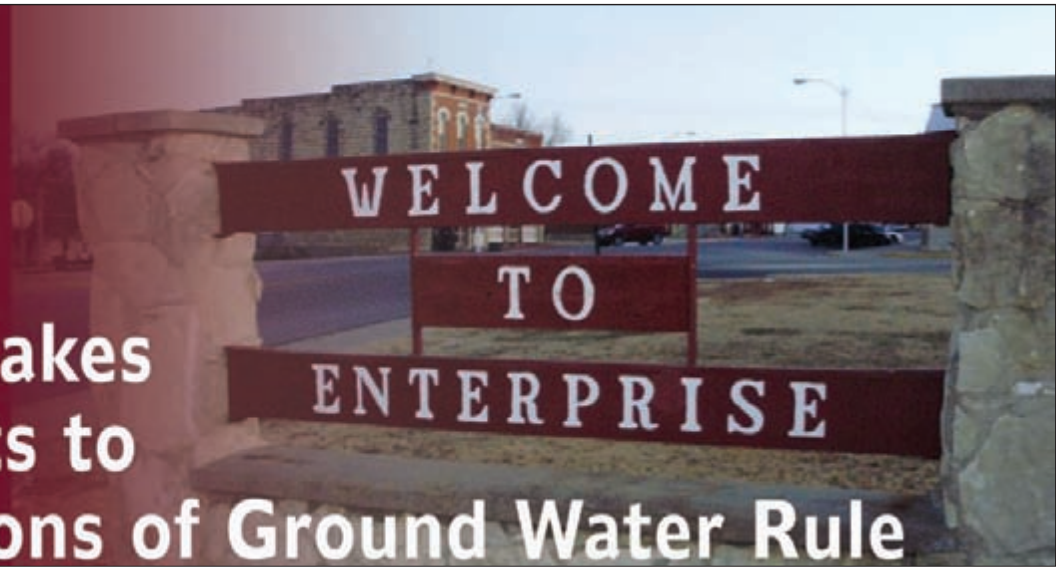
By Jeff Lamfers, KRWA Consultant



Enterprise Makes Improvements to Meet Provisions of Ground Water Rule

This sign and the 816 residents of Enterprise, Kansas welcome visitors. Enterprise boasts of having the first organized kindergarten in Kansas.

Enterprise, Kansas is a city of 816 people located on the Smoky Hill River south of Interstate-70 in Dickinson County. The town was incorporated in 1878; railroads arrived a year later. Enterprise has a rich history with claims of having the first public kindergarten in Kansas in 1903, the second congregation of the Bahai religion in the western hemisphere in 1897 and a 1901 visit from temperance crusader Carry Nation.

Original settlers were primarily of Swiss descent. One of the first inhabitants was Swiss-born Christian Hoffman who started a flourmill on the Smoky Hill River. Eventually, Mr. Hoffman merged with several other mills in town and continued to mill flour until early 1930.

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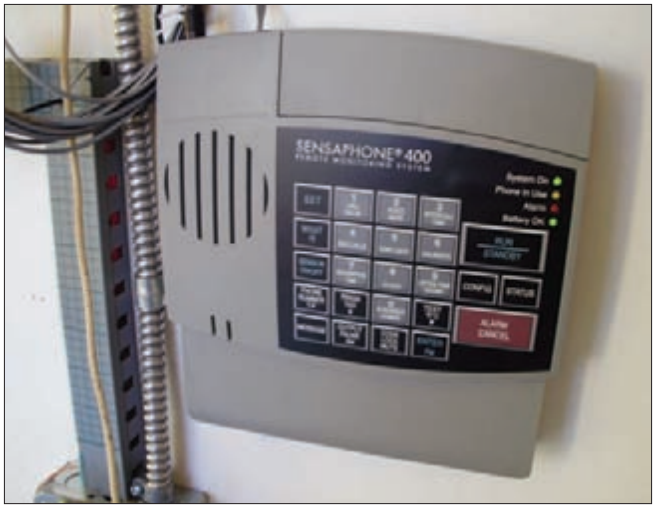
Another early entrepreneur was Jacob Ehrsam who built a dam across the Smoky Hill. He was a millwright and mechanic, operating both a gristmill and machine shop that manufactured machinery for handling grain and processing flour. In later years, he modified his machinery to manufacture wallboard from gypsum. Upon incorporating in 1902, the business lasted for almost 100 years. The company was sold to a Swiss firm in 1990 and eventually closed in 1996.

