1. NAME AND LOCATION OF PROPERTY

Historic Name: Kregel Windmill Company Factory

Other Name/Site Number: Kregel Wind Mill Company**;** Kregel Windmill Factory Museum

Street and Number (if applicable)**:** 1416 Central Avenue

City/Town: Nebraska City **County:** Otoe **State:** NE

2. SIGNIFICANCE DATA

NHL Criteria: 1

NHL Criteria Exceptions: N/A

NHL Theme(s): I. Peopling Places
3. Migration from outside and within
V. Developing the American Economy
1. Extraction and Production

Period(s) of Significance: 1902-1941

Significant Person(s) (only Criterion 2)**:**

Cultural Affiliation (only Criterion 6)**:**

Designer/Creator/Architect/Builder: Unknown

Historic Contexts: *Labor History in the United States*
XVIII. Technology
D. Tools and Machines

3. WITHHOLDING SENSITIVE INFORMATION

Does this nomination contain sensitive information that should be withheld under Section 304 of the National Historic Preservation Act?

___ Yes

_X_ No

4. GEOGRAPHICAL DATA

1. Acreage of Property: Less than one acre

2. Use either Latitude/Longitude Coordinates or the UTM system:

Latitude/Longitude Coordinates (enter coordinates to 6 decimal places)**:**
Datum if other than WGS84:

	Latitude:	**Longitude:**
A:	40.676841	-95.863553
B:	40.676841	-95.863751
C:	40.677189	-95.863751
D:	40.677189	-95.863553

3. Verbal Boundary Description: Entirety of Lot 8, Block 15 Original Town of Nebraska City, Otoe County, Nebraska. The building fronts Central Avenue to the building's south. The lot line separates the nominated area from Lot 7 to the west, a single-family dwelling-turned-museum office, which is now part of the legal parcel that also includes the Kregel Windmill Company Factory. The building's east boundary is its outer wall, which adjoins the neighboring building. The northern boundary is a gravel alley.

4. Boundary Justification: The nominated property includes the entire lot historically associated with the Kregel Windmill Company.

5. SIGNIFICANCE STATEMENT AND DISCUSSION

INTRODUCTION: SUMMARY STATEMENT OF SIGNIFICANCE

The Kregel Windmill Company Factory in Nebraska City, Nebraska, is nationally significant under NHL Criterion 1 and the NHL theme of "Peopling Places: Migration from Outside and Within," due to its outstanding ability to illustrate the windmills' instrumental role in facilitating non-indigenous settlement on the American Great Plains. The factory is also significant under the NHL theme "Developing the American Economy, Extraction and Production" for its exceptional ability to convey the history and impact of windmill manufacturing in the United States during the early twentieth century. The National Historic Landmark theme study on *Labor History in the United States* identifies the Kregel Windmill Company Factory "as possibly the only intact and extant example of a windmill company of its size," saying further that "the property has a strong ability to illustrate the significance of windmills for advancing agricultural production in Nebraska and other plains states."[1] The property is associated with the Labor History theme "Working and Moving," as windmills allowed new areas to be developed for agricultural use and settlement, contributing to the distribution of settlement and labor throughout the Great Plains. The period of significance begins in 1902, when the Kregel Windmill Company Factory was constructed, and ends in 1941, when national windmill manufacturing was dramatically reduced. This is also believed to be the year the Kregel Windmill Company produced its last windmill.

This property is nationally significant because it illustrates broad national patterns in the history of windmill manufacturing in the early twentieth century. At its peak, windmills were produced by large, national firms and small, local companies alike. Kregel represents the latter, as a family-owned business, operating out of a single building, and relying predominantly on local sales. Each manufacturer designed and patented its own windmill to avoid copyright infringement, creating a vast collection of windmill types across the country. For the Kregel Windmill Company, its patented mill was the ELI. Kregel and nearly all other windmill manufacturers also sold a variety of products that were often agriculturally related or of interest to local customers. Over the thirty-nine-year period of significance, the Kregel Windmill Company's fortunes mirrored those of the national windmill market. Consistent production during the first two decades of the twentieth century slowed following World War I as an agricultural depression set in. During the Great Depression, the business leaned heavily on maintenance and repair of existing mills, selling very few new mills. Finally, the Kregel Windmill Company ceased windmill manufacturing in the early 1940s as the country committed itself to its involvement in World War II and new technology replaced the role of the windmill.

The Kregel Windmill Company Factory is unparalleled in its ability to illustrate the history of windmill manufacturing in the early twentieth century. While other windmill manufacturing buildings remain, most large manufacturing complexes have lost a considerable portion of their buildings or have been substantially modified. Smaller manufacturing buildings remain but have been altered for various uses over the past seven decades. The interior of the Kregel factory remains intact and contains a full complement of functional and functioning wood and metal equipment used in the manufacturing of windmills remaining *in situ* in workspaces as they appeared during the factory's operation. The building and its contents demonstrate how Americans effectively constructed wind machines to employ the renewable power of the wind. A rehabilitation of the building completed in 2012 followed the Secretary of the Interior's Standards, resulted in minor visible alterations, and allowed for the building to be opened as a museum. The property retains a very high degree of historic integrity. The company's records, dating back to Louis and George Kregel's formation of the Kregel

[1]Rachel Donaldson, *Labor History in the United States,* A National Historic Landmarks Theme Study (Washington, DC: National Historic Landmarks Program, National Park Service, January 2022), 358.

Manufacturing Company, are housed at the Nebraska State Archives in Lincoln, and constitute the only complete collection of windmill manufacturing records available for public research, giving an unparalleled look into the history of a windmill manufacturing company.

Windmills played an important role in allowing railroad expansion across the arid prairie, thus connecting the eastern United States with territories and states in the west. The expansion of the railroads and windmills' ability to obtain subsurface water made possible the settlement of the vast dry acres of the Great Plains by farmers and the growth of the large ranches of the western prairies. Though the Kregel Windmill Company Factory never produced windmills for railroad usage, it is the sole remaining intact factory that represents the windmill makers who helped facilitate the expansion of the American railroad, along with over one-thousand others who provided windmills for domestic and agricultural use.

PROVIDE RELEVANT PROPERTY-SPECIFIC HISTORY, HISTORICAL CONTEXT, AND THEMES. JUSTIFY CRITERIA, EXCEPTIONS, AND PERIODS OF SIGNIFICANCE LISTED IN SECTION 2.

Development of American Windmills

Windmills began appearing on the American landscape during the seventeenth century, brought to the New World by European settlers. Modeled after those used in the settlers' native countries, these mills were slow and cumbersome. The first windmill in America is believed have been erected in 1621 at Flowerdew Hundred Plantation, Virginia. Over the course of the next two centuries, hundreds of European-style ("Dutch") windmills dotted the eastern United States and continued in operation until after the American Civil War. Usually containing between four and eight large, fabric-covered blades, the wheel was mounted atop a multi-story building. As the wind moved the wheel, interior milling machinery was powered to process grains into flours, meal, and feeds, all while requiring consistent attendance by the mill operator. These mills, however, were not adept at pumping water or operating machinery on a small scale. The 1850s was a period of great interest in the development of wind power as sixty wind power related patents were approved during the decade.[2]

Daniel Halladay, owner of a small machine shop in Ellington, Connecticut, developed the first commercially successful windmill design in the United States. Halladay's design fit within the American economy and landscape, and met the need for a small, factory-built windmill that could be mass-produced and easily distributed. Impetus for the design came in 1854 from a local pump-maker named John Burnham, who asked his fellow townsman about the possibility of building a small windmill specifically designed for pumping water or operating small machinery. Knowing that his windmill design needed to be cheap enough for the average farmer, small enough to be shipped to the customer and assembled on site, while being durable enough to withstand high-velocity winds, Halladay successfully designed the first self-governing windmill.[3]

The key feature that differentiated Halladay's windmill design from its European predecessors was that it replaced a few large blades with dozens of smaller blades to receive the wind and, therefore, foregoing the need

[2]T. Lindsay Baker, "A Guide to United States Patents for Windmills and Wind Engines, 1793-1950," *Bibliotheca Molinologica* 18 (Watford, England: The International Molinological Society, 2004): 14-16; Norman W. Hall, "Boyd's Windmill," National Register of Historic Places Nomination, January 26, 2001; B. Christopher Bene and Richard B. Harrington, "Jamestown Windmill," National Register of Historic Places Nomination, March 14, 1973.

[3]The 'self-governing' design allowed the windmill to automatically turn its face toward changing wind directions while controlling its operating speed, preventing damage, or possibly destruction, from high winds. T. Lindsay Baker, "Blowin' in the Wind: Windmill Manufacturing and Distribution in Kansas," *Kansas History* 19, no. 1 (Spring 1996): 7-8; A. Clyde Eide, "Free as the Wind," *Nebraska History*, no. 51 (1970): 26-27; Terry G. Jordan, "Windmills in Texas," *Agricultural History* 37, no. 2 (April 1963): 80.

for a large building on which to mount the wheel. Not only was Halladay's design an eventual success in the United States, in the following years it proved a popular design in Europe, rapidly replacing traditional Dutch windmills.[4]

Burnham and Halladay partnered to create the Halladay Wind Mill Company but found a limited market in New England due to the region's ample rainfall and access to surface water. Burnham relocated to Chicago, Illinois, in 1857, forming the U.S. Wind Engine and Pump Company. Recognizing that future sales looked much more promising along America's western frontier, Burnham's company purchased the Halladay Wind Mill Company and in 1863 moved its entire operation to Batavia, Illinois, just west of Chicago. This placed the windmill's point of manufacture much closer to its client base, reducing both the shipping costs and delivery time for their customers. The move to Batavia did not result in an immediate boom in windmill sales, but over the next decade windmill sales gained momentum, evolving into large production by the mid-1870s.[5]

As Burnham envisioned, the Great Plains provided a market of windmill customers stretching from the Dakota Territory to Texas and into the Southwest. As railroads and settlers pushed westward across the Plains, they encountered a land that became increasingly arid. Annual precipitation drops from 38-45 inches at points along the Plains' eastern edge to less than half, or to even a third of that amount, by crossing to the western edge of any of the regions' states. Crossing Kansas, for example, annual precipitation drops from roughly forty inches to approximately ten by its western boundary, with greater discrepancies present across Oklahoma and Texas. As available water could be found underground, the new windmills provided a convenient and necessary tool for extraction, its efficiency aided by the near-constant presence of wind as a power source.[6]

Between the 1870s and the 1910s, windmill factories were established in areas within or with rail access to the Great Plains, where manufacturers expected the greatest demand for their products. Batavia emerged as the most notable hub of windmill manufacturing, aided by its proximity to established and growing railways, a growing customer base in neighboring states, and access to materials and labor. Following the arrival of Burnham's U.S. Wind Engine and Pump Company in 1863, five other windmill manufacturers set up in Batavia, including the Challenge Company, Benjamin Danforth, Batavia Wind Mill Company, Appleton Manufacturing Company, and Snow Manufacturing. Windmill manufacturing also had a significant presence in northeast Indiana, and Springfield, Ohio, boasted notable companies such as Mast, Foos, and Company, which made the first all-metal windmill in 1872, along with E.C. Leffel and Company, and the Springfield Machine Company.[7] Many of these manufactures may have lasted a single season or made very few windmills, yet the mere presence of that many manufacturers indicates the potential that was seen in windmill manufacturing.

A few notable manufacturers were established on the Plains, with Kansas and Nebraska each having companies that produced windmills for decades. Most prominent of the Kansas manufacturers was the Currie Windmill and Pump Company, which had a reputation of producing the least expensive of all factory-made windmills.[8]

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[4]Alfred R. Wolff, *The Windmill as a Prime Mover* (New York, NY: John Wiley & Sons, 1900), 74-75.

[5]T. Lindsay Baker, "Turbine-Type Windmills of the Great Plains and Midwest," *Agricultural History* 54, no. 1 (January 1980): 38; Baker, "Blowin' in the Wind," 8.

[6]U.S. Department of Commerce, National Oceanic and Atmospheric Administration, "NOAA Technical Report NESDIS 142-4, Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Part 4. Climate of the U.S. Great Plains," (Washington, DC, 2013), 13; Gerlach Brothers, interview by L. F. Sheffy, Canadian, TX, December 29, 1929, quoted in Baker, "Turbine-Type Windmills of the Great Plains and Midwest," 38; Erwin Hinckley Barbour, "Wells and Windmills in Nebraska," *Water-Supply and Irrigation Papers of the United States Geological Survey* no. 29 (Washington, DC: Government Printing Office, 1899), 33, 45.

