Spring 2010

An Artesian Well System in Beaver Crossing, Nebraska- It's Development and Demise

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INTRODUCTION

The history of Seward County in Nebraska is filled with stories and accounts of finding fresh clean water and green lush valleys in an area well suited for settlement and eventually agriculture. The early pioneers found in this area just what they needed for successful settlement on the plains. In southwest Seward County the town of Beaver Crossing was founded in the 1890's as a gateway between the early settlements of the area and the vast land out west, which had yet to be widely inhabited by European settlers. Shortly after its incorporation, Beaver Crossing became well known for the many flowing wells that yielded clean fresh water into the homes of its residents and into a city pool for the enjoyment of thousands of visitors each weekend. The source of this remarkable creation of nature had its beginnings many years before the settlers found their way here.

Through millions of years of repeated flooding, erosion, and compaction, the deposition of silt and sediment created a natural geological phenomenon. The town of Beaver Crossing provides an example of how a single community could benefit from the gift of a natural resource. The artesian wells that developed in the High Plains Aquifer underneath Seward County proved to be a precious occurrence that provided economic growth and livelihood to a newly forming community. However, Beaver Crossing is also an example of how the demise of this resource could negatively impact a town and its residents.

As the small town grew, it continued to enjoy its prosperity and seemingly endless

bounty of fresh water. Over time residents and nearby farmers were forced to pay closer attention to, and in some cases correct, some of their community development practices. Early in the twentieth century, people began to pay attention to groundwater issues and how they would affect the lives of settlers. This is especially true in rural areas where groundwater pumping began as soon as farmers figured out how to tap into their underground resource with rudimentary irrigation wells.

DEVELOPMENT OF AN ARTESIAN WELL SYSTEM IN BEAVER CROSSING

Aquifers and Wells

The largest source for fresh underground water in the central plains of the United States lies within the High Plains Aquifer which underlies most of Nebraska and parts of Colorado, Kansas, New Mexico, Oklahoma, Texas, South Dakota and Wyoming. This regional aquifer, which covers 174,000 square miles, consists of hydraulically connected geologic units of late Tertiary or Quaternary Age (Guetentag et al 1984).

In eastern Nebraska, the aquifer includes sands and gravels of the Pliocene Age (late Tertiary), Pleistocene Age (early Quaternary), and the Ogallala group of Miocene Age (also late Tertiary) (Kuzelka et al 1993). The Ogallala formation, which underlies 134,000 square miles, is the principle geologic unit in the High Plains Aquifer. This formation consists of clays, sands and gravels deposited by streams that had flowed eastward from the Rocky Mountains. In many parts of the High Plains Aquifer, Quaternary alluvial deposits directly overlie the Ogallala or other Tertiary units, forming hydraulically connected aquifers (Guetentag et al 1984). This is the sort of formation that is well suited for obtaining groundwater from below, either by drilling into for a well or

tapping into water under pressure to access an artesian well.

A water well is made by digging or drilling through the zone of aeration into the zone of saturation. The zone of aeration contains both air and water in its open pores. Within the zone of saturation all spaces are filled with water. The water table is the surface that separates these two zones. At the surface of the water table, within the capillary fringe, water will rise up from the saturated zone to the zone of aeration by surface tension (Monroe and Wicander 1995). A well for irrigation pumping is completed by placing a casing and a screen inside the drilled borehole, along with a pump inside the casing.

When drilling a well, once the zone of saturation is reached, water seeps into the well through the screen and fills it to the level of the water table. Most wells must be pumped to bring groundwater to the surface. With continued pumping the water table surrounding the well is lowered because water is often removed faster than it is replenished. A cone of depression will form around the well depending on how much water is being withdrawn and the ability of the zone of saturation to transmit water. If water is pumped faster than it is being recharged the water table is lowered and if the well is too shallow it will go dry (Monroe and Wicander 1995). These basic principles also apply to free flowing or artesian wells.

An artesian well is a system in which groundwater is confined above and below by an impermeable layer, an aquiclude. Because the water is confined, hydrostatic (fluid) pressure builds up. When the aquiclude, or confining layer, is drilled through, pressure is reduced and water is forced upwards through the well hole. The surface defined by the water table, called the artesian pressure surface, determines the height to which water will

rise. An artesian well will flow freely at the ground surface if the well head is sunk to a level below the artesian pressure surface. If the well head is at or above the artesian pressure surface, the well will be non-flowing (Fig. 1, Monroe and Wicander 1995).

