

SYSTEM ID: KY V6

NARRATIVE DESCRIPTION

The KY V6 system is based on a real-world water distribution system in Kentucky. It serves 2,850 customers and sells water for \$7.38 to \$8.12 per 1,000 gallons. The system has an average demand of 1.56 MGD. The network was used by Jolly et al. (2014) as part of a classification study. A general schematic of the system is shown below. The system has two reservoirs, two pumps, three elevated storage tanks, and 58.5 miles of pipe. Water loss within the system is estimated to be 19%.

NETWORK SCHEMATIC:



HISTORY OF THE NETWORK FILE

The KY V6 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](https://doi.org/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 V6 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

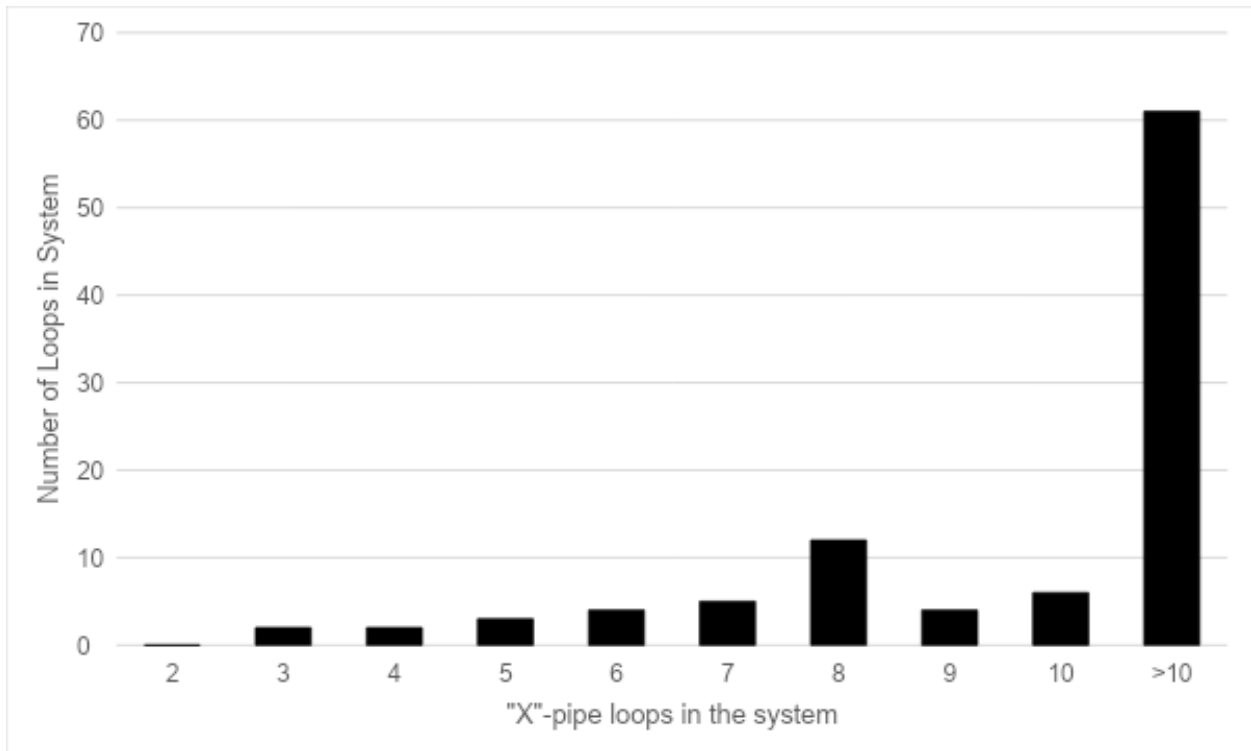
Physical attributes	Yes
Schematic diagram	Yes
Network geometry data	Yes
GIS data file	Yes
Background map	Yes
Elevation data	Yes
Pipe data	Yes
<i>Pipe material</i>	No
<i>Pipe age</i>	No
<i>Pipe pressure class</i>	No
<i>Nominal or actual diameters</i>	Actual
Pump data	Yes
<i>Useful horsepower</i>	Yes
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

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 V6 system is provided below. Using this information, Hoagland et al., classified this system as being a LOOPED system.