[7]Batavia Public Library, *Windmill City: A Guide to the Historic Windmills of Batavia, Illinois* (Batavia, IL: 2013), 3; T. Lindsay Baker, *A Field Guide to American Windmills* (Norman, OK: University of Oklahoma Press, 1985), 34-5.

[8]T. Lindsay Baker, "The Currie: 'The Poor Man's Windmill,'" *Windmillers' Gazette* 4, no. 1 (Winter 1985): 3.

Nebraska was home to various windmill manufacturers, the largest of which was the Dempster Manufacturing Company in Beatrice. Two other Nebraska-based firms found sustained success in the windmill business—the Fairbury Windmill Company, located in Fairbury, and the Kregel Windmill Company in Nebraska City.

Some settlers decided to construct their own windmills, though the manufacturing of windmills was never threatened by the practice. Typically made from on-hand scrap material, they cost virtually nothing to produce and the maker was intricately aware of how to fix it should it break down. For many, that was a worthwhile tradeoff for its lower efficiency, especially given the possibility that a farm or ranch may possess multiple windmills spread across its acreage.[9]

Until the early 1880s, windmills were primarily wood with some iron and steel parts. The first successful all-metal windmill was the Mast, Foos, and Company's IRON TURBINE, patented in 1872. Resembling a large metal pinwheel, its curved sheet metal sails were arranged in a spiral pattern. Despite some early success, it took another two decades before metal windmills came into popular use. The man largely responsible for pushing the metal windmill to the forefront of the market was Thomas O. Perry, an engineer at the U.S. Wind Engine and Pump Company. In tests conducted over the course of two years, 1881-1882, Perry determined the proper speed for the wheel to turn, along with the best form, angle, and curvature of the mill's blades. His best performing test wheel was 87 percent more efficient than popular wood models.[10]

Despite Perry's findings, leadership of the U.S. Wind Engine and Pump Company declined his recommendations, deciding to stay with its well-received wood models. Undeterred, Perry teamed up with entrepreneur and inventor LaVerne Noyes and, in partnership with other capitalists, formed the Aermotor Company in 1888. Beyond its steel construction, the AERMOTOR model set itself apart with its back-geared operation. Requiring several revolutions of the wheel to produce one stroke of the pump, the AERMOTOR could run smoothly, rapidly, and in lighter wind than existing direct-stroke wood mills, and was mimicked by its competition.[11]

Though superior in pumping ability, the AERMOTOR and its imitators did not immediately surpass their wood competition. Two components of marketing any product to consumers are cost and reliability. When Mast, Foos, and Company first produced the IRON TURBINE in 1872, and when the AERMOTOR was introduced in 1888, steel prices made the products much more expensive than their wood counterparts. Sales took off in the 1890s when steel prices dropped, making the metal windmills and towers more affordable.[12] In Nebraska, the Kregel Windmill Company turned toward metal windmills and towers shortly after the turn of the century. The local newspaper documented George Kregel's decision in 1902, reporting that he had "been manufacturing only wooden towers for his wind mills, but the people seem to demand a steel tower, and as soon as he gets located in his new place of business will begin the manufacture of the steel towers."[13]

[9]Barbour, "Wells and Windmills in Nebraska," 31-2.

[10]Baker, "Turbine-Type Windmills of the Great Plains and Midwest," 40; Eide, "Free as the Wind," 28-29; Baker, *A Field Guide to American Windmills*, 36-8.

[11]The overall production from the back-geared and direct-stroke mills was relatively equal. A back-geared mill required multiple revolutions per pump, started more easily, slowly ascended to its maximum output, and continued at that rate for a longer time, making it better suited for areas with average low-wind velocities. A direct-stroke generated one pump from the well for each windmill revolution, required a stronger wind to start and rapidly increased and decreased to and from its maximum rate of speed, making it slightly better where high velocity winds were present for long periods of time. It also had less machinery and less wear compared to geared windmills. Baker, "Turbine-Type Windmills of the Great Plains and Midwest," 46; P.E. Fuller, "The Use of Windmills in Irrigation in the Semiarid West," *U. S. Department of Agriculture, Farmers' Bulletin No. 866* (Washington, DC: Government Printing Office, 1910): 20.

[12]Jordan, "Windmills in Texas," 83; Baker, *A Field Guide to American Windmills*, 33.

[13]"He Will Build," *Nebraska City News*, April 11, 1902.

Wood windmills continued to be produced at a growing rate, but that rate of growth was slower compared to that of steel windmills. The cattlemen of Texas and the Southwest continued to rely on their more durable and more-easily repaired wood towers rather than adopt steel models. Some even preferred wood mills because they were quieter than steel windmills. Wood mills and towers remained popular in Texas until World War I, after which their prevalence over steel mills continually declined as new purchases favored the steel windmills.[14]

Although the wind was a free source of energy, that did not mean that the windmill was a cheap or easy item to maintain. The major issue facing manufacturers and their customers was addressing the need for routine maintenance, considering a windmill could run around-the-clock for consecutive days. Care of windmills became as essential to windmill owners as almost any other operation. The constant oiling of windmills led large ranches to employ a "windmiller" whose sole responsibility was to travel from windmill-to-windmill to inspect, oil, and repair them. The mill's height and susceptibility to unexpected wind gusts often put windmillers at risk.[15]

To reduce the windmill's maintenance requirement, the Elgin Wind Power and Pump Company of Elgin, Illinois, worked for six years on a design for a windmill with an oil reserve. When the design was finally completed in 1912, the Elgin WONDER hit the market as the first self-oiling windmill. With working parts and gears operating in a bath of oil, the parts were enclosed from the elements, drastically extending the timeframe for maintenance from weekly to annually. Closed-gear self-oiling windmills dominated the windmill industry moving forward, with nearly all manufacturers altering their designs to incorporate the advancement. Regardless of windmill style preference, the development of self-oiling windmills marked the end of the wood mills and the older open-geared steel mills.[16]

On ranches and farms, windmills were first employed primarily for pumping water for livestock and domestic use, then increasingly for small-scale crop irrigation. For these purposes the windmill proved both reliable and economical. Even inefficient windmills could pump more water than a family typically needed at one time, necessitating the construction of earthen reservoirs. When water was released from these reservoirs, positive pressure moved water through irrigation channels to crops. Beyond irrigation use, reservoirs brought previously unthought of luxuries to the prairie and, eventually, were increasingly viewed as indicators of an owner's prosperity. Reservoirs also allowed settlers to raise fish or recreate by swimming or deploying a small boat. Those in northern climates could cut ice from their reservoir to use for food refrigeration or enjoy skating during the winter.[17]

Windmill technology was applied to other ventures with varying degrees of success. Windmills could be geared to turn drive shafts rather than a reciprocating pump rod. Often mounted on barn roofs, mills were used to grind feed, saw wood, and run churns. Wind power was integrated into factory functions such as turning lathes, powering printing presses, and even ore extraction. Windmills were also used to drain marshes and swamps, remove water from shallow mines, and pump water from ocean going ships. Some attempts were made to use windmills to pump oil. Utilizing wind power for electricity was considered as early as 1860s and was first

[14]F.L. Dole, "Windmill Economy," *The Cattleman* 19, no. 5 (October 1932): 14-15; Baker, *A Field Guide to American Windmills,* 33; Baker, "Turbine-Type Windmills of the Great Plains and Midwest," 45; Jordan, "Windmills in Texas," 83.

[15]Baker, *A Field Guide to American Windmills,* 41-55; Fuller, "The Use of Windmills in Irrigation in the Semiarid West," 44.

[16]Eide, "Free as the Wind," 42; Baker, *A Field Guide to American Windmills,* 43; Baker, "Turbine-Type Windmills of the Great Plains and Midwest," 47-8; Baker, "Blowin' in the Wind," 8-9.

[17]Wolff, *The Windmill as a Prime Mover,* 3; Barbour, "Wells and Windmills in Nebraska," 33-36; Fuller, "The Use of Windmills in Irrigation in the Semiarid West," 28; Eastman, "Windmill Irrigation in Kansas," 183-4; Baker, *A Field Guide to American Windmills,* 57-8.

successful near Cleveland, Ohio, in 1887. In a circular printed prior to 1913, the Kregel Windmill Company described the potential to charge batteries as the "Future of Wind Mills" while listing the bevy of household items batteries could power. The idea of harnessing the wind to generate electricity increased following World War I as electric lighting and radio technology became increasingly popular. In the mid-1920s, both the Dunco WIND-CHARGER and the Perkins AEROLECTRIC mills were promoted for their ability to charge radio and automobile batteries, along with a variety of household appliances and machinery.[18]

Windmills and the Railroad

There is little chance of overstating the importance of the windmill-railroad relationship. As observed by historian Samuel Porchello, the relationship:

> … forever changed America's physical, economic, and social landscape. Boosted by railroad sales, the windmill industry grew and flourished, creating a powerful transportation legacy and enabling the transition of the Great Plains from unplowed prairie to cultivable farmland. Railroad transportation and agricultural opportunities in turn influenced migration patterns and westward settlement, while widespread windmill usage planted the early seeds for the renewable energy movement.[19]

When paired with the growing railroad industry, windmills played a significant role in the expansion and building of America. The railroad was a primary customer of windmill manufacturers, and the railroads' use of the machine promoted its effectiveness to those considering one for themselves. The railroads' purchases contributed greatly to the growth of windmill sales and their use across the Great Plains.[20]

Traditional, steam-powered locomotives required frequent water access to refill their steam engines. Water used in locomotive boilers had to be pure so not to clog nor leave mineral deposits in the boiler tubes, which would eventually result in the engine's loss of efficiency or, possibly, an explosion. Railroad companies discovered the most economical and efficient means to provide water for the engines was to drill wells at predetermined intervals and use windmills to pull water to the surface.[21]

The railroads' purchase, installation, and use of the windmill increased in the 1870s and continued until the end of the century, with windmills and their accompanying tanks lining railroad rights-of-way throughout the country. As railroads transitioned to diesel engine locomotives, windmills and tanks became obsolete by the mid-1900s, leaving few surviving examples today as nearly all have been dismantled and sold for scrap.[22]

Windmill manufacturers signed contracts with railroad companies to produce a large quantity of a specific model of wind machine, dubbed "railroad pattern" windmills. In some instances, windmills were tasked with pumping water from depths of 130 feet or more, requiring them to be much larger than standard mills, varying from sixteen to thirty feet in diameter. Along with the windmill, manufacturers also produced related products

[18]Eide, "Free as the Wind," 31; Baker, *A Field Guide to American Windmills,* 19-20, 58-9; Kregel Windmill Company, "Circular," 1912, Series 6, Subseries 1, Box 33, Kregel Windmill Company Records, Nebraska State Archives, Lincoln, NE (hereafter referred to as KWCR); H.W. Pond, "Heat without Coal: Utilization of Wind Power," *Scientific American* 18, no. 1 (January 4, 1868): 3; Alfred B. Wolff, "Windmills for Generating Electricity," *The Engineer* 65 (February 3, 1888): 88; H.E. Dunn, "The Dunco Wind-Charger – As Free As the Wind," [Advertisement], H.E. Dunn, Inc. to Kregel Windmill Company, April 8, 1925, Series 7, Box 54, KWCR; Landon J. Porter to Kregel Windmill Company, February 11, 1926, Series 7, Box 54, KWCR.

[19]Samuel Porcello, "Windmills and Railroads: A Successful Partnership," *Windmillers' Gazette* 35, no. 3 (Summer 2016): 7.

[20]Ibid., 6; T. Lindsay Baker, "Windmills and the Union Pacific Railroad," *Windmillers' Gazette* 6, no. 4 (Autumn 1987): 4.

[21]T. Lindsay Baker, "Windmills and Railroad Water Systems," *Windmillers' Gazette* 28, no. 2 (Spring 2009): 2.