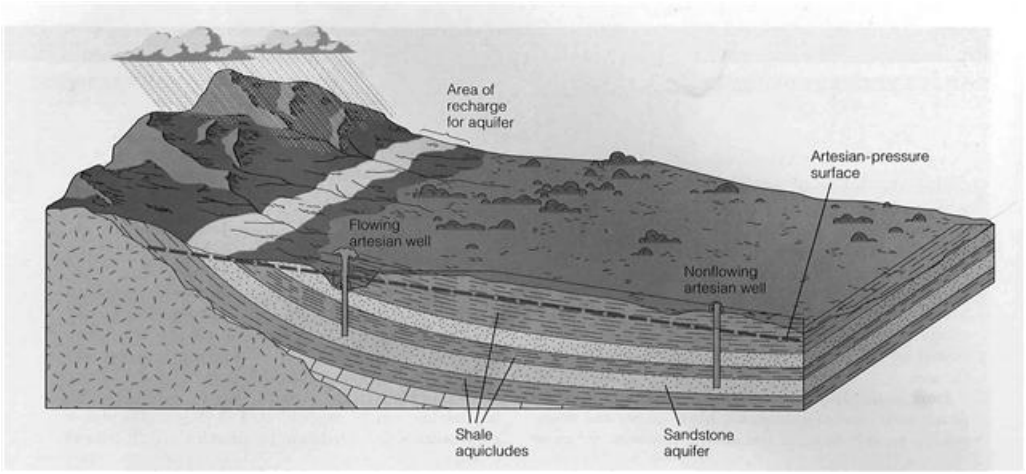

Figure 1. Typical Artesian System (Monroe and Wicander 1995)

For an artesian system to develop three geological conditions must be present: (1) the aquifer must be confined above and below by aquicludes that prevent water from escaping; (2) the rock sequence is generally tilted and exposed at the surface, enabling recharge to occur; (3) sufficient precipitation must occur to keep the aquifer recharged. These conditions can occur in a variety of ways and are common in areas underlain by sedimentary deposits and along stream valleys and terraces (Monroe and Wicander 1995). It is such a system in Seward County, that provided the water in Beaver Crossing's artesian wells in the early days of the community.

Figure 2. Location of Seward County in Nebraska (Keech 1978)

Seward County is in southeastern Nebraska (Fig. 2, Keech 1978). The western two-thirds of the county is underlain by sand and gravel deposits of the Quaternary Age (Keech 1978).

The western most part of the county also has deposits of the Pleistocene Age in valley positions and beneath the uplands (Quandt 1974). The village of Beaver Crossing lies in the extreme southwest corner of the county along the West Fork of the Big Blue River in the M township (sec. 2, T.9 N., R.1E) (Fig. 3 Plat Maps Seward County 2002). It is in this streambed, among the sand and gravel deposits, that the artesian basin responsible for the flowing wells lies (Fig. 4, Keech 1978). The early settlers in the area would find this to be one of the best reasons to settle there.

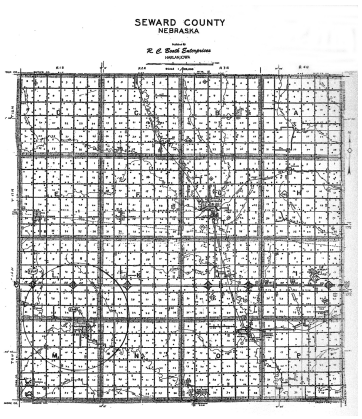

Figure 3. Location of Beaver Crossing Township M in southwestern Seward County along the West Fork of the Big Blue River, (Plat Maps Seward County, 2002).

