By Jon Steele, KRWA Tech Assistant

KRWA Assists With a Well Cleanup at City of Lyons

The rehabilitation of a water well is periodically required during the life of a well. This need occurs because of several reasons, but mainly because groundwater contains minerals that can cause plugging of well screens or even the gravel pack. The result is that the production of the well can be dramatically reduced. Other problems such as biological fouling of the well water also often results.

Brian Vagts, the new Utilities Director at the city of Lyons in central Kansas, requested assistance with a problem with one of the city's wells. The problem at Well No. 3 manifested itself because of the inability for the city to maintain a chlorine residual by the time the water traveled through a mile of 12-inch and 18-inch transmission main. Lyons has five wells with 100 hp pumps that are capable of delivering more than 1,000 gpm each at an operating pressure of 100 psi and 2,000 gpm at 50 psi. The city has 550 million gallons of vested water rights in the Cow Creek drainage basin.

The first order of business when investigating a well problem is to collect a water sample for inorganic analysis to know exactly the nature of the problem that needs to be addressed. I generally like to collect these myself and in the case at Lyons, I also wanted a coliform bacteriological sample and a "first draw start up sample" to test for iron and manganese. Iron and manganese are notorious consumers of chlorine especially in the presence of iron or sulfate reducing type bacteria.

Well No. 3 had been sitting idle for some time. Not pumping a well often exacerbates water quality issues in that well. Typically, wells are cycled on a regular basis and at least flushed to waste if the water cannot be used because of contamination issues such as high nitrate levels. Many times I see wells that are considered to be "standby wells" and to be only used in emergency situations. Many of those wells are not regularly operated. Such wells should be valved so that they could be operated and pumped to waste on a regular basis.

The samples collected at Lyons indicated no presence of coliform bacteria. That eliminated any pathogenic type of issues. The inorganic samples were typical of what might be anticipated in the ground water in central Kansas. The water quality tests showed Total Hardness at 233 mg/L, chloride at 90 mg/L, sulfate of 55 mg/L, iron at .734 mg/L and manganese of .016 mg/L. The result on iron was very high, however a subsequent test after operating the well at 1,800 gpm for 30 minutes showed a result of .026 mg/L. There are no regulatory requirements with respect to iron and manganese however the suggested levels for iron are .3 mg/L and .05 mg/L for manganese.

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Shock chlorination treatment

After reviewing the sample results I suggested a routine "shock" chlorination treatment of the well.

Shock chlorination is widely used to limit the growth of iron bacteria and rehabilitate wells that have lost production because of biofouling bacteria. Some experts suggest chlorination treatments as high as 500 to 2,000 ppm. Once the highly chlorinated water is injected into the well, additional water is added to force the chlorine mix into the formation. The treatment of wells using high chlorination methods is more successful the longer the contact time.

For the project at Lyons, Utility Director Brian Vagts and I developed a plan. First, it would be necessary to make some plumbing modifications and to also utilize a special fitting I built in my shop at home. A drum of sodium hypochlorite was purchased from Diane Patten at Waterwise. It's important to make sure that whatever chlorine is used meets the specifications on the label. An important point is that the chlorine product strength should always be tested upon delivery to verify the concentration. This can be done with a hydrometer and a conversion chart that can be found in the USA BlueBook pocket handbooks. There are other high-test kits available however I found them to be more complicated. I prefer the specific gravity method; it is quick and simple.

We used 14,000 gallons of water that had a chlorine concentration of 400 mg/L to treat the well. I also like to use a good food grade biodegradable wetting agent. This helps the chlorine solution have better results in penetrating biofilms and any encrustations. Sometimes however, wetting agents can create foam which can be problematic to the process. The chlorine solution is either pumped or gravity fed into the well. The solution must be surged back and forth from the well to the mix tank. This surging should be done for several hours to create a mixing and washing action. After the solution has been surge pumped for several hours it should be allowed to remain in the well for several days or perhaps longer if possible. The well is then flushed to waste using a surge pump method to remove any unused chlorine. Care has to be taken with the water flushed. Although not generally environmentally harmful chlorine in high enough concentrations will kill

Utility Superintendent Brian Vagts checking Chlorine after treatment 2

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Mixing 400 ppm chlorine solution.

fish. It may be necessary to dechlorinate with a dechlorinating agent such as sodium bisulfite while flushing.