[22]Ibid., 5; Baker, "Windmills and the Union Pacific Railroad," 4.

such as storage tanks, columns, and goosenecks specifically for use along the railroad. The result of these contracts was cyclical, as windmills allowed the railroad to continually expand, which meant the railroad continued to buy windmills necessary to maintain operations along existing lines and further that expansion.[23]

The Union Pacific Railroad oversaw the first transcontinental railroad with a main line that stretched from its headquarters city of Omaha, Nebraska, to Ogden, Utah. Over this line's 1,039 miles the company counted seventy-five water stations spaced roughly fourteen miles apart and equipped with a Halladay STANDARD windmill. Others followed suit and by the 1870s, over one hundred railroads used Halladay's STANDARD. Other railroad companies bought large quantities of Fairbanks, Morse & Company's ECLIPSE. Given the changing terrain and environmental factors, mills that performed satisfactorily on Nebraska's prairies suffered damage from windstorms on the Front Range of the Rocky Mountains. After nearly two decades, the Union Pacific decided that the solid-wheel ECLIPSE better suited its needs across the Plains and made it their primary windmill.[24]

The expansion of the railroad network also provided an efficient means for windmill manufacturers to distribute their products to settlers in the Great Plains. These companies needed to reach customers who lived too far from factory locations to purchase and transport windmills themselves. For such long-distance orders, railroads clearly provided the most efficient mode of shipment. Utilizing a growing railroad network, large manufacturers could now effectively distribute their products for uses on farms, ranches, and in early settlements.[25]

The ease with which Halladay's design allowed windmills to be manufactured, shipped, assembled, and erected greatly contributed to the rapid growth of production and consumer demand for windmills in the late nineteenth century. Mass-produced and manufactured in pieces, windmills could easily be shipped to the railway station closest to a customer who could transfer it home, allowing water to be drawn virtually anywhere throughout the Great Plains. Once a well provided access to subsurface water, only basic hand tools and limited mechanical knowledge were required to assemble the windmill and tower, allowing the owner to do it themselves.[26]

To improve the efficiency of transporting mills to customers hundreds of miles from their midwestern factories, large manufacturers created branch houses throughout the Plains, which received mills and accessories to be redistributed throughout the region in a timely manner either by train or freight wagon. These branch houses gave national manufacturers a local presence along the frontier, either in competition with or in the absence of smaller, local windmill manufacturers.[27]

Large manufacturers incorporated separate shipping departments and loading docks along railway sidings into their complexes.[28] As beneficial as it was for manufacturers to use rail lines to transport their products to the Great Plains, it was equally as profitable for rail companies as they steadily collected freightage costs for the shipment of windmills. Where spur lines were not able to be laid to a windmill manufacturer, railroads attempted to entice a manufacturer to relocate their shops near their line. Such was the case in Nebraska City,

[23]Baker, "Windmills and Railroad Water Systems," 3; T. Lindsey Baker, "New Mexico Windmill Towers as Vernacular Architecture," *New Mexico Architecture* 28, no. 4 (July-August 1987): 13; Baker, *A Field Guide to American Windmills*, 51-2; Eide, "Free As the Wind," 30-1; Porcello, "Windmills and Railroads," 6-7.

[24]Porcello, "Windmills and Railroads," 7; Wolff, *The Windmill as a Prime Mover*, 94; Everett Dick, "Water, A Frontier Problem," *Nebraska History*, 49 (1968): 241; Baker, "Windmills and the Union Pacific Railroad," 3-4.

[25]T. Lindsay Baker, "How Windmills Moved from Factory to Farm," *Windmillers' Gazette* 39, no. 1 (Winter 2020): 5; Baker, "New Mexico Windmill Towers as Vernacular Architecture," 11.

[26]Baker, "Blowin' in the Wind," 9; Baker, "How Windmills Moved from Factory to Farm," 5-6.

[27]Baker, "How Windmills Moved from Factory to Farm," 6; Baker, *A Field Guide to American Windmills*, 75-6.

[28]Baker, "How Windmills Moved from Factory to Farm," 7.

Nebraska, where the local paper noted that "the Missouri Pacific people are trying their best to get [George Kregel] to locate his wind mill factory on their right of way, somewhere near their freight depot."[29] Kregel did not acquiesce to the Missouri Pacific's request but did, however, embrace a new method of windmill delivery about a decade later, obtaining an automobile license and delivering windmills by truck rather than by horse and wagon.[30]

The Windmill's Impact on Settlement and Agriculture in the Great Plains

The windmill's profound impact on American settlement and agriculture was most visible across the Great Plains, but that is not to suggest that windmill technology was not implemented in nearly all corners of the country. Halladay and Burnham had a market, albeit a small one, from their initial point of business in the northeast. Windmills dotted the Southern landscape, with J.T. McKenzie erecting an Aermotor on his Georgetown, Tennessee, property, and a Challenge 27 similar to the one that President Jimmy Carter's father purchased in 1935 is a point of interest to visitors at the Jimmy Carter Boyhood Farm near Plains, Georgia. President Carter later pushed for the development of wind energy to combat a global energy crisis and authorized the creation of the Department of Energy in 1977, whose official seal includes a depiction of a windmill. During the 1880s, A.H. Southwick of Des Moines, Iowa, advertised that his mills were "California's Favorite." In that state's San Joaquin Valley, near Stockton, windmills were used nearly universally for crop irrigation by 1900, and windmill-irrigated gardens filled markets in urban areas throughout the state.[31]

The Great Plains' drought-resistant river valleys and areas surrounding ground-fed bodies of water were areas that attracted the region's first settlers. The railroad's use of windmills spurred farmers and ranchers to also use them, encouraging non-indigenous settlement and agricultural practices across what was referred to as the Great American Desert and increasing the rapidity of settlement.[32]

Although overland trails had allowed for transcontinental migration by the 1840s, initial non-indigenous settlement of the Plains was slow. With passage of the Homestead Act of 1862, expansion of the railroad, abandonment of the Permanent Indian Frontier, the forced relocation of Native American tribes onto reservations, and the mass production of the American windmill, Great Plains settlement increased rapidly. By the mid-1870s a substantial number of windmills began appearing on the Great Plains beyond those used by the railroads. Early settlers heralded the windmill as "a national blessing" and foresaw its potential in aiding settlement of the vast prairie.[33]

Small towns were established at many of the railroads' water stops, often through the railroads' recruitment of settlers to establish them. The federal government had granted much of the best land on the Great Plains to railroad companies to subsidize the construction of rail lines. Railroad companies painted the Great Plains as an abundant, boundless garden, rather than the semi-arid region it truly was, to attract both American emigration and European immigration. Railroad companies printed circulars and employed overseas agents to attract immigrants, sometimes organizing large groups to relocate as a colony which, if successful, attracted a greater

[29]"He Will Build," *Nebraska City News,* April 11, 1902.

[30]Baker, "How Windmills Moved from Factory to Farm," 7; Baker, *A Field Guide to American Windmills,* 64; "Local Brevities," *Nebraska City News,* June 23, 1914.

[31]Ann Toplovich, "McKenzie Windmill," National Register of Historic Places Nomination, July 6, 1982. The Challenge 27 is a contributing resource to the Jimmy Carter National Historic Site, Plains, Georgia. Stephanie Cohen, "Energy Dreams and Energy Realities," *The New Atlantis* 5 (Spring 2004), 7; Baker, *A Field Guide to American Windmills,* 14; T. Lindsay Baker, "Irrigating with Windmills on the Great Plains," *Great Plains Quarterly* 385 (1989): 219.

[32]Porcello, "Windmills and Railroads," 7; Baker, *A Field Guide to American Windmills,* 51.

[33]Baker, "Turbine-Type Windmills of the Great Plains and Midwest," 41.

number of friends and family from their homeland, providing a steady stream of customers and revenue for the railroad.[34]

Lacking a centralized water system, entire villages often depended upon wind power to pump the town's water supply. This often started as a single town windmill providing water for a public-access point. As settlements began to transform into established communities, municipal water systems powered by windmills were established, creating what could be described as "a forest of wooden towers and whirling wheels" on the arid plains.[35] Town water systems expanded to include standpipes, water mains, and hydrants, all providing domestic water service and ample pressure for fire protection. In urban areas, windmills and tanks also appeared on the roofs of tenement buildings, pumping water for the occupants within.[36]

Windmills could provide rural homes and small villages some of the comforts and modern conveniences of larger cities. Eventually sod houses and ranches included flower beds, hot and cold water faucets, marble basins, and porcelain tubs due to the reliable water access the windmill provided. Outside, clusters of trees became a more common feature near windmills, providing the comfort of shade in the hot prairie summers and some level of protection from harsh winter winds.[37]

Dozens of windmills could be seen in any town, and rail travelers could see the windmills' constant presence across the rural landscape, illustrating the windmill's profound impact on the landscape of the prairie.[38] In Kansas's Arkansas River Valley, windmill irrigation so transformed the land that one person reported that the town of Garden City "was hidden by a luxuriant growth of foliage," that farms were green from early in the spring until fall, and orchards and vineyards had been planted.[39] To the north, University of Nebraska professor and State Geologist Erwin H. Barbour described Nebraska as "the heart and center of the windmill movement" at the close of the nineteenth century.[40] Rainfall in the Platte River Valley was rather limited, generally arriving during the growing season and the sandy soil allowing for much of it to be absorbed, rather than evaporating, to be retrieved later by one of the many windmills in the region.[41]

Many farmers reportedly moved into the Plains and west Texas falsely believing the windmill had the ability to convert the Great American Desert into the Great American Garden. Turning the hot summer wind that once burned and shriveled crops into fuel for windmills, farmers were encouraged to install windmills to take advantage of the inexhaustible resource of the wind to irrigate their fields. However, the wind pumping machines' ability to irrigate large areas of cropland was limited. Many who settled during the unusually wet years of the 1880s retreated east when the typical dry years returned and crops could not survive on the scant moisture the sky provided. Despite promoters' promises about the usefulness of windmill irrigation, the truth was that windmills could never fully support the needs of extensive farming operations. Estimates as to how many acres each windmill could effectively irrigate generally fell between two and five acres, with up to ten acres being possible under the most favorable conditions. While in some instances up to fifty acres were

[34]Jason E. Pierce, *Making the White Man's West: Whiteness and the Creation of the American West* (Boulder, CO: University of Colorado Press, 2016), 153-154; Frederick C. Luebke, "Ethnic Settlement on the Great Plains," *Western Historical Quarterly* 8, no. 4 (October 1977): 410.

[35]Eide, "Free as the Wind," 30-1; Barbour, "Wells and Windmills in Nebraska," 65-6; Jordan, "Windmills in Texas," 83; Baker, *A Field Guide to American Windmills*, 53; Jordan, "Windmills in Texas," 83 (quotation).

[36]Barbour, "Wells and Windmills in Nebraska," 65-6; Eide, "Free as the Wind," 30-1.

[37]Erwin Hinckley Barbour, "The Homemade Windmills of Nebraska," *Bulletin of the U.S. Agricultural Experiment Station of Nebraska* 11 (Lincoln, NE: University of Nebraska, 1899), 5; Barbour, "Wells and Windmills in Nebraska," 29-32.

[38] Barbour, "Wells and Windmills in Nebraska," 65-6.

[39]Philip Eastman, "Windmill Irrigation in Kansas," *Review of Reviews* 29, no. 2 (February 1904): 183-4.

[40]Barbour, "Wells and Windmills in Nebraska," 35.

[41]Ibid., 71.

irrigated via windmills, this required multiple mills, which was not financially feasible for all but a select few settlers. These limitations eventually doomed the belief that large-scale agricultural practices were possible under windmill irrigation.[42]

Though the windmill could not support extensive farming practices, it did play a pivotal role in allowing farmers to remain on their land during the Plains' many droughts. Bringing a level of independence to the frontier farmer, windmills could irrigate a small garden and allow settlers to "laugh at droughts when they come, as you can easily battle against their power to destroy."[43]

During a season of drought, a small field irrigated by a windmill was of greater value to a settler than a large field at the mercy of the skies. Irrigation engineer P.E. Fuller encouraged large-area farmers to irrigate small sections of crops to withstand the periods of scant rainfall, referencing the failures of many unfortunate settlers who did not prepare for droughts by irrigating a small section of their land.[44] During the exceptional drought in the early 1890s, central Nebraska nursery owner J.L. Brown found that "profits from the [homemade] mill during the three years of drought and crop failure exceeded that from the rest of the farm." For farmers like Brown, Fuller contended that while profits from the irrigated parcel were not great, "when this is all that is left it becomes relatively large."[45]

The windmill increased the number of acres that could be utilized for garden truck agriculture, fruit orchards, and small-scale farming operations, as well as increasing and improving the production of ranchers, sheep herders, and dairy producers. Windmill irrigation was best suited for truck gardening and raising small-scale crops, such as fruits and vegetables, which could then be taken to local stores or markets for sale.[46]

The windmill's limited pumping ability did not allow for large scale crop irrigation, but it proved ideal for providing water for cattle on large ranches that began to take hold across the Plains. By the 1880s, farseeing cattlemen had spent the previous two decades securing land that contained surface water for their herds to graze on. Cattle could travel a maximum of fifteen miles in a day, allowing the rancher who controlled a watering hole to monopolize the grassland around it for seven and a half miles.[47]

In areas not suitable for farming and previously too arid for ranching, barbed wire and windmills stabilized the cattle industry by opening an entire region to raising livestock. On the treeless prairie, fences were difficult, if not impossible, to construct due to the scarcity of lumber. With the 1874 improvements to barbed wire, much of the lumber need was eradicated. The use of barbed wire on the Plains grew exponentially between 1879 and 1883 as ranchers began fencing off grazing lands around precious water sources. At the same time, advances in well drilling made it possible to reach the water table at greater depths. Adopting windmills and water tanks from the railroad, cattlemen soon realized that the windmill largely solved their water problem, with windmills spreading out across acres of ranchland at the beginning of the 1880s. Ranches became more evenly distributed

[42]John Opie, "100 Years of Climate Risk Assessment on the High Plains: Which Farm Paradigm Does Irrigation Serve?" *Agricultural History* 63, no. 2 (Spring 1989): 243-269; Baker, "Irrigating with Windmills on the Great Plains," 218, 224; Eastman, "Windmill Irrigation in Kansas," 183-4; Jordan, "Windmills in Texas," 83; Baker, "Blowin' in the Wind," 10; Barbour, "Wells and Windmills in Nebraska," 31.