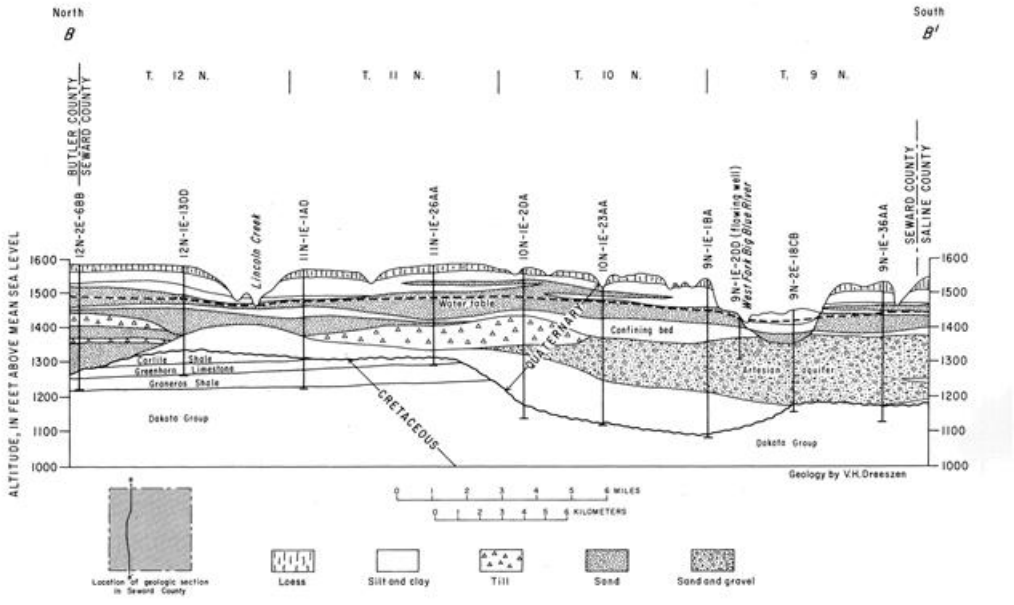

Figure 4. Cross section of Geologic units below Seward County. West Fork of the Big Blue is on the right (Keech 1978).

SETTLEMENT OF BEAVER CROSSING AND DISCOVERY OF FLOWING WELLS

The Early Years

During the 1860's, as westward expansion was happening in the United States, one route to the Oregon Trail from Fort Leavenworth, Kansas followed a course due west of Nebraska City to the North Blue River. It was here that the first bridge in Seward County was built across this stream. Where the West Fork of the Blue River meets Beaver Creek in the northern part of the county, the wide valley provided for easiest access to the west. After following the valley a short distance the travelers encountered a tributary of the West Blue River. Walnut Creek was dry only several months a year and a detour had to be found. A crossing was found about three miles to the north reentering the West Blue Valley a couple of miles east of Beaver Creek. Here in the valley on the site of an ancient lake bed, coarse thick gravel provided easiest passage for wagons and schooners weighted down with freight. This was the 'Beaver Crossing' from which the town derives its name. First settlement here is recorded in 1862 (Graff 1967).

As settlement in the area increased a thriving flour mill was built on a piece of land about four miles southeast of the crossing. In approximately 1871, a post office and store were erected along side the mill and the towns center was moved away from the original crossing. However, the town retained its name. A plat was surveyed and filed at the county seat in 1875. The population of Beaver Crossing at this time was approximately 50 people (Graff 1967).

In 1895 one of the towns' mercantile owners had a well in his store for public use, but the water had become impure and unfit for use. The owner hired someone to

sand-pump and sink the well deeper to secure better water. As the well went deeper and deeper, water that had been held under pressure, forced its way up into the cellar. The cellar began to fill with water at a very rapid rate. This caused great excitement and others in town were anxious to try their luck for such a well. Before long there were many flowing (artesian) wells around town and within three or four miles on either side of town (Graff 1967).

The wells brought great potential to the town, not only for firefighting but also for production of ice in the winter to preserve food. Soon almost everyone with a flowing well had an irrigated garden or orchard. Truck farming became a very profitable business, and as soon as the first pool was filled, it became one of the most popular destinations in the area.

In the years before the turn of the century, Beaver Crossing grew into a small frontier town. By 1888, its population was estimated at 218 residents, and it was home to a flour mill, two churches, a grain elevator, a post office, a school, a newspaper, and a doctor (BCCC 1975). By 1891, the enrollment at the school was up to 92 students and the population of the town grew from 212 in 1892 to 500 people in 1900 (BCCC 1975). By then, residents were enjoying the water that flowed freely from artesian wells all over the community, as well as up and down the valley.

