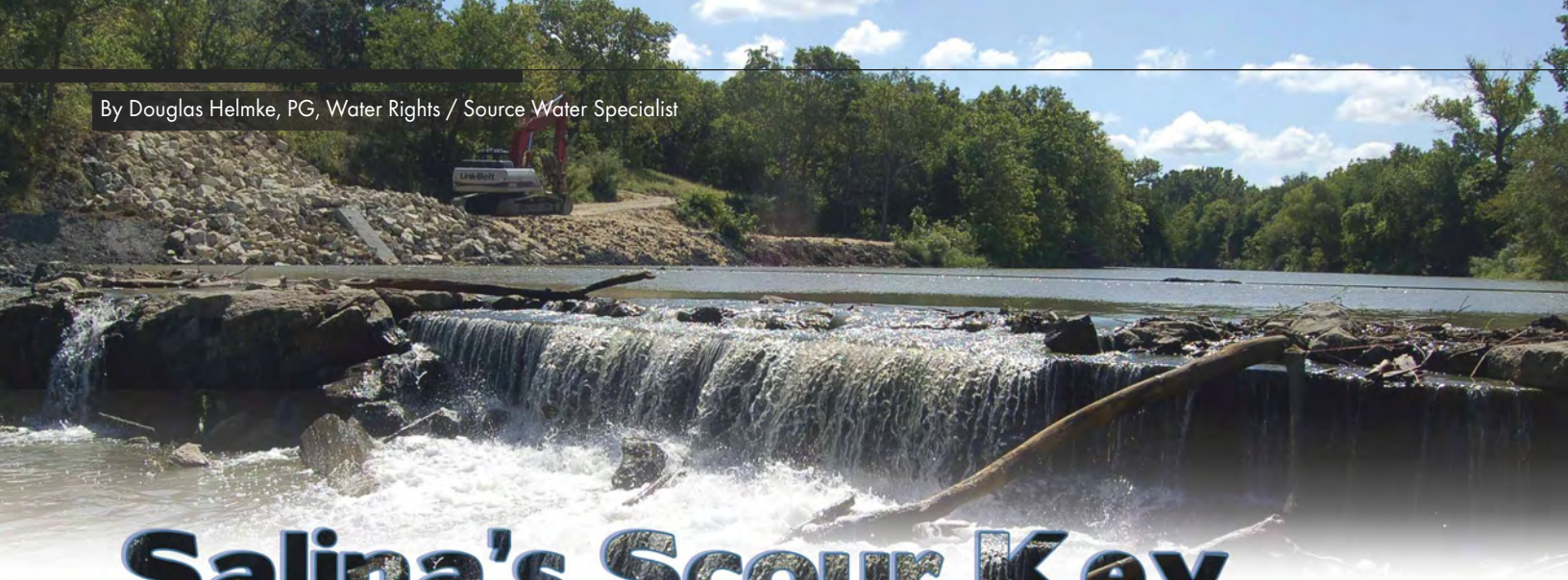

By Douglas Helmke, PG, Water Rights / Source Water Specialist

Salina's Scour Key Replacement Project

The new scour key was designed and constructed at the same elevation as the previous structure, and is barely perceptible in this view upstream.

While many politicians and governmental bodies bemoan the lack of funds for transportation maintenance and improvements, it seems that water, wastewater and flood protection infrastructure don't receive as much attention. The public doesn't fret about the possibility of not having water for a shower or for coffee in the morning when at most, that is the biggest inconvenience anyone can imagine concerning their public water system. The fear is that our favorite (and only) bridge to town is suddenly closed for unsafe conditions or outright collapse really gets to us when we think about the possibilities. Going back to the Kansas Avenue Bridge collapse in Topeka in 1965, there have been at least seven bridge failures to date in the U.S. which resulted in human deaths, according to information at the Web site, Bridgehunter.com. So it may be a surprise that the city of Salina is benefiting from a project, at relatively no cost, to make repairs and improvements to their Smoky Hill River Scour Key.

"What is a scour key?" A scour key is an erosion-resistant structure placed in the bed of a flowing river or canal.