[43]Baker, *A Field Guide to American Windmills,* 57; Baker, "Irrigating with Windmills on the Great Plains," 226. Quote from: "Well Contracts," *Wallet No.1*, Capitol Freehold Land and Investment Company Papers (XIT Ranch Papers), Research Center, Panhandle-Plains Historical Museum, Canyon, Texas.

[44]Fuller, "The Use of Windmills in Irrigation in the Semiarid West," 5, 38-9.

[45]Barbour, "Wells and Windmills in Nebraska," 38.

[46]Barbour, "The Homemade Windmills of Nebraska," 5; Baker, "Irrigating with Windmills on the Great Plains," 219, 224.

[47]J. Frank Dobie, *A Vaquero of the Brush Country: The Life and Times of John D. Young* (Dallas, TX: The Southwest Press, 1929), 276; Dick, "Water, A Frontier Problem," 242.

across the Plain as the dependence on a natural water source was removed and cattlemen were able to subdivide their land into numerous pastures. With scarcely ever a lack of wind on these newly created pastures, slow pumping windmills could keep a tank full at all hours, giving grazing cattle a constant water source.[48] With a continuous water supply and prairie grasses that could sustain cattle herds in all seasons, Professor Barbour believed "the only prerequisite is the irrigation of one acre on which to raise garden truck for the family, and this the windmill renders possible."[49]

Along with cattle ranching, sheep-raising was another important Plains industry which relied heavily upon the windmill's water supply. A description of the typical turn-of-the-century sheep herder's camp first noted the presence of a windmill with thousands of sheep around it, before referencing the sheep-herder's dwelling, which was typically a sod house but in some instances nothing more than a tent or a covered wagon.[50]

The combined inventions of barbed wire and the windmill, the expansion of the railroad, and the removal of American Indian tribes from much of the Plains led to a growing movement to settle the lands between Mississippi River and the Rocky Mountains during the 1870s and 1880s. Nebraska was one state greatly impacted by the simultaneous advancements in agricultural technology. With settlement already established in the eastern third of the state, settlers flooded western Nebraska, filing 160-acre homestead claims, building small dwellings, often out of sod, and attempting to cultivate the land. Erwin H. Barbour reported to the Department of the Interior in 1899 that "the windmill has an important effect on population," with the number of Nebraskans west of the 98th parallel increasing 877 percent from 1880 to 1890.[51] The 1890s experienced disastrous droughts and thousands of once-optimistic settlers discovered that 160-acre homesteads were inadequate to support their families. Ten percent either relinquished or abandoned their claims by the end of the decade. Barbour believed that without the windmill, "emigration would result, and the State would lose not only important industries, but desirable citizens with their retinue of helpers."[52]

Settlement of the Great Plains slowed during the 1890s, largely due to the combination of multiple dry years and a national financial panic. Another factor was that the land that was open for settlement in the 1890s was located in the more arid western Plains and not suitable for establishing a successful farm on 160-acre tracts, with or without a windmill. The windmill's shortcoming in irrigating large fields for agricultural crops, and the limitations of trying to raise livestock on 160 acres left millions of acres of the Great Plains unclaimed by homesteaders. Even with railroad access to unclaimed tracts, prospective homesteaders refused to stake claims because the remaining land could not come close to supporting even the most industrious settler.[53]

The Homestead Act of 1862 and the Kinkaid Act of 1904 are two examples of multiple pieces of legislation that fueled Great Plains settlement and provided a large client base for windmill manufacturers. The Desert Land Act of 1877, the Timber Culture Act of 1878, the Enlarged Homestead Act of 1909, and the Stock Raising Homestead Act of 1914 all contributed to continued settlement and ranching of the region, as well. North and South Dakota, for example, underwent two different population "booms" related to these acts; the first from

[48]Jordan, "Windmills in Texas," 81-83; Barbour, "Wells and Windmills in Nebraska," 26; Dick, "Water, A Frontier Problem," 242-244.
[49]Barbour, "Wells and Windmills in Nebraska," 31.
[50]Ibid., 32.
[51]Ibid., 31.
[52]Ibid., 31; Arthur R. Reynolds, "The Kinkaid Act and Its Effects on Western Nebraska," *Agricultural History* 23, no. 1 (January 1949): 20.
[53]Reynolds, "The Kinkaid Act and Its Effects on Western Nebraska," 21; "A Lot of Drygoods," *The Alliance Times*, January 23, 1903.

1878 through 1887, followed by a second population increase between 1902 and 1915.[54] These acts allowed settlers to gain title to tracts of land, but the windmill played a key role in their ability to establish and sustain homes, farms, and ranches and remain on the land through years of varying precipitation.

Exemplifying the impact of these various acts, the Kinkaid Act of 1904 spurred drastically increased settlement in the western two-thirds of Nebraska in areas where the windmill was instrumental in providing water for domestic and agricultural use. Nebraska congressman Moses P. Kinkaid pushed for legislation to increase the size of homesteads in Nebraska from 160 to 1,280 acres, compensating homesteaders in quantity of land that could be claimed, rather than quality. When passed, the Kinkaid Act quadrupled homestead allotments in the thirty-seven Nebraska counties west of the 98th parallel to 640 acres. Lands that could be irrigated from surface water were excluded from the bill, further emphasizing the need for subsurface irrigation to occur to make the large homesteads viable.[55]

Land-seekers from all over the country rushed to western Nebraska to take up claims. Just two years following the Kinkaid Act's passage, merchants and implement dealers saw a marked increase in profits. A western Nebraska newspaper heralded the success and impact of the Kinkaid Act on the region, which "must have people to prosper, and if the homesteaders had not rushed in and taken Kinkaid claims, western Nebraska would still be jogging along in the same old way."[56]

The pronounced development of central and western Nebraska in the decade following the Kinkaid Act was unquestionably attributed to its passage. The windmill provided Kinkaiders, as those who entered into 640-acre homesteads were aptly nicknamed, the opportunity to turn their small part of the Nebraska prairie into a comfortable and profitable homestead. Most of the land was successfully used for grazing, and the great herds of the cattle barons were broken up and replaced with smaller ranches, increasing livestock production in quantity and, reportedly, in quality. Roughly forty acres of each quarter-section tract (160 acres) was under cultivation for crops, with valuable lowlands growing enough grain to feed the stock during the winter and to provide flour for the homesteaders' families. Early sod houses were replaced by comfortable residences with plastered interiors and modern conveniences, surrounded by barns, silos, and windmills which dutifully pumped an endless supply of water for the homesteaders' family, garden, and livestock.[57]

Kinkaiders and related service-providers triggered a dramatic population rise in the thirty-seven county area. After reaching 124,508 in 1890, outmigration of the following decade reduced the population to 107,434 at the century's end. By 1910, with the Kinkaid Act having only been in effect for six years of the decade, population increased nearly 50 percent to 162,217. As the population of western Nebraska increased, so too did the number of beef cattle, the availability of new products, and the acres of taxable land under the care of self-supporting settlers and their families.[58]

[54]Allyson Brooks and Steph Jacon, *Homesteading and Agricultural Development Context* (Vermillion, SD: South Dakota State Historic Preservation Office, 1994), 12-14.

[55]Reynolds, "The Kinkaid Act and Its Effects on Western Nebraska," 21-22.

[56]Ibid., 27; "Prosperity for Western Nebraska," *North Platte Weekly Telegraph*, May 26, 1906.

[57]U.S. Congress, House, *Grazing Homesteads and the Regulation of Grazing on the Public Lands: Hearing Before the Committee on the Public Lands* 63rd Cong., 2d sess., 1914, H.R. 9582 and H.R. 10539; Reynolds, "The Kinkaid Act and Its Effects on Western Nebraska," 28.

[58]Francis Moul, "The Biggest Partner: The Federal Government and Sioux County, Nebraska," *Nebraska History* 80 (1999): 156; Reynolds, "The Kinkaid Act and Its Effects on Western Nebraska," 29-29.

Negative Impacts of Windmills

Despite its many benefits, the success of the American windmill and its association with the railroad were both due to and a factor in creating negative outcomes for the prairie's original inhabitants, bison herds, and ecosystem.

The advancement of the American frontier and settlement of the Great Plains had an immeasurable impact on American Indian tribes that had populated the region for millennia and the bison herds that many of those tribes relied on for survival. In the 1830s President Andrew Jackson's Indian Removal Act led to the forced relocation of tens of thousands of southeastern American Indians to lands west of the Mississippi River, not to include land within Louisiana, Missouri, or the Territory of Arkansas. With the United States' acquisition of California and the Southwest in 1848 as a result of the Mexican-American War, and the subsequent discovery of gold in California, Americans' interest in the West reached new heights. In 1851 the United States Congress passed the Indian Appropriations Act, abandoning the Permanent Indian Frontier established two decades prior, removing from the land tribes that had called the Great Plains home for millennia and more-recently relocated American Indians to reservations set aside for them by the United States government. As a result, American Indians were severely restricted in their ability to hunt, fish, and gather and grow traditional foods, as they had done for centuries before U.S. expansion. Due to these restrictions, the federal government often instituted food rations, which introduced new elements into American Indian diets, impacting the health and increasing illness amongst tribal members.[59]

In 1854, the same year Burnham approached Halladay about a designing a wind engine, the Kansas-Nebraska Act established those two future states as territories, allowing for their settlement and the construction of the transcontinental railroad through Nebraska. Over the ensuing decades, railroad companies often requested and received protection from the U.S. Army to ease their fear of attacks from American Indians. The army established garrisons on or near the rail route and used the lines to effectively transport goods and personnel.[60] The increased military presence further restricted American Indians' freedom on the prairie.

By 1885 the Department of the Interior was promoting homesteading and settlement of "unoccupied lands" that the government had received via treaty with American Indian tribes, claiming that "it is not beneficial to the Indians to have millions of acres of valuable land remain unoccupied around them."[61] Indian leaders disputed such claims, as well as those designed to allow railroads to pass through the Indian Territory.[62] Many American Indians attempted to stem the tide of railroad expansion by pulling up surveyors' stakes, killing railroad workers, removing bolts and fishplates, prying apart rails, and causing train wrecks, along with tearing down telegraph poles. So effective were these tactics that Indian agent Frederick Dodge declared, "We've got to clean the damn Indians out or give up building the Union Pacific Railroad."[63] While extermination of American

[59]Fort Scott National Historic Site, "Permanent Indian Frontier," National Park Service webpage, https://www.nps.gov/fosc/learn/historyculture/pif.htm, accessed December 5, 2022; National Library of Medicine, "Native Peoples' Concepts of Health and Illness," National Library of Medicine webpage, https://www.nlm.nih.gov/nativevoices/timeline/317.html, accessed December 6, 2022.

[60]United States Senate, "The Kansas-Nebraska Act," United States Senate webpage, https://www.senate.gov/artandhistory/history/minute/Kansas_Nebraska_Act.htm; accessed December 6, 2022; Catherine R. Franklin, "Black Hills and Bloodshed: The U.S. Army and the Invasion of Lakota Land, 1868-1876," *Montana: The Magazine of Western History* 63, no. 2 (Summer 2013): 34, 39.