# Total Pipes:	1852
# Branch Pipes:	529
Ratio (Branch Pipes / Total Pipes):	0.29



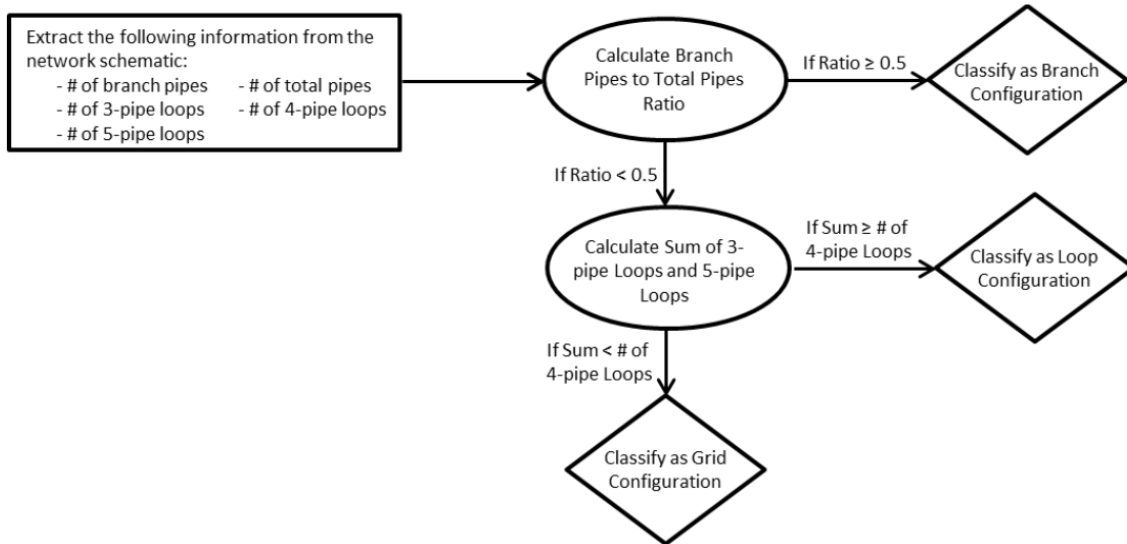


Figure 3.4. Classification Algorithm (Hoagland et al., 2015)

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	1504
Pipes	1156
Nodes	1406
Average Diameter	7.9
Reduced Nodes	242
Reduced Edges	340
Branched Edges	414
Branched Index	0.5
Meshed Connectedness	0
Reduced Meshed Connectedness	0.21
Loop Density	0
Average Node Degree	2.1
Hwang & Lansey Classification	Distribution Branch

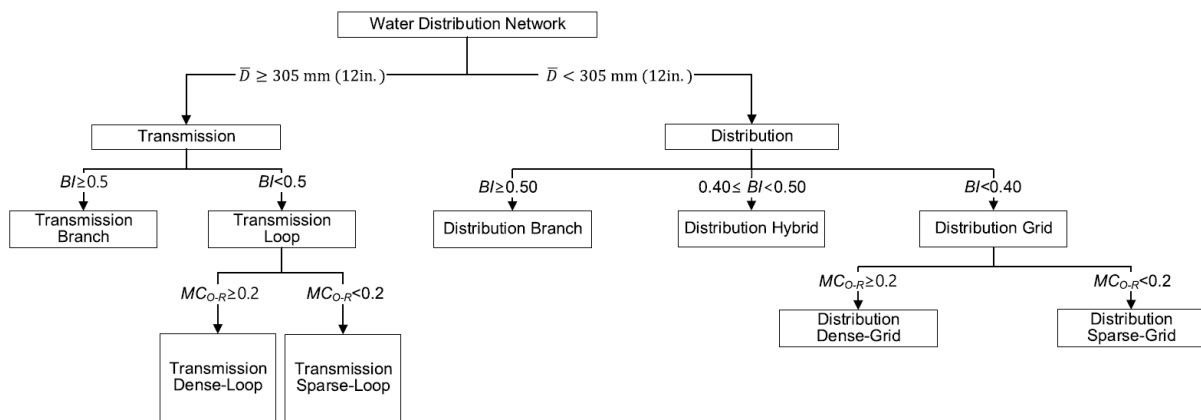


Figure 7. Water Distribution System Classification Flowchart (Hwang & Lansey, 2017)

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](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:	1852
# Junctions	1401
# Reservoirs	2
# Tanks	3
# Regulating Valves	1
# Isolation Values	345
# Hydrants	Unknown
Elevation Data	YES

PIPE DATA:

Diameter (in)	Length (ft)
1	9952
2	33,108
3	7,085
4	15,207
6	149,680
8	17,993
12	33,381
16	40,523
18	1,790

PUMP DATA:

Pump Horsepower	YES
Pump Curves:	NO

DEMAND STATISTICS:

Demographic Type	Population	Households
Directly Serviceable:	6,534	2,902
Indirectly Serviceable:	14,122	6,997
Total Serviceable:	20,656	9,899

Production Statistics	
Total Annual Volume Produced (MG):	730.311
Total Annual Volume Purchased (MG):	
Total Annual Volume Provided (MG):	730.311
Estimated Annual Water Loss:	19%

Water Costs	
Customer Type	Cost per 1000 gallons
Customers within the municipality	\$7.38
Customers outside the municipality	\$8.12

CUSTOMERS AND USAGE:

Customer Type	Customer Count	Average Demand (MG)
Wholesale:	1	171.077
Residential:	2,423	141.014
Commercial:	405	191.111
Institutional:		
Industrial:	21	85.300
Other:		
Total Customers:	2,850	
Flushing, Maintenance & Fire Protection:		
Total Water Usage:		588.502

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