W.G. Froelich was another early entrepreneur who built a stone building in the city's downtown in 1891 that housed a grocery store and dry goods business. These businesses were in the Froelich family for four generations until they were sold in 1986. The building has now been converted to a convenience store.

Carry Nation, who visited Enterprise in 1901, was an activist who believed alcohol was the cause of many problems in society. Her first protests consisted of praying and singing hymns outside saloons. However, she eventually moved to more violent forms of protest and immediately gained national attention. After destroying three bars in Wichita, including one in the city's finest hotel, Carry Nation traveled to Enterprise at the invitation of one of the town's leading citizens. It was in Wichita where she first used a hatchet. On January 23, 1901, she destroyed a "joint" in Enterprise and was attacked by the owner's wife. After two days of "hatchetations" as they became know, she left for Topeka and destroyed Topeka's Senate Saloon, a favorite watering hole of Kansas legislators. While in Topeka she met with then Governor William Stanley and a portrait was made of their meeting. The sketch shows Nation's right eye badly bruised from her saloon smashing in Enterprise a few days earlier.

This photo shows Enterprise City Marshall leading Carry Nation to jail after she and her temperance followers smashed up a saloon in Enterprise on January 23, 1901. *Photo courtesy of KansasMemory.org, Kansas State Historical Society*



The city's Sensaphone 400 Remote Monitoring System monitors the water system for high or low chlorine residuals, chlorination system failure and power outages. If a warning is detected this system immediately notifies city staff so they can respond promptly.

Previously used as a railroad signal shack, the structure was modified for use as the city's new chlorination building. Another shack was used to house the city's Hach Cl-17 Analyzer and POE sample tap.

Changes to achieve 4-log inactivation

Fortunately, things are much calmer in Enterprise today. The city has three utilities: water; sewer; and, electric distribution. City Superintendent Paul Froelich and his staff have recently made major improvements to the city's public water supply system in order to comply with provisions of the Ground Water Rule. Namely, they have made modifications in order to increase their CT (disinfectant concentration x contact time) to achieve 4-log inactivation of viruses. I believe Enterprise may be the first water supply in Kansas to make major changes in order to achieve 4-log inactivation. By providing 4-log inactivation, the city has reduced the risk of waterborne illness caused by microbial contaminants. The city also now has the additional benefit of not conducting triggered source water monitoring as required by the Ground Water Rule should a routine bacteriological water sample test positive for coliform. The city obtained approval from the Kansas Department of Health and Environment (KDHE) prior to upgrading the system and spent approximately $10,000 on the improvements. KDHE conducted a final inspection and the new system was placed in service December 1, 2010.

Prior to making modifications to achieve 4-log inactivation, Enterprise's water system consisted of two wells

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north of town, a 1.5-mile long 6-inch transmission line, gas chlorination system, 80,000 gallon clearwell and two high-service pumps. Because free chlorine was not added until water reached town (before the clearwell), the city could not take advantage of the contact time provided by the transmission line. The only contact time the city really had was the clearwell and EPA only allows using a small percentage of that contact time due to the potential for short-circuiting through the structure.

Consequently, the city changed the point of chlorination and moved it upstream to the wells, at the head of the 1.5-mile transmission line. Because both wells (Wells 6 and 7) are pitless units, the city would have to provide a building to house chlorination equipment. The city decided to use recycled railroad signal shacks for this purpose. Two were set up near the wells: the north shack was the chlorination building and the south shack housed the city's point-of-entry sample tap. The city switched from gas chlorine to 12.5 percent sodium hypochlorite solution. The solution is fed using a peristaltic feed pump with a maximum feed rate of 14 gpd. The city also decided to purchase a Hach Cl-17 Free Residual Chlorine Analyzer. The Ground Water Rule requires systems that serve more than 3,300 customers to monitor the residual at the point of entry (POE) continuously. Systems serving 3,300 or fewer are only required to take grab samples daily at the POE. While Enterprise serves fewer than 3,300 customers, the city still wanted to monitor residuals continuously in order to prevent higher-than-desired residuals in town. Using the Hach Cl-17 in conjunction with a Sensaphone 400 Remote Monitoring System, the city is also immediately notified if residuals are either too high or too low. The remote monitoring system also issues warnings if there is a chlorination system failure or power outage.