[61]Paul Frymer, "A Rush and a Push and the Land is Ours: Territorial Expansion, Land Policy, and U.S. State Formation," *Perspectives on Politics* 12, no. 1 (March 2014): 130; Department of the Interior, 48th Cong, 2d sess. (January 26, 1885).

[62]Alex Ruuska, "Ghost Dancing and the Iron Horse: Surviving through Tradition and Technology," *Technology and Culture* 52, no. 3 (July 2011): 583.

[63]Ruuska, "Ghost Dancing and the Iron Horse," 587.

Indians was not an official policy of the United States, disease, starvation, and murder were not uncommon extreme measures taken to protect the expansion of U.S. society and culture.[64] Overlooked is the windmill's role in settler colonialism and dispossession of Native lands by its facilitating of railroad construction, farming, and ranching in the Great Plains.

The windmill industry's connection to the decimation of the Great Plains' bison herds is two-fold. Not only did windmills allow railroads to expand and make bison hunting profitable for American hunters and entrepreneurs, but industrial machine belts, examples of which are still present in the Kregel factory, were one of the many items that buffalo hides were used for.[65]

The number of bison on the Great Plains in 1800 was estimated to have been as high as 20 million. Over the next half-century, the demand for bison robes led to increased hunting, primarily by American Indians who then sold or traded robes to European Americans, and roughly halved that number. As the railroad expanded in the nineteenth century, the great bison herd was divided into northern and southern herds and they were intensively hunted along the rail corridor. After new hide tanning techniques were introduced in 1871, the market for bison hides grew exponentially, and the railroads provided cheap and easy access for hunters into the interior and a means to ship their harvest to factories.[66] By 1876, bison were extinct in Kansas, Oklahoma, and eastern Colorado, and were gone from west Texas by 1880. Hunters then shifted their attention to the northern herd. From Glendive and Miles City, Montana Territory, the northern herd was nearly wiped out during 1881-1884. By 1890, the great bison herds were decimated, numbering roughly a thousand wild bison, plus 200 more protected in Yellowstone National Park.[67] Conservation practices have since increased the number of bison in the Great Plains, yet the railroads' connection to the near-extermination of the bison and the impact the herd's decimation had on the ecosystem and the American Indians who relied heavily on them is a negative consequence of the windmill and the railroad's relationship.

By introducing and making possible the pumping of subsurface water, windmills heavily contributed to the creation of an artificial environment and the planting of crops that prairie soils were not meant to host. Irrigation of the Plains was initially believed to be a cure for the drought-plagued region. In what was dubbed an "Irrigation Crusade" at the turn of the century, "Forty Million Forty Acre Farms" became a national slogan. Water diverted from the region's few rivers would never be adequate or able to be properly distributed to support widespread farming needs, with the *Denver Republican* proclaiming that eastern Colorado agriculture "must depend on the reservoirs and the underground strata of water." With the assistance of windmills, large areas of soil not suitable for crop farming were placed into production based on the belief that such fields could match or even surpass agricultural production of the Midwest.[68]

Many farmers came to the Plains during wet years, stuck out the hard times thanks to windmill irrigation, and were still working their land during World War I. This peak period for windmill production coincided with the advent of mechanical farming and the plowing of fifty million acres of marginal land to meet the need of food exports intended for the war-ravaged European mainland. Following the Armistice, crop production outpaced demand, causing the agricultural depression of the 1920s. Facing low crop prices, high machinery costs, and the fear of foreclosures, farmers placed additional land into production in the hopes of generating additional

[64]Pierce, *Making the White Man's West*, 230-231.

[65]Dean Lueck, "The Extermination and Conservation of the American Bison," *The Journal of Legal Studies* 31, no. S2 (June 2002): S619-S620.

[66]Tanning refers to preparing hides for use after skinning from the animal.

[67]Lueck, "The Extermination and Conservation of the American Bison," S610, S619-S620.

[68]Baker, "Blowin' in the Wind," 21; Opie, "100 Years of Climate Risk Assessment on the High Plains," 255; Gilbert C. Fite, "Great Plains Farming: A Century of Change and Adjustment," *Agricultural History* 51, no.1 (January 1977), 247.

income. This practice of turning over greater swaths of soil long held in place by the deep roots of native prairie grasses proved to be disastrous during the severe droughts of the 1930s. Failed crops left nothing to hold the soil in place, resulting in dust storms that devasted the region and deposited airborne soil as far away as the East Coast. During the 1930s more than a quarter of a million people left the Plains, abandoning their homes for opportunities elsewhere.[69]

Heyday of Windmill Manufacturing

For roughly forty years, windmills were applied in various manners from railroad to domestic use to agriculture from the mid-1870s to the end of World War I. Encouraged by the success of Halladay's self-regulating windmill, competitive windmill manufacturing greatly increased the number of U.S. windmill patents and transformed windmill-making from a small, cottage industry which sold less than $30,000 worth of products in 1860 to a major, national business with annual sales of over $1 million in 1880. A decade later, approximately seventy-seven windmill manufacturers employed over 1,100 workers generating a collective annual revenue of more than $4 million.[70]

Beyond the windmill's popularity, the ability of the industry to grow so quickly can be attributed to the relative ease and economy of the windmill manufacturing process. Windmill production needed little else than a small woodworking shop, a unique windmill design (to avoid infringing on the patent rights of others), and if the metal work was not contracted out, a metalworking shop. This encouraged the establishment of hundreds of small windmill manufacturers between 1860 to 1900, though most lasted just a few years. At the turn of the century some cities manufactured over five thousand windmills on average, each year. In addition to windmill manufacturing, windmill-related work was a major industry, employing everyone from well drillers and salesmen to men who performed routine maintenance or repaired damaged mills and towers.[71]

The export of windmills became an important component of windmill sales early in the twentieth century. Exporting windmills began as early as the 1860s and grew considerably in the 1880s; companies even employed agents overseas to promote their products. Foreign markets ranged from Australia and Latin America, along with Canada, Great Britain, mainland Europe, Africa, India, and the Middle East, including a noticeable presence near Aleppo, in northwest Syria. Flint & Walling exported a large number of windmills to Russia in 1892. Following World War I, importing countries imposed greater tariffs on windmills and towers, causing international sales to wane. By 1928, roughly one quarter of the 100,000 windmills produced were exported.[72]

The demand for windmills reached its pinnacle during the first two decades of the twentieth century. A mild climate helped Great Plains farmers expand commercial production, increasing the number of farmsteads—and windmills—across the Plains. With the start of European hostilities in 1914, the U.S. experienced an economic and agricultural boom, creating temporary prosperity in rural areas. Prices for grain, meat, and cotton reached

[69]Opie, "100 Years of Climate Risk Assessment on the High Plains," 249; National Drought Mitigation Center, "The Dust Bowl," University of Nebraska-Lincoln website, https://www.drought.unl.edu/dustbowl.Home.aspx, accessed November 9, 2021.

[70]Jordan, "Windmills in Texas," 83; Eide, "Free as the Wind," 26; Porcello, "Windmills and Railroads," 7.

[71]Baker, *A Field Guide to American Windmills,* 60, 66; Wolff, *The Windmill as a Prime Mover*, 2; "Thousands Invested in Windmills," *Sheep and Goat Raisers' Magazine* 10, no. 4 (November 1929): 110.

[72]Baker, *A Field Guide to American Windmills,* 101-5; Etienne Rogier, "The Windmills of Aleppo," *Windmillers' Gazette* 36, no. 2 (Spring 2017): 7; Leah D. Rogers and Melissa A. Allen, "Iowa Wind Mill & Pump Company Office and Warehouse," National Register of Historic Places nomination, September 14, 2012, 8/20; T. Lindsay Baker, "World War I and the American Windmill Industry," *Windmillers' Gazette* 37, no. 4 (Autumn 2018): 4; "Thousands Invested in Windmills," 110.

unprecedented levels, allowing struggling agricultural families to finally succeed, allowing many to purchase their very first windmill or update their existing outdated model.[73]

Reflecting this increased demand for windmills, the Kregel Windmill Company nearly doubled their business from 1916 to 1917, leading the company to consider expanding its works to accommodate the increased orders. During 1917's first two months, the local Nebraska City newspaper reported a high demand for Kregel's ELI "despite the fact that it is really not the season for the sale of their mills, [and] are kept busy all of the time…The company could double their capacity, if they only had the capacity to enable them to turn them out."[74] In a single week in February, Kregel sold five windmills with several more prospects on the horizon. By the end of 1917, the company was manufacturing more windmills than ever before and purchased a large amount of material to meet the anticipated springtime demand.[75]

The World War I years, 1914-1918, represented the peak of windmill manufacturing in the United States. Following the Armistice, sales decreased as growing competition from gas pumps and the onset of an agricultural depression eventually caused the market to stall.[76]

Sales and Economics

Corporate marketing was as important for the success of large-scale windmill manufacturers as the production of the mills themselves. By the 1880s standard marketing practices were largely in place after two decades of promoting the mills' irrigation potential, appealing primarily to truck gardeners. The largest manufacturers utilized the railroads and branch houses (remote warehouses of the parent company) to ship their products across the country, while other large manufacturers covered surrounding states in a regional sales area. Some manufacturers used agents who bought mills at wholesale prices from the manufacturer and then sold the mills to customers at retail prices, or traveling salesmen took orders for the parent company directly from customers. Where a dispersed population made these means ineffective, companies marketed themselves through mail-order catalogs, such as *Montgomery Ward* or *Sears, Roebuck*. Small manufacturers encouraged their clients to keep their money local by selling almost exclusively in a thirty- to fifty-mile radius from their point of manufacture. The Kregel Windmill Company, for example, advertised that their "small territory reserved for retailing…is about 12 miles east to west and 18 miles north to south" from its Nebraska City factory.[77]

Local windmill manufacturers occasionally utilized agents, but on a much smaller scale than larger companies. The Kregel Windmill Company advertised roughly a dozen agents for their ELI windmill in Nebraska, Iowa, and Missouri, all within thirty miles of the Kregel factory. Company records include long lists of various dealers across the Plains who bought ELIs at wholesale prices from the factory for retail sale in their communities. However, most small, local windmill manufacturers generally sold directly to the customer, cutting out the middleman, thereby reducing costs and increasing profits. Local manufacturers leaned heavily on county and state fairs to display their mills to consumers. These events, complete with model mills, promotional

[73]Robert Steele Ball, *Natural Sources of Power* (New York, NY: D. Van Nostrand Company, 1908), v; Opie, "100 Years of Climate Risk Assessment on the High Plains," 249; Baker, "World War I and the American Windmill Industry," 2-3.

[74]"Local Brevities," *Nebraska City News*, January 19, 1917.

[75]"Local Brevities," *Nebraska City News*, February 9, 1917; "Turning Out Many Mills," *Nebraska City News*, November 20, 1917.

[76]Baker, "World War I and the American Windmill Industry," 2-3; Baker, *A Field Guide to American Windmills*, 106.

