Examples of Situations Where System Design Resulted in Problems

These are real situations that have occurred in Missouri. General descriptions of system size and location are provided rather than system names. The situations are categorized by type of problem.

Developer changed design post-approval

SWRO – small village

The developer constructed a ground storage tank instead of an elevated tank, changed the locations of Pressure Reducing Valves (PRVs) and bypassed a PRV with an unapproved extension. This resulted in pressures in excess of 210 PSI on water mains designed for no more than 160 PSI. The other result was 8 PSI pressure at the base of the ground storage tank with a significant deficiency. The cost to bring adequate and safe drinking water in accordance with the original design demand is being borne by the subsequent system's owner (and customers) after the initial developer went bankrupt.

SWRO – condominium

Design Guide articles -- 2.4.a. Siting requirements that a site in general shall not be subject to risk from pollution & 7.0.3 storage tank location at least 50 feet from sources of contamination. This system has two ground storage tanks of several thousand gallons each. The original approved plans and specs showed all the water system components, including the tanks approximately 600 feet from the wastewater treatment facility servicing the same development. The developer moved the storage tanks to within 50 feet of the activated sludge wastewater treatment plant that emits aerosols and presents an obvious unnecessary risk.

Contractor built not in accordance with existing design standards

SWRO – condominium

Design Guide article 7.4.8 requires certification of hydropneumatic tank. A non-standard 14-feet diameter by 8-feet long 5,000-gallon hydropneumatic tank was installed that was not fabricated to ASME Boiler and Pressure Vessel Code. It was un-stamped and had nearly flat plate heads welded to the cylinder instead of dished heads. At startup the heads blew off and the tank failed. The engineer had specified it correctly to start with and the plans/specs reflected a code vessel, but construction did not meet the approved plans/specs. Since then, bladder tanks were installed at customers' expense after the debris was hauled off.

SERO – rural water district

The system was properly designed but contractors took liberties during construction with the design and quality control that resulted in a system built in a way that did not meet our standards. Low pressures, additional leakage, etc. are the result.

Alterations and construction without approval

SERO – municipality

The city made modifications "in-house" by local water system operators, plumbers, or contractors, and no professional engineer was employed. They added water lines and even small booster stations that do not meet our minimum standards. High confidence exists that low water pressures and frequent system outages occur because of the way they were constructed.

Funding agency changed design

NERO – rural water district

The water district had to build a second solids contact unit so that they could continue plant operation while replacing the metal interior working of the existing solids contact unit. The transmission main was also undersized with high service pumps unable to deliver enough capacity to the standpipe. During high usage periods the plant had difficulty keeping the standpipe full. The district had to take on an additional loan on top of an existing loan to replace the under-designed components with an elevated water tank and a larger transmission main that actually carries the designed plant flow.

NERO – rural water district

(Summary) We have a water district that started out constructing undersized water mains as required by the funding agency. The only thing that kept them from having low water pressures from the start was because only half of the services were active. The district was expanded twice and each time the water lines were undersized as required by the funding agency. When the district finally began to grow and reached approximately 75% of its designed number of active services, low pressure problems occurred throughout the district. The water treatment plant was expanded repeatedly partly because higher pumping rates were needed to keep Standpipe #1 full. The district spent hundreds of thousands of dollars building plants, pumping stations, elevated water storage and larger water lines to maintain safe service to existing

customers all while still paying for the previous facilities. Because the funding agency required downsizing of the transmission main from the water plant, several miles of lateral 6-inch water main had to be constructed to serve existing municipal customers. Furthermore, a plant was constructed to operate at two different rates because the 6-inch transmission main from the water plant to the elevated tank is undersized and cannot serve one of the municipal areas from the distribution system. *(Detail)* Initially constructed in 1972 as a single alluvial well, a 40 gpm iron removal plant, 65,000 gallon standpipe and 131 service connections. At any one time no more than half of the service connections were active.

In 1980 a major expansion was constructed adding 187 services reconstructing the water treatment plant to produce 120 gpm, adding a second well and adding two variable speed booster pumping stations to push water through the system at higher pressures. Still at any one time no more than half of the service connections were active.