The Swimming Pool at Artesian Park

In 1908, the town acquired nine acres of ground to create a park for its residents. The area chosen was a spot with plenty of shade and several flowing wells. A large spring-fed lake was already being used by locals for swimming, boating, and fishing. The

town leased it to a local resident and with the addition of bath houses, it soon became a favorite local attraction. By 1909, the town had been hosting annual summer picnics for years, so the addition of an open air pavilion with a seating capacity of 2,000 people added to the attraction (Fig. 5, BCCC 1975).

Figure 5. An early photo of the pool approximately 1908 (BCCC 1975)

The population of the village would peak during these early years. Between 1901 and 1910, the village was home to seven churches, three blacksmiths, six doctors, three pool halls, several mercantile stores, and two hospitals. The population count in 1910 was 1,000 people, the most recorded in its history (Graff 1967).

In 1913 another well was bored into the west side of the lake in the city park, and two new bridges were built, one across the southwest corner of the lake, the other across the north end. This provided access to more of the park for guests. In 1915, a new bath house was built and in 1916 a large platform, the 'turtle roost', was built in the center of the pool. The roost served as a diving platform, as well as a resting place for swimmers. The next year 20 new bath houses were built. A reported 500 people were at the park the

week before these were completed. Eventually, a bandstand was constructed at the top of the 'turtle roost' (Fig. 6, BCCC 1975).

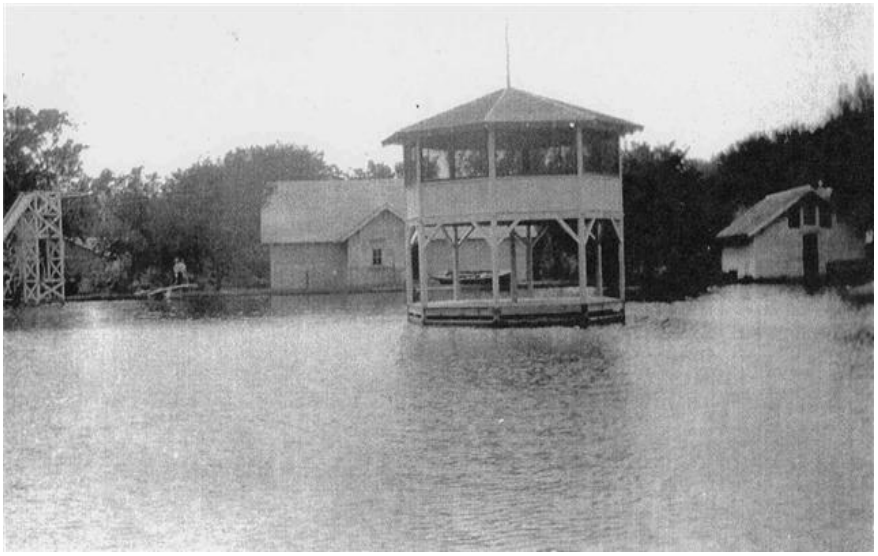

Figure 6. Swimming Pool, the 'Turtle Roost' and Bath Houses (BCCC 1975)

Growth of the pool and park continued at an amazing pace. In 1918, several fountains were added to the park as well as the purchase of a slide, swings, and boats for use at the pool. A front street bridge was added to give direct access to the park for automobiles and an entrance arch spanned the street. By now, the park had been dubbed Artesian Park. The pool, measuring 225 feet across and being fed by fresh, cold water, made it the only one of its kind in the state. On a busy July weekend in 1919, an estimated 1,500 visitors used the park and its facilities (BCCC 1975).

By 1923, Artesian Park was home to an ice-cream parlor, an amphitheatre, a baseball diamond and grandstand, an entertainment pavilion, many bath houses, and electric light poles. On two different weekends in July of 1925, an estimated 3,000 to 4,000 people visited the park (Fig. 7, BCCC 1975).

Figure 7. An afternoon in the Pool (BCCC 1975)

During the twenties the town had two hospitals, several saloons, a lumber and coal company, two banks, at least one blacksmith, up to five churches and a number of grocery and retail stores. The population in 1920 was 543 people (BCCC 1975).