[77]Baker, *A Field Guide to American Windmills*, 74-77, 81; Baker, "Irrigating with Windmills on the Great Plains," 216; Southern Steel Wind Mill Company, "Southern Steel Wind Mill Company: Manufacturers of the Galvanized Steel Wind Mill Pomona" [Advertisement], *Rural Californian* 15, no. 10 (October 1892): 558.

literature, and competitive trials, often attracted sales staffs of larger windmill companies and remained popular attractions into the early twentieth century.[78]

The price of a windmill varied greatly depending on date of manufacture, model, quality, and size. Prices generally decreased as windmills became more popular and railroads increased customer accessibility to competing models. As the first commercially successful self-governing American windmill, the price for a 12-foot Halladay STANDARD ranged from $130 to $160 during the mid-1850s; by 1875 the price declined to $135. By the end of the century, the price for the STANDARD dropped to $100. Toward the end of its production history, in 1916 the 12-foot STANDARD sold for $70.15 to $83.65; tower and installation sold separately.[79] Prices of a single windmill model varied based on size, with larger mills naturally costing more. During the Great Depression the prices for a 6-foot open-geared CURRIE windmill dropped to $17.25 while a self-oiling model was advertised for $26.50, earning it the nickname the "Poor Man's Windmill."[80]

Beyond the price of the mill proper, the tower on which it was mounted came at an additional cost, the price of which depended on the height and material used. Wood towers could be built comparatively cheaply, while steel towers were substantially more. Annual cost of keeping the mill properly oiled was negligible, at less than fifteen cents per month, and while potentially dangerous, it could be done quickly on a calm day. With all costs considered, the windmill was incredibly cost-effective, nearly paying for itself annually from the products owners produced from the irrigation it provided.[81]

Windmill historian T. Lindsay Baker has identified over a thousand windmill manufacturers, many of which appeared for just a short time, suggesting profits were not sufficient to maintain many companies for long. Financial results were likely varied, with bigger companies recording more sales and, therefore, more profit. Thomas Snow, for example, owned half of the three hundred available shares of the Challenge Company (Batavia, Illinois) in 1882, valued at $150 apiece. Upon Thomas Snow's passing in 1903, his son, Frank Snow, became president of the company and purchased Frank Lloyd Wright's 1906 Ravine Place from its original owner in 1912. The Snow family retained ownership of the home for seven decades, suggesting that the Snows' success at the Challenge Company allowed them to set aside funds sufficient to withstand the agricultural depression of the 1920s and Great Depression of the 1930s.[82]

Near the other end of the spectrum were small windmill manufacturers. George Kregel, owner of the Kregel Windmill Company, was given an annual salary of $600 when the company incorporated in 1910. His salary doubled by 1920 but returned to its original amount in 1930 and his pay stopped being recorded during the

[78]"The Eli Wind Mill," *Nebraska City News*, February 28, 1913; "Eli Wind Mill Agents," *Nebraska City News*, April 28, 1914; "In buying a windmill be sure you are right," *Nebraska City News*, June 15, 1915; Baker, *A Field Guide to American Windmills*, 75-6; T. Lindsay Baker, "Selling Windmills at County and State Fairs," *Windmillers' Gazette* 29, no. 4 (Autumn 2010): 3-5.

[79]The 1850s prices are estimated to be between $4,248 and $5,449 in 2022 dollars. The 1875 prices are estimated to be $3,657 in 2022. Baker, *A Field Guide to American Windmills*, 76; Baker, "Irrigating with Windmills on the Great Plains," 221; Baker, "What Profits Earned From Manufacturing Windmills Could Buy," 6.

[80]T. Lindsay Baker, "New Deal Specials: Bargain Windmills of the Depression Era," *Windmillers' Gazette* 4, no. 2 (Spring 1985): 5.

[81]Baker, "New Mexico Windmill Towers as Vernacular Architecture," 12; Wolff, *The Windmill as a Prime Mover*, 137; Barbour, "Wells and Windmills in Nebraska," 30.

[82]Baker, "What Profits Earned From Manufacturing Windmills Could Buy," 6-7.

Great Depression.[83] George's son, Arthur Kregel, later quipped "there were no best years" [84] for the company and that "we never made any money out of [windmills]. If we'd made any more, we probably would have gone broke."[85] After taking over the company in the mid-1940s, Arthur's fortunes did not significantly improve. After thirty years of managing the company, Arthur and his wife Louise lived in a small home where "only the lower part is in useable condition. The upper part has…no heat & floors are bad."[86] The Kregels, it appears, were much closer to being one of the many windmill companies that went out of business than those who made a fortune out of the trade.

For most windmill manufacturers, windmills were only one of multiple items that they produced and sold. The products the Kregel Windmill Company offered ranged from pumps and water tanks, which were a natural fit to accompany their ELI windmill, to fencing wire, walking plows, and plaques manufactured in the metal shop. George Kregel even manufactured and sold his own patented beehive, along with other bee-keeping items. The breadth of other manufacturers' products ranged even greater, including bicycles, buggies, piano stools, and school furniture.[87]

Many large windmill manufacturers merely added windmills to their lines of merchandise and viewed them as subsidiary goods. The Stover Manufacturing Company (Freeport, Illinois) sold barbed wire and other small engines, and both the Sandwich Enterprise Company's (Sandwich, Illinois) and the Marseilles Manufacturing Company's (Marseilles, Illinois) primary product was corn shellers, with windmills a secondary product.[88]

Decline of Windmill Manufacturing

For more than half a century, windmills reduced the severity of the need for water on the Plains but never fully satisfied it.[89] Despite the windmill's popularity and impact on settlement and ranching, the search for a means of large-scale irrigation continued.

Early efforts were made to irrigate utilizing available surface water. The first irrigation cooperative in Nebraska began in 1870, drawing water from the South Platte River and irrigating 3,000 acres, but increased rainfall caused the effort to be abandoned. In 1883 North Platte Company was able to survive the reluctance of local

[83]Kregel Windmill Company, "Articles of Incorporation," March 23, 1910, Series 1, Box 1, Folder 2, KWCR; "Profit and Loss Statement of the Kregel Windmill Company. From Dec. 31, 1919 to Dec. 31, 1920," Series 2, Subseries 6, Box 21, Folder 3, KWCR; "Profit and Loss Statement of the Kregel Windmill Company. From Dec. 31, 1929 to Dec. 31, 1930," Series 2, Subseries 1, Box 1, Folder 15, KWCR.

[84]Dennis W. Keim, Interview with Art and Louise Kregel, 1977. Sent to T. Lindsay Baker, February 4, 1985. From T. Lindsay Baker Collection at Kregel Windmill Factory Museum, Nebraska City, NE.

[85]Baker, "ELI and the Kregel Windmill Company," 5.

[86]Otoe County Assessor, "1902 North 19th Street," June 7, 1977, Series 2, Subseries 6, Box 22, Folder 15, KWCR.

[87]"Our Manufacturers," *Nebraska City News*, December 16, 1887; Kregel Wind Mill Company, "Now is the time to put your farm water system in good shape," *Nebraska City News*, October 25, 1910; Kregel Wind Mill Company, "The unreliability of most wind mill," *Nebraska City News*, February 20, 1912; Tom Allan, "Nebraska Byways: Windmill Shop Still Turns Out Quality Work," *Omaha World Herald*, June 5, 1988; Baker, "The Goods We Make," 2; "Bee Hive and Bee Keepers' Supplies. Cypress and Steel Tanks. Eli, Sampson, and other Wind Mills, with Wood or Steel Towers" [Advertisement], *Nebraska City News*, April 26, 1904; *Michigan State Gazetteer and Business Directory, 1887-8*, 215; Terry Housholder, "Northeast Indiana Played Key Role in Building Windmills," *KPC News*, November 25, 2012, https://www.kpcnews.com/article_2f6abd45-a810-50a5-a7db-fadaf2beb110.html.

[88]Baker, *A Field Guide to American Windmills*, 60; Mary X. Barrett, ed., *History of Stephenson County, 1970* (Freeport, IL: County of Stephenson, 1972), 528-30; "Daniel C. Stover," *Farm Implement News*, 20, no. 4 (January 23, 1908): 28; *History of Stephenson County*, 477, 465; Henry D. McCallum and Francis T. McCallum, *The Wire that Fenced the West* (Norman, OK: University of Oklahoma Press, 1965), 91, 244-5; *The Lowell Directory, 1983*, 1016; Baker, *A Field Guide to American Windmills*, 61; Baker, "The Goods We Make," 2.

[89]Baker, "Turbine-Type Windmills of the Great Plains and Midwest," 51.

farmers to pay for irrigation and eventually gained the stability that evaded many of its predecessors. Their successful projects combined with occasional droughts, stimulated the rapid growth of irrigation systems, and solidified irrigation agriculture on the North Platte. Between 1870 and 1900, nationwide irrigated acreage had grown from less than 20,000 to more than 7 million. In the 1890s Nebraska led the nation in proportional increase of irrigated acreage with an estimate of 1,489,000 acres under irrigation in the century's final year. Before becoming a poster-city for the benefits of windmill irrigation in the 1890s, the Arkansas River Valley around Garden City, Kansas, contained enough canals to water 2,000 acres. However, sparse settlement and upstream irrigation districts that depleted the water supply limited the number of irrigated acres under the project.[90]

To increase efforts for surface irrigation in the West during the early twentieth century, the U.S. Congress passed the Reclamation Act of 1902, creating what became the Bureau of Reclamation (BOR). One of the BOR's first efforts was the North Platte Project, designed to irrigate up to 400,000 acres in Nebraska and Wyoming through a series of dams and reservoirs that were completed in 1908, 1909, and 1927, respectively. Within the project's area, nearly a thousand newly established farms were irrigated by 1912, and by the second half of the twentieth century, canal irrigation had expanded across the Plains into neighboring regions.[91]

During the early twentieth century, some farmers and ranchers attempted to replace the windmill with gas engines. While stationary windmills could run on free wind and cost less to maintain, gas engines eliminated the need for climbing towers for maintenance, provided fresh water whether the wind was blowing or not, and could be moved to a work site to be used as a power source. Windmills and gas engines coexisted on American farmsteads and ranches until the middle of the twentieth century, when rural electrification and the electric pump appeared.[92]

The first major blow to windmill manufacturing and sales was the post-World War I agricultural depression. Drought and the overproduction of fifty million acres of marginal land led to price drops and drastic profit reduction. Wheat, for example, dropped from $2 a bushel in 1919 to $0.83 a bushel in 1921. From its heyday, windmill sales declined dramatically in the 1920s. Owners repaired what they could, purchased a second-hand mill rather than new, or settled for pre-1900 models over self-oiling mills. For many, buying a new mill was a last resort. The sales price for a windmill and tower never returned to pre-war levels, and the windmill market never fully recovered from the steep decline in agricultural commodity prices in 1921.[93]

Any hope for a rebound in the windmill market was dashed when the country sank into the Great Depression, further reducing the demand for and manufacture of windmills.[94] With drought returning to the Great Plains, settlers abandoned the idea of windmill irrigation. Large and small manufacturers were impacted alike. At the close of 1930, the nationally recognized Baker Manufacturing Company implored the small market Kregel

[90]L. Carl Brandhorst, "The North Platte Oasis: Notes on the Geography and History of an Irrigated District," *Agricultural History* 51, no. 1 (January 1977): 167-168; Baker, "Irrigating with Windmills on the Great Plains," 217.

[91]Brandhorst, "The North Platte Oasis," 166, 169-70; Moul, "The Biggest Partner," 154.

[92]Baker, *A Field Guide to American Windmills,* 58; David Dunfee, "Replaced Windmill with Gas Engine," *Gas Power* 6, no. 12 (June 1909): 66; "Thousands Invested in Windmills," 112; Baker, "Windmills and the Union Pacific Railroad," 4; T. Lindsay Baker, "As Old as the Hills and Just as Stationary: The Battle Between Windmills and Portable Gas Engines," *Windmillers' Gazette* 9, no. 1, (Winter 1990): 6.

[93]Opie, "100 Years of Climate Risk Assessment on the High Plains," 249; Baker, "New Deal Specials," 3; Baker, "World War I and the American Windmill Industry," 4.

[94]Baker, *A Field Guide to American Windmills,* 107.

Windmill Company to make good on their debt of $126.83 as "the year is rapidly drawing to a close, and we are needing every dollar that we have outstanding in past due account, so as to take care of our own obligations." [95]

Many windmill manufacturers who had struggled in the previous decade went out of business. Those determined to stay afloat adopted several strategies to do so. Some reduced the number of models offered, focusing on those that were cheaper to make and more affordable to consumers, or reintroduced outdated models. Manufacturers lowered prices of mills, reduced dividends to stockholders, limited work hours, lowered wages for those who were lucky enough to keep their job, or took on defense contracts to supplement lagging sales. Others dropped windmills from their product line entirely. By 1930 the number of windmill manufacturers decreased significantly, and only a few survived through World War II.[96]

Ultimately, the windmill was a casualty of rural electrification. On May 20, 1936, Congress passed the Rural Electrification Act, establishing the Rural Electrification Administration (REA) and allowing the federal government to make low-cost loans to farmers who banded together to create non-profit cooperatives for the purpose of bringing electricity to rural America. The REA was joined by the Tennessee Valley Authority (TVA) in the South and the Bureau of Reclamation (BOR) in the West to make rural electrification a government priority, putting in motion the electric pump's dominance of rural irrigation. Rural electrification grew at an astounding rate, increasing the percentage of America's electrified farms from 11 percent in 1935 to almost 48 percent by 1945. That number nearly doubled in the following decade with national electrified farmsteads reaching 93 percent. This impact can be seen acutely in Nebraska where between 1936 and 1944, twenty-one rural public power districts were constructed, energizing 11,055 miles of rural electric transmission and distribution lines. In 1936, only 5,278 Nebraskan farms had access to electricity, which nearly quadrupled to 21,090 farms by July 31, 1944, serving an estimated 95,000 people. Not only was electric power reasonably cheap, it was also more reliable than the wind, it powered dozens of appliances throughout the home and supplied power to run dairy equipment, grind feed, cut silage, and electrify fences, all the while providing light to work by. Some farmers and ranchers used electric pumps only when the wind was not sufficient to power a windmill. Windmills remained in use in sparsely settled places where power lines were not run, but the windmill's importance and popularity were forever diminished.[97]

The final nail in the coffin of large-scale windmill manufacturing came as the early years of World War II rapidly increased prices for all consumer goods, including windmills. On April 11, 1941, Congress established the Office of Price Administration to recommend price controls for the prevention of wartime inflation; its first act was to freeze steel prices. Wartime rationing of materials forced farmers and ranchers to go through a long, convoluted application process to secure needed parts to repair windmills; meanwhile their crops, livestock, and homes went underwatered.[98]

The difficulty of customers securing windmills was compounded by the few remaining manufacturers further reducing or completely halting production. After struggling for more than a decade to earn a profit from

[95]Baker Manufacturing Company to Kregel Windmill Company, December 15, 1930, Series 7, Box 54, KWCR.

