

# ***SYSTEM ID: KY V18***

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## **NARRATIVE DESCRIPTION**

The KY V18 system is based on a real-world water distribution system in Kentucky. It serves about 4,875 customers and sells water at a rate of \$3.20 to \$4.48 per 1,000 gallons. The system has an average demand of 2.2 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 one reservoir, three pumps, three elevated storage tanks, and 112 miles of pipe. Water loss within the system is estimated to be 8%.

## **NETWORK SCHEMATIC:**



## **HISTORY OF THE NETWORK FILE**

The KY V18 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*.

## **HISTORY OF THE NETWORK FILE**

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### **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 V19 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

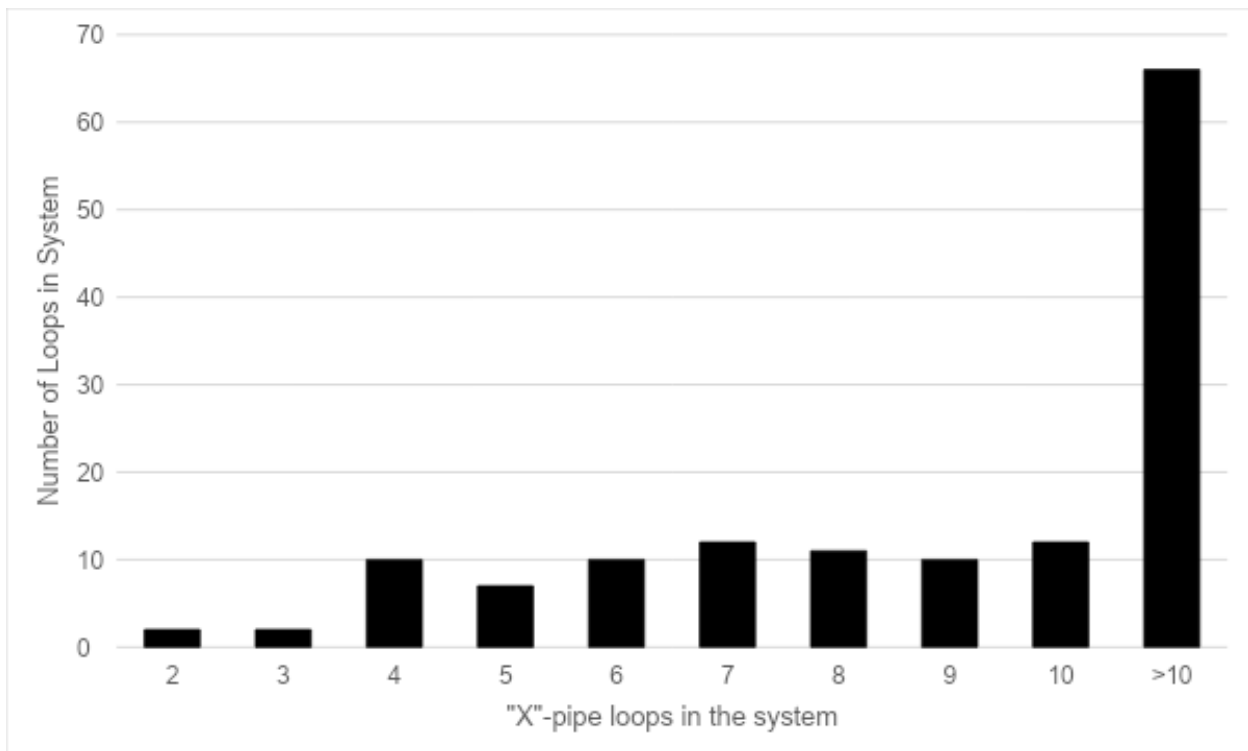
Physical attributes	Yes
Schematic diagram	Yes
Network geometry data	Yes
GIS data file	Yes
Background map	Yes
Elevation data	Yes
Pipe data	Yes
<i>Pipe material</i>	Yes
<i>Pipe age</i>	Yes
<i>Pipe pressure class</i>	No
<i>Nominal or actual diameters</i>	Nominal
Pump data	Yes
<i>Useful horsepower</i>	No
<i>Pump operating curves</i>	Yes
Tank data	Yes
<i>Elevation data</i>	Yes
<i>Stage storage curves</i>	Yes
<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>	Yes
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	Yes
<i>Hydraulically calibrated model</i>	Yes
<i>Field hydraulic calibration data</i>	Yes
Water quality data	Yes
<i>Disinfection method</i>	Yes
<i>Chlorine residual data</i>	No
<i>Booster station data</i>	No
<i>Fluoride/Chloride field data</i>	Yes
<i>Water quality calibrated model</i>	No
Operational data	No
SCADA datasets	
<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 V18 system is provided below. Using this information, Hoagland et al., classified this system as being a GRIDDED system.