You may be asking, "What is a scour key?" A scour key is an erosion-resistant structure placed in the bed of a flowing river or canal. Its purpose is to maintain the current elevation of the bed of the channel. The city of Salina has a scour key that not only stabilizes the stream bed, it also performs as a low-head dam to maintain water at an suitable elevation for their surface water intake to function. During multiple high-flow events, the Smoky Hill River was able to erode the banks beyond the ends of the scour key, which jeopardized the entire structure. Repair work was badly needed. The latest scour key is the fourth one in the history of the Salina flood control project.

Fluvial history

Salina lies at the confluence of two rivers, the Smoky Hill River and the Saline River. Geologists believe that at the time of maximum glaciation in Kansas, flow from the Republican, Solomon and Saline Rivers was blocked from flowing to the east. The water in these rivers, and the water eventually melting from the top of the lobe of ice, backed up at the face of the glacier until water spilled over the first divide between present day Salina and Lindsborg and the divide between Lindsborg and McPherson. After the glacier melted, the outflow channel that became the Equus Beds was abandoned by the Smoky Hill River in favor of the new glacial meltwater and river channel that was cut from present day Manhattan to Lindsborg. Since that time, the Smoky Hill River flows in the opposite direction of the flow of the river that cut the valley from Lindsborg to Manhattan. In essence, enough down-cutting was employed by the redirected Smoky Hill River to overcome the original tendency to flow to the west and south.

The result of this fluvial history gives us the very flat Smoky Hill River valley in Saline and Dickinson counties. Flooding of this valley would likely be a lot more common if not for Kanopolis and Waconda Reservoirs. Salina, being located near the confluence of the Smoky Hill and Saline, and in the middle of the valley, was especially prone.

Records show that the city of Salina was flooded in 1895, 1903, 1927, 1928 and twice in 1929. With floods appearing to become more than an annual event, proposals were made to eliminate the flow of water in the Smoky Hill River channel in downtown Salina by building a cut-off channel. A report from 1932 co-authored by the city of Salina engineer shows that approximately seven miles of winding natural stream channel could be disconnected with the construction of a new, nearly straight, 1.5-mile channel. Nothing but talk was evident through the Depression and World War II, but the Flood of 1951 brought everyone's attention back to the existing flooding risk.

Salina's water system

Because Salina's history of flood control and the public water supply are linked, a discussion of the water system should be explained before going any further. The public water system in Salina was in existence as early as 1883. Attempts by the city government to get approval to purchase the private water system were made as early as 1909, but in 1925, voters finally (and overwhelmingly) approved the issuance of bonds to make the purchase. In 1926, Salina completed the purchase of the water system. The first source of water for the system was a 27-foot diameter, hand dug well lined with finished stone near the water pumping plant. It was 40 feet deep. Other wells were drilled during the succeeding years as needed. In 1954, a water right application was filed to use surface water from the Smoky Hill River that flowed right next to the water plant. Salina's vested water right utilizing groundwater allows the use of 1,152 million gallons per year. The surface water right was certified in 1981 for 1,638.4 million gallons per year. The ratio of groundwater use to surface water use today averages about "fifty-fifty". Other important items to know is that softening has been added to the water plant's function and when Schilling Air Force Base closed, the city was able to obtain the vested water right and the wells previously owned by the military. The water plant has a treatment capacity of 20 million gallons per day.

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Flood control

The cut-off channel idea proposed in 1932 became a finished reality in 1961. There were also levees constructed that nearly surrounded the entire community. A few previously existing levees on the southwest side of town that protected the city from floods on Dry Creek were incorporated in the project. The design of the cut-off channel was critical because the cut-off channel provided a drop of elevation of approximately 12 feet in 1.5-miles instead of the same drop over the length of the seven mile long, through-town, river channel. Because the channel bottom gradient and the water flow velocity would be increased, one design aspect was the installation of a scour key, which would help prevent induced river bed erosion upstream

The Salina water treatment plant is located near the downtown district, on the bank of the old Smoky Hill River channel. The plant has air-stripping, settling, softening, filtration and disinfection processes that produce high quality drinking water from surface water and groundwater.