Produce Gardening

In the early 1900's, as the flowing wells provided clean, available water to the community, more residents of Beaver Crossing began to irrigate gardens and fruit orchards. Small fruit, especially strawberries, and potatoes were the main crops. In 1904, the community shipped, by rail, 96 cars of potatoes with 500 bushels each (BCCC 1975). This proved profitable well into the 1920's. As early as 1905, villagers began talk of building a canning factory. Committees formed and meetings were held, as truck farmers considered this development and their possible economic gains.

Ice Harvesting

Almost as soon as the people of Beaver Crossing could access clean, fresh water

from the numerous artesian wells around the community, they began to reap benefits from

it. As early as 1888, at least one ambitious resident built an ice house and began to harvest ice for the residents. Next to a marsh, which was fed by a flowing well, he built a shed into the ground. The ice ‘chunks’ or ‘cakes’ were packed with chipped ice to prevent thawing and a thick layer of straw was added to the top to provide ice well into the summer months (BCCC 1975).

Aquiculture

In August, 1927, Mr. Erle Smiley purchased some land southeast of town and platted it for a fish farm. He chose the artesian well area because he knew that rainbow trout would successfully breed in the constant year round temperature of 54 degrees. After several attempts with dirt bottom ponds, which proved too porous to hold water, he constructed nine concrete ponds 50 x 8 feet and three feet deep (Fig. 8, Anne Miiler). After some trial and error, a few years later he added a hatching house. He proved successful in hatching, raising, and selling thousands of the trout to hotels and the Pullman dining service(BCCC 1975) (Fig 9, Anne Miiler).

Figure 8. Concrete pond, artesian well at rear, Smiley's Water Garden (Anne Miiller, Private Collection)

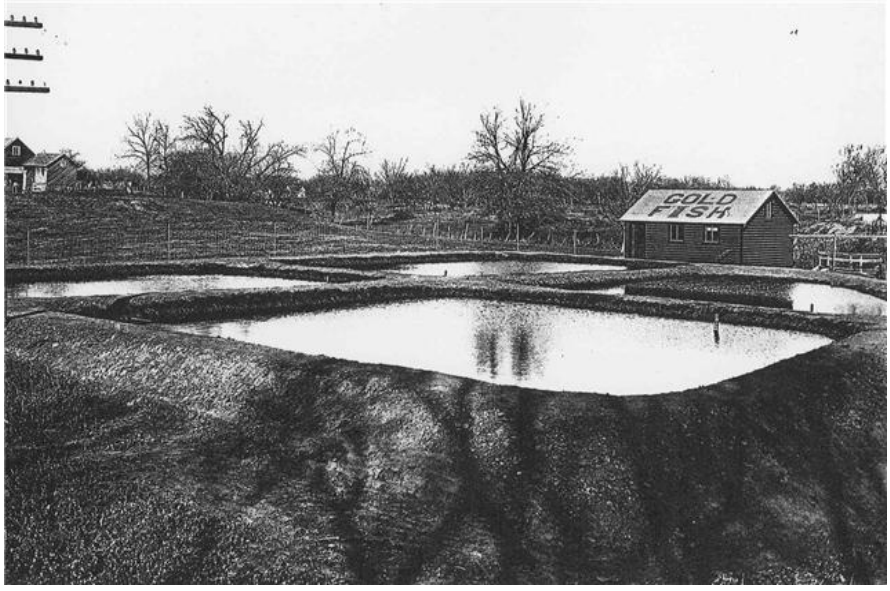

Figure 9. Early hatching house and fish pond at Smiley's Water Garden (Anne Miiller, Private Collection)

By 1931, Mr. Smiley had fifty ponds used to propagate goldfish and water lilies for commercial industry. Along with a wide variety of other flowers he grew on his property, he sold the goldfish and water lilies to every state in the union. His botanical gardens brought hundreds of people to Beaver Crossing each summer and these gardens were the second largest of their kind in the world at the time (BCCC 1975) (Fig.10, Anne

Miiller)

Figure 10. Lily Ponds at Smiley's Water Garden (Anne Miiller)

Mr. Smiley passed away in 1938 and tenants tried to carry on, but soon their lack of experience and funds forced closure on this beautiful site. Eventually, many of the ponds were filled in (BCCC 1975).