In 1991 a third major expansion to add 166 services was added. This involved rebuilding and expanding the water plant to produce 200 gpm adding a 65,000 gallon standpipe and converting the booster pumping stations to constant rate pumps. Again at any one time no more than half of the service connections were active. The second standpipe was added so that the pumping stations could be converted to constant rate pumps. Because of very low water use at night the variable speed pumps were using high amounts of electricity and had very short lives of two to three years. The water treatment plant was expanded so that it could keep Standpipe #1 full during daily peak usage. Theoretically the 120 gpm plant produced enough water to serve daily demands because of the low number of active services. The number of people moving into the water district increased until roughly 75% of the water services was actually active. As a result, the district started to experience low water pressures and difficulties in keeping their standpipes full enough. In the late 1990s a moratorium was placed on new service connections in the eastern half of the water district. In 2004 a 200,000 gallon elevated tank was constructed to relieve the demand on Standpipe #1 and a booster pumping station was constructed to push water east. A third much taller (131 feet verses 110 feet) standpipe and additional 4-ich water main were constructed in the east half of the district.

A new 6-inch water main was constructed from the treatment plant to the elevated tank. The engineer proposed an 8-inch transmission main but the funding agency downsized it to 6-inch. The design engineer and representatives from DNR both protested the downsizing because of the evidence that the district was going to grow not only in the east but in the west. Negotiations had begun between the district and a municipality for the municipality to purchase water from the district. The application for 8-inch line was overruled by the funding agency and a 6-inch line was constructed. Around 2010 a second (lateral) 6-inch water main was constructed from the treatment plant to the municipality and construction began on a new 400 gpm water treatment plant. Presently the water plant is undergoing another expansion, this time to serve another municipal area. Two sets of high service pumps have been installed in the water plant because the 6-inch transmission line to the water tower is not large enough to serve both municipalities from the district's distribution system.

NERO – Rural Water District

Started in 1973 as a pumping station and distribution system for several municipalities. The water main from ground storage and booster pumping station to the next standpipe consisted of Class 160, 3-inch and 2½-inch pipe. The water transmission main to these municipalities consisted of mainly 3-inch pipe. Water pressures at the booster pumping station were in excess of 100 psi to fill the Standpipes which resulted in frequent water main breaks. After construction, the district began to grow modestly and in 1980 a booster pumping station was rebuilt with larger higher head pumps. Two new 4-inch transmission mains were also constructed for two existing municipal customers. The small diameter of the transmission mains were protested for two reasons. First, the district was growing modestly but steadily and the small transmission mains left no room for growth. Second, even with larger transmission mains, pressures at the pumping station were 100 to 130 psi resulting in frequent water main breaks. In 2010 the Booster pumping station was again rebuilt with larger capacity pumps and 6-inch transmission mains. Water pressures are still high in the 100 to 130 psi range but class 200 pipe was used this time and an elevated tank was constructed to replace the existing standpipe. They have three different sized transmission mains constructed from the pumping stations to serve existing municipalities with replacement mains being constructed before the previous main was paid off.

KCRO - rural water district

The regional office received a letter of complaint that was submitted to the Governor's office from a property owner. According to the district's clerk the property is on a 2-inch water line, and the water district is serving the maximum number of customers they can while maintaining adequate water pressure.
Plans for creating the district were submitted in 1987 with a projected population for design of 626. The final inspection of the newly constructed system was conducted in May 1989. Of the initial construction of the distribution system, approximately 331,000 lineal feet of undersized 2-inch pipe was installed.

The water system has been in service now for 24 years and there are ten years remaining on the original loans and bonds. There have been approximately eighteen improvements and replacements since 1987 in an attempt to maintain adequate service.

The total expected construction cost of the project, including valves, meters, stream-crossings and highway crossings at the time was $2,778, 277.00. According to the associated construction cost opinion, the cost of using 3-inch pipe instead of the 2-inch pipe as the minimum size would have added $44,221.60 to the total project, a 1.592% increase.

In 1993 the district also submitted plans for an expansion and improvement project, which included 1,563,500 lineal feet (296-miles) of pipe, of which 1,039,250-ft (196.7-miles) was to be 2-inch. This project was eventually greatly reduced and not constructed as originally submitted. Eventually, the district began limiting new connections in 2005 for some portions of the district, and in 2007 a district wide new connection moratorium was imposed by the department.

