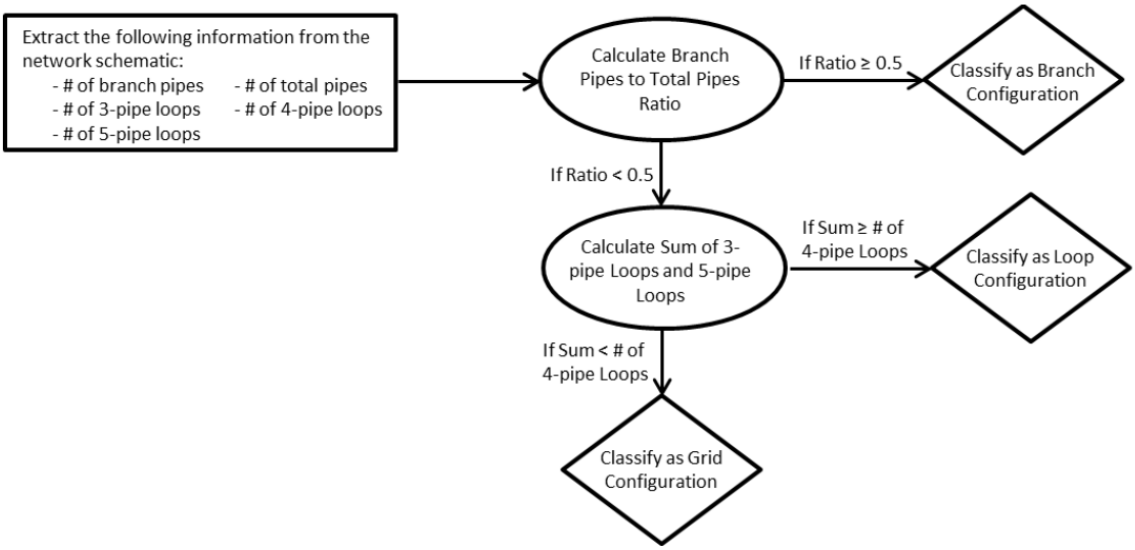


Figure 3.4. Classification Algorithm (Hoagland et al., 2015)

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 system yields the following statics and associated classification:

Parameter	Value
Edges	249
Pipes	201
Nodes	212
Average Diameter	6.1
Reduced Nodes	77
Reduced Edges	114
Branched Edges	47
Branched Index	0.3
Meshed Connectedness	0.1
Reduced Meshed Connectedness	0.26
Loop Density	0
Average Node Degree	2.3
Hwang & Lansey Classification	Distribution Dense-Grid

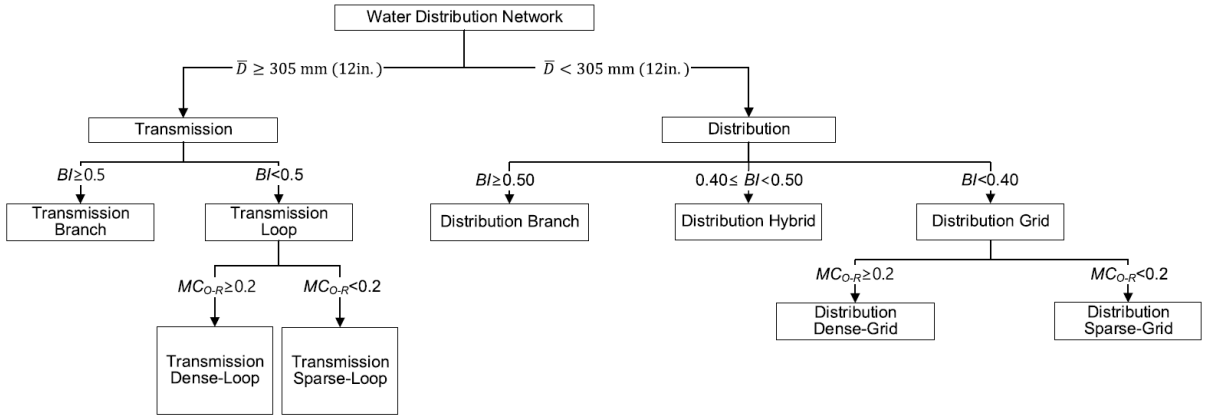


Figure 7. Water Distribution System Classification Flowchart (Hwang & Lansey, 2017)

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	0
Pumps	0
Water Sources	2

NETWORK CHARACTERISTICS:

# Total Pipes:	297
# Junctions	210
# Reservoirs	2
# Tanks	0
# Regulating Valves	0
# Isolation Values	48
# Hydrants	Unknown
Elevation Data	YES

PIPE DATA:

Diameter (in)	Length (ft)
3	5804
4	11146
6	52246
8	126
10	574
12	8087
57.5	10

PUMP DATA:

Pump Horsepower	NO
Pump Curves:	NO

DEMAND STATISTICS:

Demographic Type	Population	Households
Directly Serviceable:	2,220	1,022
Indirectly Serviceable:	10,657	4,913
Total Serviceable:	12,877	5,935

Production Statistics	
Total Annual Volume Produced (MG):	97.090
Total Annual Volume Purchased (MG):	
Total Annual Volume Provided (MG):	97.090
Estimated Annual Water Loss:	20%

Water Costs	
Customer Type	Cost per 1000 gallons
Customers within the municipality	$9.36
Customers outside the municipality	

CUSTOMERS AND USAGE:

Customer Type	Customer Count	Average Demand (MG)
Wholesale:	1	
Residential:	692	40.834
Commercial:	146	15.832
Institutional:		
Industrial:	13	8.215
Other:	53	12.233
Total Customers:	905	
Flushing, Maintenance & Fire Protection:		0.700
Total Water Usage:		77.814

DATA FILE ATTRIBUTES:

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