The 30's, the beginning of the end

Throughout the following years, the wells continued to flow clear, clean water and most residents considered them to be inexhaustible. During the 'Dust Bowl' years of the 1930's, some wells began to exhibit diminished flow due to drought as well as irrigation that was going on. As some wells began to 'go dry' along the main street, citizens began to consider methods of controlling the 'wild wells' - wells with large flow that were

allowed to run day and night, year round.

A committee was chosen and a group of men set about capping or shutting down

wells. Up and down the valley owners generally cooperated with this effort. Taking the 'wild wells' out of operation conserved enough flow that the 'dry wells' began to flow again (BCCC 1975).

Throughout the years as irrigation wells were bored, the artesian wells would decrease flow or 'go dry' during the summer and flow again in the fall. As the water table continued to drop some wells had eventually 'gone dry' permanently. An estimated 200 flowing wells were in operation during their peak, which was before the dry years of the 1930's (BCCC 1975).

The Swimming Pool at Artesian Park

In 1929, the park was deeded to the State Bank of Beaver Crossing jointly with Citizens Bank. In 1933, the village board received abstract and deed for the park from the banks in exchange for money they had on deposit when the banks closed during the 'Great Depression'. During the 1930's more construction and maintenance continued at Artesian Park. Dances were held in the pavilion and free movies were shown every Friday night until the 1940's (BCCC 1975).

By 1946, the village was leasing the park to private parties and much work was required to maintain it. By that time a new gravel bottom was required, and with dwindling attendance, it was decided to abandon use of the pool. Bath houses and the 'turtle roost' were torn down in the 1940's. In approximately 1952, the town elders decided to fill the pool and stock it with fish for the town youth. This continued for a few years, but by 1962 the site was filled with dirt and leveled (BCCC 1975).

Produce Gardening

It wasn't until 1935 that the canning factory had become a reality. In the fall of that year, over 1,000 cans of sweet corn, beets, carrots, green beans, peaches and pears were produced in Beaver Crossing. In 1936, 100 acres of land in the valley had been slated to farm tomatoes, irrigated by the water from the artesian springs in the area (BCCC 1975).

The produce business and canning factory, owned and operated by different individuals or cooperative groups, proved successful for several years. By the 1940's, with the country at war, man power for field work became scarce and the last reported factory supported by local gardening closed in the early 1950's (BCCC 1975).

THE DEMISE OF THE ARTESIAN SYTEM

Factors Influencing Groundwater Levels

When determining groundwater levels, a measurement is taken of the water's depth below ground surface. The level of the groundwater will decline if the amount of recharge is less than the amount of discharge.

Recharge occurs from precipitation as well as from irrigation return flow and seepage from surface water sources. Discharge occurs as base flow to streams and lakes and is also a result of groundwater pumping for irrigation. Discharge can also occur through evapotranspiration, the return of moisture to the air by evaporation from soil or transpiration from plants. When recharge and discharge are balanced groundwater levels remain unchanged (Korus and Burbach 2009).

Nebraska is fortunate to have soils and geology formations that allow

groundwater infiltration. Water will move slowly within these formations to reach groundwater and may stay for a long time, creating plentiful groundwater reserves (Kuzelka et al 1993). Not all available water reaches these reserves, if it does it may not stay there, largely due to the amount being pumped for irrigation (Kuzelka et al 1993).

Irrigation and Drought

In Nebraska, irrigation is the largest consumptive use of water. Surface water was first used for irrigation. Limited quantities and unreliable supply restricted its use. Groundwater is more abundant and reliable for irrigation. Once data was developed showing where groundwater occurred and technology was developed to tap into it, groundwater became the predominant source for irrigation in the state (Kuzelka et al 1993).

According to a report published by E. H. Barbour in 1901, in Scientific American, one of the earliest irrigation developments in Nebraska was 115 acres near Beaver Crossing (Keech 1978). This development was supplied with water from nine shallow artesian wells along the valley of the West fork of the Big Blue River. These wells ranged in depths from 90 - 140 feet and were developed in a sand aquifer that laid under a 50 foot confining bed of clay (Keech 1978). The territory upon which these wells were developed extended over the width of the valley for a distance of about fourteen miles up and down the valley (Waterman 1916).