[96]Opie, "100 Years of Climate Risk Assessment on the High Plains," 245; Baker, "New Deal Specials," 3.

[97]Rural Electrification Administration, *Rural Lines, USA: The Story of the Rural Electrification Administration's First Twenty-five Years, 1935-1960* (Washington, DC: U.S. Department of Agriculture, 1960), 3; Ronald R. Kline, *Consumers in the Country: Technology and Social Change in Rural America* (Baltimore, MD: The John Hopkins University Press, 2000), 219; Homestead National Historical Park, "Rural Electrification Act," https://www.nps.gov/home/learn/historyculture/ruralelect.htm, accessed November 4, 2021; C. A. Sorensen, "Rural Electrification: A Story of Social Pioneering," *Nebraska History* 25 (1944): 257, 269-270; Jordan, "Windmills in Texas," 85.

[98]T. Lindsay Baker, "For the Duration: American Windmills during World War II," *Windmillers' Gazette* 12, no. 3 (Summer 1993): 3-5.

producing and selling windmills, many manufacturers diverted production to wartime needs. Some manufacturers focused on selling repair parts rather than trying to sell new mills, substituted older materials into new mills, or simply informed customers that their windmills were no longer available. In the post-war years, only a few of the strongest firms were able to return to windmill production; even then, the market for the product had largely dried up as rural electrification led to electricity becoming rural America's primary power source.[99]

Windmills from Post-World War II to Present

In the years following World War II, technological advancements—namely, rural electrification and center-pivot irrigation—led to the abandonment of the windmill as a prime mover that made the dream of Plains irrigation a reality. The railroad industry's transition to diesel engine locomotives eliminated the need for railroad-related windmills, eliminating a major customer. After decades of economic challenges, competing technologies, and a declining market, fewer than 10,000 mills were sold in 1956. By 1960, only three windmill manufactures remained—Aermotor, Dempster, and the Heller-Aller Company of Napoleon, Ohio. Each produced mills as a small part of their larger business model, with exports as part of U.S. aid to emerging nations constituting a large portion of the 5,000 annual windmill sales by 1970. Interest in purchasing a windmill has since remained low, with brief periods of interest during the 1970s energy crisis and the development of the Windmill Technology Center at New Mexico State University in 1975.[100] At present, only Aermotor, now located in San Angelo, Texas, continues to make traditional American windmills.

Symbolism of the Windmill

The American windmill was a key tool in the expansion of the nation's railroad network and the settlement of the Great Plains and West. Erected between fifteen to twenty feet above any surrounding obstructions, these towering figures across a largely treeless landscape became landmarks upon the Plains, "lighthouses on the prairie," and in open country could be the only visible landmark for miles.[101]

Erected across the Plains in the thousands, the windmill was arguably the most dominant man-made feature in rural landscapes. Decades after their production largely ceased, the windmill remains one of the most prominent objects seen across the otherwise horizontal landscape of west Texas and the Great Plains, although today they are often missing their wheels, "standing useless…twisted and bent by the winds."[102] The windmill had become so commonplace on the landscape that their presence and importance were often overlooked. Others continued to notice the windmill, calling them "picturesque" as they towered over the treeless plains in "beautiful harmony with the physical environment," their presence and often-squeaking wheel the only fabricated sight and sound on desolate areas of the Plains.[103]

[99]Ibid., 5-6; Baker, *A Field Guide to American Windmills*, 108; Sorensen, "Rural Electrification: A Story of Social Pioneering," 270.

[100]Eric C. Edwards and Stephen M. Smith, "The Role of Irrigation in the Development of American Agriculture," *Journal of Economic History*, 78 no. 4 (December 2018): 1105; Opie, "100 Years of Climate Risk Assessment on the High Plains," 255; Eide, "Free as the Wind," 25, 43; Baker, *A Field Guide to American Windmills*, 108. At the time, Aermotor was referred to as the Braden-Aermotor Corporation, headquartered out of Broken Arrow, Oklahoma; Christopher Gillis, "Dempster: The Last 30 Years," *Windmillers' Gazette* 36, no.4 (Autumn 2017): 4; New Mexico State University, "Windmill Technology Center," New Mexico State University webpage, https://aces.nmsu.edu/ces/windmill/index.html, accessed November 8, 2021.

[101]Eide, "Free as the Wind," 41; Rose Urbanczyk interview by John Pinkham, White Deer, TX, June 17, 1974, typescript, 3, 7, Historical Research Center, Panhandle-Plain Historical Museum, Canyon, TX.

[102]Jordan, "Windmills in Texas," 85 (quotation); Barbour, "Wells and Windmills in Nebraska," 30.

[103]Dole, "Windmill Economy," 14-15; Jordan, "Windmills in Texas," 85 (quotation); "Thousands Invested in Windmills," 112.

The windmill struck an emotional chord with those who depended on them and grew accustomed to their presence amidst the prairie. Gazing at a windmill in the distance gave ranchers comfort that their herds would always be watered. The windmill left its mark on the psyche of the settlers of the Plains. Often the first visible signs of permanent habitation, the windmill was a symbol of late nineteenth-century settlers' resolve and determination to establish farmsteads and create a future for their families. As settlers ventured out into the harsh, semi-arid Great Plains the windmill became a beacon of American society where settlers scored a victory over the arid and hostile environment. Thus, the windmill became an icon of the Plains symbolizing settlers' determination to make homes on the land and America's conquest of the continent.[104]

The importance of the windmill was captured in poem by Professor Gilbert J. Jordan who penned:

You are the landmark of the plains
Tall companion of the breeze
You are the maker of the rains
That changed our western destinies.[105]

Kregel Windmill Company

Family and Company History, 1857-1901

Present-day Otoe County was traditionally inhabited by the Pawnee, Otoe, and Omaha tribes. Small numbers of White traders came to the area prior to April 1846, when the United States Army established Fort Kearney on the banks of the Missouri River. Two-and-a-half years later, in November 1848, the post was abandoned, with the garrison relocating to what is more commonly known as Fort Kearney in the central part of the state, established earlier in the year. An 1852 ferry crossing was the nucleus for the community of Table Creek, which was platted and renamed Nebraska City in 1854, following the passage of the Kansas-Nebraska Act and the formation of Otoe County. Nebraska City grew into a commercial hub as a river crossing and launching point for travelers and goods heading west into the Great Plains. Part of this growth was on the backs of enslaved laborers, who worked on the river docks, unloading goods from boats onto overland transports. Nebraska City is home to the only known extant structure associated with the Underground Railroad in Nebraska, the Mayhew Cabin, while also holding the unfortunate distinction of hosting the only documented slave sale in Nebraska. The Burlington and Missouri River Railroad was constructed through the city in April 1871, leading to an increase of industries that could take advantage of the city's access to both river and rail traffic.[106]

George Frederick Kregel moved to Nebraska City in 1879. The oldest of eight children, George was born to Dietrich and Helena Kregel on May 14, 1857, in Garnavillo, Iowa. After spending his first two decades in Garnavillo, George relocated to Nebraska City to live with the family of his uncle, Henry Kregel. Henry had moved to Nebraska City in 1868 with his family, which included son Louis, born two years after George on February 26, 1859.[107]

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[104]Jordan, "Windmills in Texas," 85; Baker, "Blowin' in the Wind," 21; Walter Prescott Webb, "The Story of Some Prairie Inventions," *Nebraska History* 34 (1953): 232; Opie, "100 Years of Climate Risk Assessment on the High Plains," 246.

[105]Jordan, "Windmills in Texas," 80.

[106]Alfred Theodore Andreas, *History of the State of Nebraska* (Chicago, IL: The Western Historical Company, 1882), 1213; Edison P. Rich, "Slavery in Nebraska," *Transactions and Reports*, Nebraska State Historical Society (1887): 95, 96, 104; Bill Hayes and Jessie Nunn, "Mayhew Cabin," National Register of Historic Places Nomination, February 11, 2011.

[107]"Noted Business Man Dies Saturday," *Nebraska City News-Press*, September 29, 1946; "Planned His Own Grave," *Nebraska City News*, June 19, 1903.

In the summer of 1878, with Henry Kregel in need of a new windmill, nineteen-year-old Louis Kregel set to work making one for the family farm. Louis successfully invented his own windmill, securing a patent for its design on July 9, 1878.[108] Reportedly refusing "an offer of several thousand dollars" for his patent, Louis began manufacturing windmills. Selling his mills at $20 less than his competition, the demand for Louis's windmills was so great he needed to expand his production capacity by the end of 1878.[109]

George Kregel came to Nebraska City to work alongside his cousin as early as March 1879. With a growing business and a second windmill improvement patent applied for, Louis Kregel expected to produce fifty mills that spring.[110]

The following month the *Nebraska City News-Press* announced "Messrs. Louis Kregel & Co. yesterday purchased the old brick church situated on the corner of 14th and Laramie [1st Avenue] streets, and are now at work fixing it up as a manufactory for their celebrated wind mills," including installing a steam engine in the building. On August 19, 1879, the cousins made the enterprise official with each putting in $1,347 to form the Kregel Manufacturing Company.[111]

Earning a strong reputation for their windmills, prices for the KREGEL windmill fluctuated between recorded entries of $80 and $100, the latter of which was fully paid in brick, presumably to aid in the construction of Louis Kregel's brick residence.[112]

The company was off to a good start during the first half of 1880, with orders sufficient to run their factory at full capacity, when Louis Kregel decided to shift his attention to a hardware business; that year he formed Noelting, Kregel, & Company. The windmill business kept on, as later that year the company displayed one of their mills and a collection of pumps at the Otoe County Fair. The mention of the erection of a Kregel windmill was not uncommon in the local paper and a dealer in nearby-Syracuse included the availability of "Kregel Windmills" in weekly advertisements in the *Syracuse Journal.* Whether Louis fully abandoned the windmill business he started with George Kregel in order to enter the hardware trade is unclear. In April 1881 the factory building was sold and in July, George was named foreman of the Wood and Paint Department of the newly formed Nebraska City Manufacturing Company.[113] Formed on June 28, 1881, the Nebraska City Manufacturing Company was a conglomeration of multiple local businesses consolidated over the previous decade. A board of directors was elected on July 7, and the company set out to manufacture plows, windmills, and other farming

[108]Louis G. Kregel, Improvement in Wind-Engines, U.S. Patent #205,877, filed March 9, 1878, and issued July 9, 1878; T. Lindsay Baker, *A Guide to United States Patents for Windmill and Wind Engines* (Watford, England: The International Molinological Society, 2004), 31.

[109]"A Nebraska Farm Boy's Invention," *Nebraska City Daily News*, September 25, 1878; "Mr. Louie Kregel," *Nebraska City News*, November 23, 1878.

[110]"Local Items," *Nebraska City News*, January 18, 1879; Louis G. Kregel, Improvement in Wind-Engines, U.S. Patent #215,636, filed January 25, 1879 and issued May 20, 1879; Baker, *A Guide to United States Patents for Windmill and Wind Engines*, 32; L.G. & G.F. Kregel, "Wind Mill Sales Book, March 22, 1879," Series 3, Box 24, Folder 33, KWCR.