# Total Pipes:	1378
# Branch Pipes:	308
Ratio (Branch Pipes / Total Pipes):	0.22



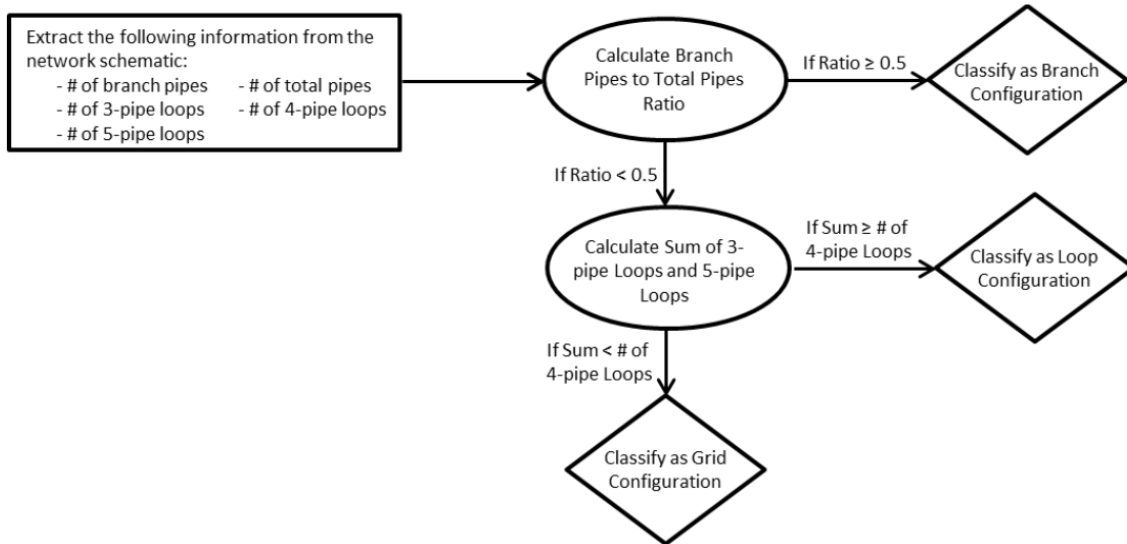


Figure 3.4. Classification Algorithm (Hoagland et al., 2015)

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	1849
Pipes	1376
Nodes	1708
Average Diameter	7.2
Reduced Nodes	1365
Reduced Edges	343
Branched Edges	1506
Branched Index	0.2
Meshed Connectedness	0
Reduced Meshed Connectedness	0.05
Loop Density	0
Average Node Degree	2
Hwang & Lansey Classification	Distribution Sparse-Grid

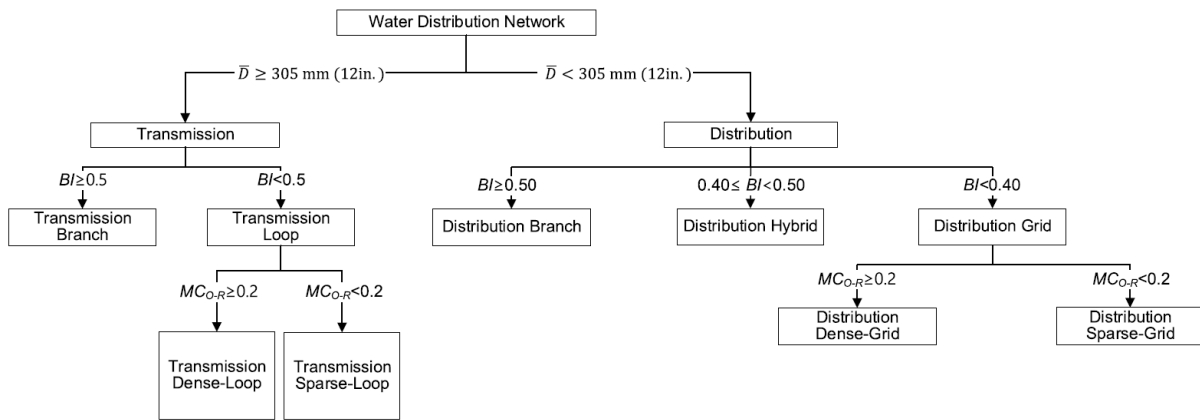


Figure 7. Water Distribution System Classification Flowchart (Hwang & Lansey, 2017)

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](https://doi.org/10.1061/(ASCE)WR.1943-5452.0000850)

## **DETAILED DATA SUMMARIES**

### **PHYSICAL ASSETS:**

<b>Asset Type:</b>	<b># of Assets</b>
Master Meters	7
Tanks	3
Pumps	3
Water Sources	1

### **NETWORK CHARACTERISTICS:**

# Total Pipes:	1378
# Junctions	1233
# Reservoirs	1
# Tanks	3
# Regulating Valves	0
# Isolation Values	3489
# Hydrants	1275
Elevation Data	YES

### **PIPE DATA:**

<b>Diameter (in)</b>	<b>Length (ft)</b>
1	1227
2	150670
2.5	49924
3	225111
6	646842
8	211563
10	119490
12	24333
16	19530
20	33849
24	4547

### **PUMP DATA:**

Pump Horsepower	YES
Pump Curves:	NO

**DEMAND STATISTICS:**

<b>Demographic Type</b>	<b>Population</b>	<b>Households</b>
Directly Serviceable:	31,336	12,856
Indirectly Serviceable:	11,824	4,647
Total Serviceable:	43,160	17,503

<b>Production Statistics</b>	
Total Annual Volume Produced (MG):	1,444.777
Total Annual Volume Purchased (MG):	56.895
Total Annual Volume Provided (MG):	1,501.672
Estimated Annual Water Loss:	27%

<b>Water Costs</b>	
Customer Type	Cost per 1000 gallons
Customers within the municipality	\$5.19
Customers outside the municipality	\$7.70

**CUSTOMERS AND USAGE:**

<b>Customer Type</b>	<b>Customer Count</b>	<b>Average Demand (MG)</b>
Wholesale:	2	255.461
Residential:	12,680	659.633
Commercial:	865	121.424
Institutional:		
Industrial:	23	64.612
Other:		
Total Customers:	13,570	
Flushing, Maintenance & Fire Protection:		
Total Water Usage:		1,101.130



**DATA FILE ATTRIBUTES:**

<b>ATTRIBUTE</b>		<b>UNITS</b>
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