Even though the development of irrigation in Seward County was recorded so early in the century, this was not a common occurrence throughout the state at the time. Real growth in groundwater irrigation would have to wait until better drilling equipment

was developed and until more was known about the quantity and location of water in the state.

One of the earliest groundwater investigations was done in 1896 in southeastern Nebraska by Nelson H. Darton. A few other studies followed shortly after that by Darton, G. E. Condra, O. E. Meizner, and R. C. Cady (Kuzelka et al 1993). An investigation of groundwater resources on the lower Platte Valley and adjacent uplands was done by the U. S. Geological Survey in cooperation with the state of Nebraska in 1930 (Kuzelka et al 1993). With well drilling becoming more common, by 1934 Nebraska became the first state to initiate a state-wide well observation program (Kuzelka et al 1993).

Although the 1930's proved to be a time of discovery in the field of groundwater investigation, and more information was becoming available, drilling equipment would not develop at the same pace. Nebraskans would have to endure the drought of the thirties before they would begin to realize any benefits from irrigating with groundwater.

Seward County's annual average rainfall between 1930 and 1972 was around 27 inches. Among the driest of these years were the 1930's. In 1934 the yearly rainfall was almost twelve inches below average, in four of the next six years yearly rainfall amounts would average six inches below normal (Keech 1978).

The 1930's in Beaver Crossing was a time when many flowing wells began to exhibit diminished flow. Residents of the village could no longer assume that the underground water supply would last forever.

With the diminishing supply of water, farmers became more interested in developing groundwater irrigation for crops. The 1940's provided ample precipitation in the area, with all but two years during the decade recording average or above average

precipitation (Keech 1978). The widespread development of irrigation would wait another decade.

By 1945 a water resource investigation by the USGS was expanded as part of a Department of Interior program (Kuzelka et al 1993). In 1947, Vince Dreezen, later director of the University of Nebraska Conservation and Survey Division (CSD) joined forces with Eugene Reed, a CSD geologist to develop a database on groundwater availability. Reed had played a critical role in initiating a state wide test-drilling program to assess groundwater supplies after World War II (Kuzelka et al 1993).

After WW II Seward County faced another drought. During the 1950's farmers began to more actively explore groundwater irrigation. Technology had progressed and information about groundwater became more available.

In Seward County a few irrigation wells were installed by the end of 1948, and only fifteen more were in use by 1952. The years between 1955 and 1957 were very dry, during two of those years rainfall in Seward County was at least ten inches below normal (Keech 1978) and farmers were becoming desperate to improve their crop yields. By the end of 1957, 300 irrigation wells were in use in the county and by 1970 the number of irrigation wells would be over 500 (Fig. 11, Keech 1978).

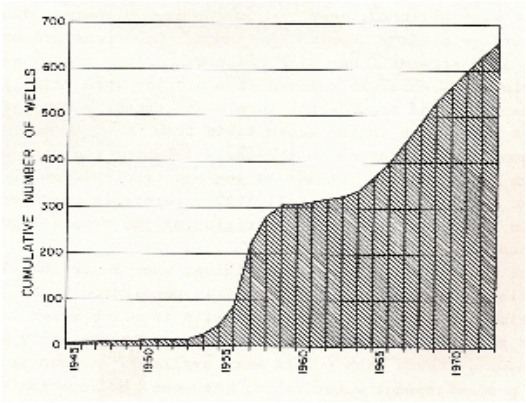

Figure 11. Number of Irrigation Wells installed per year in Seward County (Keech 1978)

The years before 1950 are considered the pre-development years because the water table configuration and amounts of groundwater showed no substantial change. The recharge and discharge remained in balance prior to development of groundwater irrigation. Heavy withdrawal of groundwater for irrigation removed water from storage and groundwater levels began to spike downward.

By 1950 Smiley's Water Garden in Beaver Crossing had been out of operation for over ten years. In 1952 the pool at artesian park was filled in, the town would never see anything like this again (BCCC 1975). The era of the flowing wells was over as groundwater levels in the area continued to fall with the advance of irrigation development,

After no significant change in groundwater levels in Seward County until 1955, the rate of decline increased greatly after 1963. The decline shown in a hydrograph from an irrigation well four miles west of the town of Seward, NE (Fig. 12, Keech) is consistent with much of the county during that period.