According to a January 2010 engineering report by a consulting firm, there are still 236 potential customers waiting for service, but cannot connect due to flow and pressure deficiencies in the system. The report stated there are currently 174 miles of water lines which are deficient due to being under-sized, and the water district is not capable of adding customers.

Redundancy and New Technology problems

SLRO – Water District

This district is an example of an engineering firm pushing against the design guide to be allowed to use a new and "improved" natural draft aerator. Neither the 1988 nor the 2003 Design Guides mention natural draft aerators because it was assumed that no one would propose one. Eventually the department allowed the system to install a new natural draft aerator and it proved to have all of the problems of the old natural draft aerators plus a few more. The system has replaced the natural draft aerator with a mechanical induced draft aerator at considerable expense to customers.

The system's plant also deviated from both the 1988 and 2003 Design Guides by not being able to operate with one of its filters out of service for maintenance. Whenever work is done on the filters, existing municipal customers have to use their old water supply systems and buy water from other systems.

Again going against the 2003 Design Guide, a single painted steel treatment basin was constructed. When this basin has to be painted the plant needs to shut down for 6 to 8 weeks. Municipal customers are forced back on their old water sources and treatment facilities. This makes it difficult for customers to justify purchasing from a regional supplier if they must continue to maintain their old water sources and treatment facilities.

Another deviation from the 1998 and 2003 Design Guides is that the water authority only has one well as its sole source of water. The system is having repeated problems with this well which requires the plant to be shut down repeatedly. While the plant is shut down the systems served have to use their old water supply systems and buy water from other systems. The result is this supplier has lost credibility as a reliable source of water.

<u>NERO – municipality</u>

After many years of struggling with a river plant and associated issues, in 1982 the city system drilled wells in the Mississippi River alluvium and built a groundwater lime softening plant several miles north of the city.

Instead of a conventional lime softening plant, and against the advice of department staff, the city and its engineers decided to construct a Spiractor. The Spiractor is a tall cone shaped treatment unit that was supposed to remove hardness from the water and convert the treatment residuals to solid beads. Because of findings suggesting that the technology would not work for this system, the Permits Section required that the proposed facilities be two-stage treatment with the second stage being a conventional solid contact unit.

The treatment facilities were constructed at the cost of $1,700,000 and as feared the Spiractor did not work well and proved to be very expensive to operate. The treatment residuals were not converted to beads and all residuals had to be pumped to sludge lagoons. In addition, the installed solids contact unit did not meet department standards or approved plans and specifications and subsequently did not provide the needed treatment.

The city did not have the funds to replace the “new and innovative” facilities and struggled with providing adequate service for several years while they searched for funding. Major repairs and replacements were necessary to maintain performance while the system waited for funding to replace the technology entirely. In 1989 they replaced the Spiractor with a conventional solids contact unit that met department standards. But they did not replace the bulk lime storage facilities or the second stage solids contact unit. Department staff insisted that they keep the second treatment stage because the city decided to save money and used painted steel for the internal baffles and workings of the contact unit.

In 1997 the residuals lagoons were modified for approximately $100,000 to allow the sludge to be dried and removed for land disposal since the Spiractor was not converting the residuals to solids. The city also replaced the original lime silo and feeding facilities at substantial additional cost because of constant conveyor and silo plugging problems that were experienced. In 2012 the system replaced the existing second stage solids contact unit with one that meets department standards and performs properly. They also made repairs to the primary solids contact unit in order to continue providing water while replacing the painted steel internal workings in the existing primary contact unit. After 30 years and millions of additional dollars paid by the customers, the city is finally where it should have been in 1982.

Contract review engineer refused to require design in accordance with design guide since it was not a rule

SLRO Subdivision

Before the developer could turn the water system over to the homeowners, the St. Louis Regional Office received some questions from residents about adequate pressure in the subdivision. This was an issue for the homes at higher elevations near the well and storage tank. The reviewing engineer (contract engineer) approved only 20 PSI normal design pressure and stated that he could not require higher pressure based on the design guide, only the regulatory minimum of 20-psi.

Only because of the magnitude of the sub-standard design that resulted in early customer complaints, SLRO was able to negotiate with the developer prior to him handing it over to the subdivision and he agreed to install two high service pumps to maintain at least 30-psi pressure in the subdivision.