This abandoned concrete-reinforced water main illustrates the extent of erosion to the sides of the cut-off channel. Note the abandoned water main under the concrete which formerly supplied water to the Salina residents east of the cut-off channel. A new water main has been bored under the cut-off channel which is much less susceptible to flood damage.

This aerial photograph shows the extent of flooding just east of downtown Salina in May 1929. The Smoky Hill River, seen on the left edge of the photo, flowed to the east and then turned to the southeast, as seen in the upper left corner of the photo. Ohio Street is seen at the top of the photo and crosses the Smoky Hill River near Ash Street. Approximately 13,500 people were evacuated from Salina during the 1951 flood. *(Source of photo: Flood Control Measures for Salina, Kansas, by Robert Justice Paulette and Guy Robert Scott, 1932.)*

of the cut-off. Another design element added to the scour key was the diversion of low flow into the original channel. However, without a regular high flow through the original channel, sediment naturally accumulated in the old channel which impaired the ability of Salina to pump their full certified amount of surface water at the water plant. In 1989, a new intake was constructed on the original channel outside the flood levee above the scour key. The elevation of the intake was designed to use the full benefit of the low-head dam design of the scour key.

Back to the present

City staff observed through the years that erosion was occurring to the walls of the cut-off and near the ends of the scour key, especially during high flows. With photographs, they documented the amount of erosion that was occurring. In 2012, design work was initiated with a local engineer to estimate the scope of the work to repair and control the erosion, including the costs. On July 30, 2013, the stream gage upstream of Salina at Mentor recorded flow at 5,590 cubic feet per second (c.f.s.). Flood stage is reached when flow reaches 5,000 c.f.s. Significant changes to the banks, with erosion around the ends of the scour key, were evident after this minor flood event and was documented with photographs. Thinking that there would be a program to jointly address the situation, the Public Works and Utility Departments met with the U.S. Army Corps of Engineers to discuss the situation, with an expectation that there would be some cost to the city to have this important infrastructure repaired.

From the east bank above the opening of the cut-off channel (from left to right), one can see the surface water intake in Bill Burke Park, the original Smoky Hill River channel where it turned to the west into the city of Salina, and the new scour key crossing the opening of the cut-off channel.

It was subsequently learned that under the Flood Control Act of 1954, flood control structures built by the Corps of Engineers that become damaged by a flood are to be repaired and restored by the Corps of Engineers at no cost to the local community. On November 21, 2014, a cooperative agreement between the Corps of Engineers and the city of Salina was signed. In round numbers, estimated costs for the replacement of the scour key were $660,000 and the bank stabilization came in at $297,000. Actual costs were higher and are estimated now at $1,200,000. The project was nearly complete in September 2015.

Future plans

Learning that the costs of repair and replacement for the flood control/water supply infrastructure damaged by the 2013 flood event could be borne by the federal government saved the city of Salina a significant amount of money. Not having to spend any of their own money as a match on the scour key means the city can continue to move forward with the new south side water treatment plant which will treat the water from the old airbase wells to the same quality as the original plant's finished water. Greater use of the airbase wells will reduce reliance on the wells near the treatment plant that could be impacted in the future by the well-known plume of contaminants that originates from the airbase. The new wellfield will provide another source of water when drought impacts flow in the river. Less pumping of the in-town wells should also decrease the chance that the plume will be drawn to those wells.

Salina is grateful for the cooperation from the Corps and the contractors that have completed this project. With better engineering and construction methods, they are hopeful that the scour key and erosion control features will last for many years, and provide greater reliability of their surface water supply.

Less pumping of the in-town wells should also decrease the chance that the plume will be drawn to those wells.

Douglas S. Helmke has been the Water Rights Tech at KRWA since June 2000, and also a Wellhead / Sourcewater Protection Tech since 2003. He holds professional geologist certification in Kansas and Missouri. Doug received a bachleor degree in geology from Kansas State University.