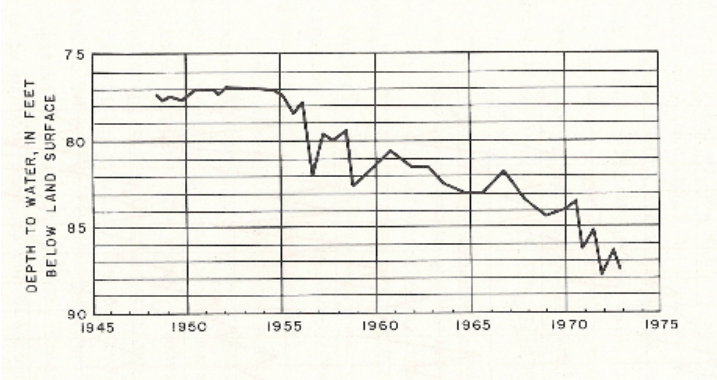

Figure 12. Hydrograph from Seward County Irrigation Well (Keech, 1978)

By 1972 water level declines between five and ten feet were common in parts of Seward County. The largest area that recorded a ten feet decline was forty square miles in the west-central part of the county along the divide between Lincoln Creek and the west fork of the Big Blue River, north and west of Beaver Crossing (Keech 1978).

Measurements of groundwater levels for Seward County in the spring of 2009 show a decline of over five feet from pre-development days (Korus and Burbach 2009). This decline is consistent with most of the state for the same time period, especially in areas where extensive use of groundwater for irrigation has been going on for decades.

CONCLUSION

The town of Beaver Crossing in south-east Nebraska was settled in the 1890's as a gateway to the unsettled lands out west. It soon became well known for its abundance of fresh water in the form of many flowing wells.

The source of these wells is found in sand and gravel deposits left over millions of years by flooding and erosion. Some of the water within these deposits is held under

hydrostatic pressure. When that water is tapped into flows freely to the surface, this is an artesian well system.

As soon as the town of Beaver Crossing discovered its underground wealth, its residents were anxious to reap some kind of benefit from it. By 1910 the town was enjoying a large park with a swimming pool fed by artesian wells. A booming produce market, as well as ice industry were also results of the abundant water.

By 1930, local resident, Erle Smiley, had built a thriving water lily and goldfish business on the south end of town. For years he exported his products to every state in the country.

Residents of Beaver Crossing seemingly paid no attention to what may occur from unlimited withdrawal of water from the artesian basin. Records indicate that when drilling first occurred some of the wells were left to flow freely, while others experienced reduced flow. After many years of enjoying the water provided by the artesian system, the

town began to see the water disappear.

The 'Dust Bowl' years of the 1930's proved to be detrimental to the supply of water. Not enough rain fell to replenish the underground aquifer and the water gardens disappeared. When technology for drilling irrigation wells became available in the 1950's and the area experienced another drought, the wells that fed the towns pool began to go dry. The pool became difficult to maintain and was not used during the fifties, by 1964 it was abandoned and filled in.

The era of the artesian water in Beaver Crossing had come to an end. Not one single factor brought this about, but probably a combination if things. Early on, residents

either paid no attention to, or just didn't know how their unintended, limitless pumping would affect water levels. This attitude, along with the droughts of the 1930's and the 1950's and growth of irrigation lowered the water table in the region. Beaver Crossing would not see this kind of activity again.

In the fall of 2009 the Upper Big Blue Natural Resource District in York, Nebraska did a count of wells in the Beaver Crossing area, along the valley of the West Fork of the Blue River. According Marie Krausnick, Lead Water Resource Technician, the count was done to see how many wells were actually still flowing, no measurements of depth or flow were done. She said they checked 32 wells along the river they thought might still be flowing, of these, 15 were still flowing above ground without being pumped (Krausnick 2010).

In the years since wells were freely flowing up and down the valley near Beaver Crossing I think people in general are more concerned about conserving water resources. Much has been learned about the availability of water and I'd like to think that if residents of town knew more about conservation when they discovered the flowing wells, maybe they would have treated them differently. The droughts that were experienced could not have been avoided, obviously, but possibly alternative practices in management could have made a difference in the long term viability of the wells and all they brought to this small town.

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