The city's Hach Cl-17 Analyzer monitors free chlorine residuals continuously at the POE. The analyzer is also equipped with a dialer system. While Enterprise's population is not large enough to require continuous residual monitoring, the city wanted to make sure operating staff would be notified if residuals were too high or too low.

Because the Hach Cl-17 has continuous flow and the effluent contains chemical reagents N-Diethyl-p-phenylenediamine (DPD) and a buffer to adjust the pH of the sample, the generated wastewater stream must be disposed of properly. Since the wellfield is north of town, the city's public sewer system was not accessible. Consequently, the city installed a 1,000 gallon in-ground poly holding tank to receive and store this wastewater. While the chemicals used are at very low concentrations, proper disposal is necessary considering proximity of one of the wells. So far, the city has had the tank pumped once.

The city also installed a three-channel datalogger which is an electronic device that records data over time via sensors. The datalogger produces a paper record of system operations. Presently, the datalogger is continuously recording free residual chlorine at the POE and the water level in the 200,000 gallon elevated storage tank. The city plans to eventually use the datalogger to also monitor the water level in the clearwell.

The city decided to shock treat the 6-inch transmission line with a strong chlorine solution before introducing chlorinated water. Since this transmission line had been used for many years to transport raw, unchlorinated water to town, a biofilm may have developed on the inside walls of the pipe. Such a biofilm could present a significant chlorine demand and/or cause offensive tastes and odors in the treated water. Consequently, the city treated the line before placing it in service as a precautionary measure.

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The city may be able to derive another tangible benefit from these improvements. The unincorporated city of Detroit is about one-half mile north of Enterprise's new chlorination building. Residents of Detroit are presently served by individual private wells and septic tank/lateral field systems. Many of the forty-eight homes are on small lots where their well is in close proximity to their septic tank system. This obviously creates the potential for cross-contamination of the wells. Detroit residents could break this cycle and ensure themselves better quality water by abandoning their private wells and purchasing water from Enterprise. This is now possible since chlorinated water is much closer to Detroit than before. Detroit would need to form a new community public water supply system regulated by KDHE and then begin purchasing treated water from Enterprise.

Of course once all the physical improvements have been made to provide 4-log inactivation, there is always mandatory paperwork that must be submitted to document these improvements. Like all water systems wanting to provide 4-log inactivation, the city first used the KDHE "CT Calculation Worksheet" to confirm they were providing sufficient CT. (See sidebar on next page.) This worksheet can be found on the KDHE Web site. Information needed to calculate CT includes transmission

Understanding "CT" – Ground Water Rule

CT = C X T
C = concentration of disinfectant residual (mg/L)
T = contact time (minutes) between point of disinfectant application and point where residual is measured
CT is expressed as (mg-min)/L

You will need to know:
- C (mg/L), the measured disinfectant residual at or before the first customer
- Length (ft) of each pipe between point of application and point residual is measured
- Diameter (ft) of each pipe
- Maximum Daily flow (gallons per minute) of system

PWS Name: City of Enterprise
PWS ID: _____

Basic Formulas:

Your Water System Calculations:

- **Calculating Pipe Cross-Sectional Area (ft²):** (∏ ÷ 4) X (diameter²) →
  Pipe Diameter (Inches): 6 → 0.196 ft²
- **Calculating Pipe Volume (gallons):** pipe length X cross-sectional area →
  Pipe Length (Feet): 8050 → 11817.0 gallons
- **Calculating Disinfectant Contact Time (minutes):** pipe volume ÷ flow →
  Highest Flow Rate (gpm): 300 → 39.4 minutes
- **Calculating CT (mg-min/L or CT):** disinfectant residual X contact time →
  Lowest Residual (mg/L): 0.3 → 11.8 mg-min/L *(CT)**