A chlorine test should be conducted for the presence of chlorine residual before flushing to waste. A lack of residual indicates that the chlorine was spent, accomplishing its purpose. However, with no residual remaining, additional treatment is needed. More chlorine will need to be added and the procedures repeated until a good residual can be obtained. When testing high strength chlorine, it is advisable to use a high strength kit. A regular low strength kit can be used, however, just be aware of how DPD reacts with high chlorine concentrations. If the chlorine is too strong for the reagent the water may indicate really dark red for just a moment after adding the reagent and then turn completely clear. This suggests a high level of chlorine is present. Or red streaks may appear as the reagent is added and then it clears. Such a reaction also indicates the residual is very high. Dilutions can be done to obtain the concentrations but the exact amount of chlorine left is not what is important. What is important is that there is free unspent chlorine remaining indicating the disinfection has been accomplished. In the case at Lyons we had 13 mg/L free chlorine after the treatment and before we started the flushing procedure.

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During a well rehabilitation, the well should be flushed until all traces of treatment chemicals are eliminated. When the well is considered ready to be placed back into service, it's advisable to allow it to remain idle for a few hours or perhaps overnight and then again pump it to waste. Sometimes, we find that the chlorine or wetting agent has not yet been totally removed and more flushing is required. A substantial amount of flushing is usually required after a large treatment process has been completed.

Pump tests should also be performed before and after treatment to determine the effectiveness of the treatment. This is especially so if the well has had a history of pumping some air. By a "good pump test", I'm referring to gathering some basic information.

Measuring drawdown

First, the static water level should be measured. This is accomplished typically by using a drawdown gage, commonly known as a "well sounder". Many original well designs incorporate air lines but those typically last a few years and then fail due to cracks developing in the air line. The static level should be measured only after the well has not been pumped for some time, or until it has fully recovered from the prior pumping. The next step is to measure the pumping water level at a given time, e.g., 30 to 60 minutes, as the water level stabilizes after pumping. The discharge rate in gpm should also be measured as well as the shut off head pressure. That is important information to have to determine the condition of the pump itself. Many drawdown tests will measure the decline in the water level much more frequently. Existing facilities should be most concerned with the water level when the pump is producing water at the

Utility Superintendent Brian Vagts tightens the fitting to enable pumping the well to waste.

normal rate of production needed by system. Also, prior background information such as a history of water level measurements when the well was operating at its peak (usually shortly after construction) would be very valuable to review when the well no longer performs as expected. The drawdown and the specific capacity or well yield can be determined from this information. Specific capacity is the calculation of gallons of yield per foot of drawdown.

Last but not least, the electrical data should be collected. Voltages from phase to phase and amperage readings on each phase are important. When working on wells I always like to look for electrical problems or safety hazards such as improper grounding or inadequate lightning protection or other wiring and control panel issues. I do not see operators collecting this type of data regularly; it puzzles me as this should be a standard procedure and should be collected at least annually. The information is critical for troubleshooting well and pump problems. But, unless someone is experienced with it, it's best to utilize your local electrician. It's safety first – always – when working around or with electrical systems.

I hope that the information provided in this article is of help. I do not profess to be a water well expert. I am relaying my experiences as a technical assistant for Kansas Rural Water Association. It was great to work with the staff at Lyons to accomplish this project. It's my opinion that many systems that rely on groundwater have wells that could benefit from periodic treatment. Such efforts should be considered ongoing maintenance. I would be pleased to visit further with any water supply that has a well that has declining yield or concerns of biofouling.

Jon Steele has been employed by KRWA as a Circuit Rider since 1995. Jon is certified as a water and wastewater operator. He has more than twenty-five years experience in public works, construction and industrial arts.