** Compare this CT value (mg-min/L) with the required CT value from the below table at the appropriate temperature for 4-log inactivation. If your system's CT is larger than the corresponding CT value in the below table, then your water system is achieving 4-log inactivation of viruses with free chlorine.*

CT Values for Inactivation of Viruses by Free Chlorine, pH 6.0 - 9.0

Degrees (C)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Degrees (F)	33.8	35.6	37.4	39.2	41.0	42.8	44.6	46.4	48.2	50.0	51.8	53.6	55.4	57.2	59.0	60.8	62.6	64.4	66.2	68.0
Inactivation (log)																				
2	5.8	5.3	4.9	4.4	4.0	3.8	3.6	3.4	3.2	3.0	2.8	2.6	2.4	2.2	2.0	1.8	1.6	1.4	1.2	1.0
3	8.7	8.0	7.3	6.7	6.0	5.6	5.2	4.8	4.4	4.0	3.8	3.6	3.4	3.2	3.0	2.8	2.6	2.4	2.2	2.0
4	11.6	10.7	9.8	8.9	8.0	7.6	7.2	6.8	6.4	6.0	5.6	5.2	4.8	4.4	4.0	3.8	3.6	3.4	3.2	3.0

Developed by Kelly D. Kelsey - KDHE - Bureau of Water; 1000 SW Jackson St.; Suite 420; Topeka, KS 66612

If you plan to report 4-log inactivation to KDHE under the Ground Water Rule, the following forms must be submitted:

KDHE CT Calculation Worksheet:
http://www.kdheks.gov/pws/download/groundwater/CT_calculation_for_Ground_Water_Rule.xls

KDHE 4-log Treatment Certification Form:
http://www.kdheks.gov/pws/download/groundwater/4-log_notification_letter_to_KDHE.doc

KDHE Monthly Disinfection Report for the Groundwater Rule (compliance monitoring form):
http://www.kdheks.gov/pws/download/groundwater/Monthly_Disinfection_Report_Sheet.xls

General information on the KDHE Web site about the Ground Water Rule:
http://www.kdheks.gov/pws/groundwater_rule.htm

line length and diameter, maximum flow rate and lowest chlorine residual that will be maintained at the POE. The CT calculated must be greater than 4.0 mg-min/L which is the minimum CT that must be provided using free chlorine at a water temperature of 59.0º F (15º C) in order to provide 4-log inactivation. The city's CT value is 11.8 mg-min/L (see sidebar for details of calculation).

Enterprise also submitted the standard certification form officially notifying KDHE of the city's intentions. This form also confirms the groundwater system plans to conduct compliance monitoring. Compliance monitoring is simply monitoring chlorine residuals daily at the POE to confirm that residuals never drop below the residual used to calculate the system's CT. In the case of Enterprise, they used 0.3 mg/L free chlorine to calculate their CT. These disinfection forms must be submitted to KDHE monthly and are due by the tenth day of the following month. These forms can also be found on the KDHE Web site.

The Ground Water Rule does not require all groundwater systems to provide 4-log inactivation. However if a system does provide 4-log, they will not be triggered into source water monitoring of all their wells should a routine bacteriological water sample test positive for coliform. I suggest visiting the KDHE Web site for guidance and information if you are seriously considering providing 4-log inactivation and plan to report such to KDHE. I am also available to assist water systems with deciding whether or not reporting 4-log inactivation would benefit your system. I can be reached at (913) 850-8822 or email me at jeff@krwa.net. I hope that readers will also attend the KRWA annual conference to attend excellent training sessions about water system operations, regulatory issues and meet with vendors who provide many products and services.

Jeff Lamfers began work for KRWA in November 2008. Jeff has more than 30 years of regulatory experience in the oversight and operation of water and wastewater systems with the Kansas Department of Health and Environment. He is a graduate of the University of Kansas with a degree in Environmental Studies with an emphasis in aquatic biology.