[111]"This Date in History: Fifty Years Ago, 1879," *Nebraska City News-Press*, June 18, 1929; Kregel Windmill Museum, "Kregel Windmill Company History," Copy on file at Kregel Windmill Company Museum, Nebraska City, Nebraska.

[112]"Johnny Wales has at last completed his well," *Nebraska City Daily News*, November 24, 1879; "The stone work is now finished," *Nebraska City News*, June 12, 1880.

[113]"Kregel Bro's wind mill factory," *Nebraska City News*, May 8, 1880; "The Kregel wind mill works is running to their full capacity," *Nebraska City News*, June 5, 1880; "New Hardware, Stove and Tinware Store," *Nebraska City News*, June 5, 1880; "A Miniature Store," *Nebraska City News*, September 11, 1880; "Fair Fabrics: Minor Items," *Nebraska City News*, September 11, 1880; "Local Squibs: Friday," *Nebraska City News*, May 28, 1881; Vanderhoof & Bliss, [Advertisement], *Syracuse Journal*, May 13, 1881; Vanderhoof & Bliss, [Advertisement], *Syracuse Journal*, July 1, 1881; "Local Squibs: Thursday," *Nebraska City News*, April 23, 1881; "A Manufactory: Organization of the Nebraska City Manufacturing Company," *Nebraska City News*, July 16, 1881.

implements.[114]

In August 1881 Louis Kregel disposed of his interest in Noelting, Kregel & Company to commit himself entirely to the Nebraska City Manufacturing Company, but his direct involvement in the company was short-lived. On the same page of the *Nebraska City News* that heralded Louis's commitment to the company was the announcement of his departure from the city to St. Louis, Missouri, accompanying Miss Laura Logeman. Louis and Laura married in St. Louis in November 1882. Louis Kregel opened new businesses in St. Louis and remained there until his death in 1903 at the age of forty-four.[115]

George Kregel moved from a department foreman in the Nebraska City Manufacturing Company to its secretary, overseeing the official consolidation of the Kregel Wind Mill Manufacturing Company's machinery and goods into the new business by October 1881. After temporarily joining Louis Kregel at his company in St. Louis in August 1883, George was back in Nebraska City by February 1884, purchasing stock in the Nebraska City Manufacturing Company and turning his full attention toward the company by the end of the year.[116] George's business prospects were not the only reason he returned to Nebraska City after his short stay in St. Louis. In January 1885, he married Clara Petring, whom the local paper reported was "one of the most beautiful and accomplished young ladies" in Nebraska City.[117] George and Clara Kregel would have five children: Robert, Donald, Ella, Mark, and Arthur.[118]

George Kregel apparently gave the Company a much-needed lift as upon his purchase of stock the company immediately acquired a large amount of material and hired a "full force of men," with the intent to produce more goods in the coming year than in any year prior.[119] Within a few years of George reinvesting, the Nebraska City Manufacturing Company was turning out twice as many goods as before, with orders backing up to the point where George was considering expanding the company to accommodate demand. The company had $23,400 of capital stock and had grown to employ eighteen workmen who turned out 125 plows a week largely thanks to George, whom the local paper credited with bringing "the company from almost bankruptcy up to its present good financial standing" within the first three years of his involvement, proving "himself an able businessman and a good financier."[120]

During these years of success, George Kregel saw an opportunity for the company to increase its manufacturing of the KREGEL windmill. A former Nebraska City resident living in northwest Kansas reported that the Nebraska City Manufacturing Company's plows were very popular and "as windmills are the next most important necessity," the company should promote its windmills in the area.[121] Five months later, in March 1886, the company secured a large order for windmills from Kansas, leading George to travel the state later that

[114]Andreas, *History of the State of Nebraska*, 1215; "A Manufactory: Organization of the Nebraska City Manufacturing Company," *Nebraska City News*, July 16, 1881.

[115]"Local Items," *Nebraska City Daily News*, August 15, 1881; "Personal," *Nebraska City News*, August 15, 1881; "Kregel-Logeman," *Nebraska City News*, November 4, 1881; "Local Squibs: Wednesday," *Nebraska City News*, May 19, 1883; "Planned His Own Grave," *Nebraska City News*, June 19, 1903.

[116]Andreas, *History of the State of Nebraska*, 1215; "Local Squibs: Wednesday," *Nebraska City News*, May 19, 1883; "Local Squibs: Friday," *Nebraska City News*, August 18, 1883; "Great Western Fire Co." *Nebraska City News*, February 16, 1884.

[117]"Kregel-Petring," *Nebraska City News*, January 10, 1885.

[118]"Noted Business Man Dies Saturday," *Nebraska Daily News-Press*, September 29, 1946.

[119]Andreas, *History of the State of Nebraska*, 1215; "Local Squibs: Wednesday," *Nebraska City News*, May 19, 1883; "Local Squibs: Friday," *Nebraska City News*, August 18, 1883; "Great Western Fire Co." *Nebraska City News*, February 16, 1884; "Local Squibs: Thursday," *Nebraska City News*, October 4, 1884.

[120]"Persons and Things," *Nebraska City News*, February 11, 1887; "Our Manufacturers," *Nebraska City News*, December 16, 1887.

[121]Win K., "A Newsy Letter: From a Nebraska City Boy Who is in Kansas," *Nebraska City News*, November 14, 1885.

year to promote the company's goods.[122]

The company was unable to sustain their success, however. Just two years after declaring "the outlook is far brighter than I have ever seen it since I have been in the city and connected with this establishment…and it has made too many advancements to get a setback now," George Kregel announced the Nebraska City Manufacturing Company was quitting the agricultural implement business as unprofitable.[123] He was "confident, however, that implements can be successfully made in this state…if the business is properly started and managed with sufficient capital to make a line of goods large enough …that dealers could be supplied in [railroad] car lots, and not be overstocked with any one article."[124] The Nebraska City Manufacturing Company remained in the Nebraska City Business Directory at the same location under George Kregel's management as late as 1890, which turned out to be a seminal year in the history of Kregel windmill manufacturing.[125]

That Louis Kregel designed the KREGEL windmill that he and George Kregel, and later the Nebraska City Manufacturing Company, sold is clear. What is more confused is the history of the ELI windmill's creation, for which George and the Kregel Windmill Company became known. Even George's son, Arthur Kregel, was not "sure why my father picked the name ELI, except it was short, could be painted big and could be seen a long way."[126] In September 1890 the *Syracuse Journal* reported that Louis's father, Henry Kregel, was seeking a patent for a "simple and economical [windmill]…that can easily stand all storms" and had one on display at his nephew George's factory.[127] That description is close to that of an ELI, and with the model mill on his company's property, the first known reference of an ELI windmill appears on George's letterhead in December 1890. Roughly sixty-seven at the time he was working on his new windmill design, it is unlikely Henry was looking to start a new business manufacturing a windmill of his own design. After the recent decline of the Nebraska City Manufacturing Company, however, his nephew George likely had an interest in a new windmill design.

The ELI was an impressive wind engine, as best described by T. Lindsay Baker:

> All the ELI windmills are direct-stroke machines; that is, one revolution of the wind wheel produces one stroke of the pump...The ELI, in fact, has a remarkably simple design…The wheel of the ELI contains one of its most striking design elements. Unlike almost all other windmills manufactured in America, the blades on the ELI are mounted behind the outer wheel rims. Almost every other mill has outer rims that pass through openings in the blades or are positioned behind the blades. The ELI is different. While the blades are riveted to the inner rims in a conventional manner, the out ends of the blade are riveted to L-shaped galvanized steel brackets that hold them in a position completely behind the outer rims. The maker claimed that this design was superior because the L-shaped brackets reinforced the blades to within seven inches of their tips and avoided weakening the blades with large holes for rim mounting. Although the design is unusual, one cannot help but be impressed by the large proportion of the wheels that have

[122]"Local Squibs: Thursday," *Nebraska City News*, March 20, 1886; "As Time Goes By: One Hundred Years Ago," *Nebraska City News-Press*, June 18, 1986.
[123]"Persons and Things," *Nebraska City News*, February 11, 1887.
[124]"How They Answered: Opinions from Our Manufacturers Regarding Protection and Business," *Nebraska City News*, April 12, 1889.
[125]Kregel Windmill Museum, "Kregel Windmill Company History," Copy on file at Kregel Windmill Company Museum, Nebraska City, Nebraska.
[126]Tom Allan, "Nebraska Byways: Windmill Shop Still Turns Out Quality Work," *Omaha World Herald*, June 5, 1988.
[127]"Nebraska City," *Syracuse Journal*, September 19, 1890.

survived intact on derelict ELI mills observed in the field.[128]

The ELI was also self-regulating, allowing the wheel to automatically pivot away from increasing winds, while the vane remained parallel with the wind. When the wheel pivoted away from strong winds, the hinged vane assembly would raise, then lower with the decreased wind speed, drawing the wheel back to face the wind, giving the mill a relatively regular rate of operation.[129]

George Kregel and the ELI were linked in 1891 under his entry in the *Farm Implement News Buyer's Guide.* In local advertisements, George referred to his address as "At the Plow Factory," with large bold letters announcing the availability of windmills—with no reference to what model—along with a full accompaniment of farm water supply items: water tanks, pumps, pipes, pipe fittings, and regulators. George displayed the ELI at the Otoe County Fair and Nebraska City's Fourth of July celebration as the turn of the century neared. In the years since first advertising the ELI, it became an increasingly popular windmill in southeast Nebraska and southwest Iowa.[130]

Period of National Significance, 1902-1941

The year 1902 began with George Kregel advertising, for the first time, galvanized steel tanks in addition to the white pine and cypress versions he had sold through the previous decade. But George's introduction of galvanized tanks was far from the company's most significant change that year. L.F. Cornutt & Son, owners of the land on which George had operated two companies for over two decades, decided to expand their lumberyard, causing George to look for a new spot for his windmill factory. After rejecting an offer from the Missouri Pacific railroad to relocate within their right of way, in early April George announced his intention to build a new factory near the corner of Fifteenth and Central Avenue, just a half-block west and on the opposite side of the street from his previous location. In early May, George purchased lot 15, block 8 in Nebraska City's original town section and began construction of a new factory; five weeks later George was nearly settled in his new factory. H.F. Winkelmann and the Overland Roofing Company installed the building's tar and gravel roof, but no information has been located about the builder or designer.[131] George F. Kregel, and then the Kregel Windmill Company, remained at this location for the next eighty-nine years, until George's son, Arthur Kregel, passed away in 1991.

Company Development

Having previously only produced wood ELI models, demand for steel ELIs led George Kregel to produce them upon the opening of his new factory. The early years at 1406 Central Avenue progressed with the factory producing ELI mills and wood and steel windmill towers, reselling other models of mills that had been replaced

[128]The direct-stroke design that Dr. Baker references was introduced to the ELI in 1913. T. Lindsay Baker, "ELI and the Kregel Windmill Company," *Windmillers' Gazette* 5, no. 3 (Summer 1986): 2-3; "Correction," *Windmillers' Gazette*, 5, no. 4 (Autumn 1986), 10.

[129]Baker, "ELI and the Kregel Windmill Company," 2-3.

[130]"Wind Mills," *Farm Implement News Buyer's Guide: Where to Purchase Farm Implements, Machines and Vehicles, 1891* 3 (1891): 214; George F. Kregel, [Advertisement], *Nebraska City News*, October 16, 1891; "Patriotism and Pleasure: Nebraska City Celebrates Our County's Natal Day," *Nebraska City News*, July 7, 1899; Nebraska City's Display: An Exhibit of Some of the Articles Manufactured in this City," *Nebraska City News*, May 17, 1901; "He Will Build," *Nebraska City News*, April 9, 1902.

[131]"Local Brevities," *Nebraska City News*, February 7, 1902; "He Will Build," *Nebraska City News*, April 9, 1902; "Local Brevities," *Nebraska City News*, May 30, 1902; The official deed was not signed until May 26, transferring the property from Harry Wales to Clara Kregel, not George, for $300. "George Kregel has purchased," *Nebraska City News Press*, May 7, 1902; "Warranty Deed. From Harry Wales (sole) to Clara M. Kregel," Series 1, Box 1, Folder 11, KWCR; "George Kregel has about got settled," *Nebraska City News Press*, June 10, 1902; "Agreement: G.F. Kregel and Overland Roofing Company," Series 9, Box 54, KWCR.

with ELIs, and selling other farm-related goods. Orders were primarily local but at least one was taken from as far away as Brush, Colorado, eighty miles northeast of Denver. In April 1904 a 10-foot ELI with a 30-foot wood tower cost $47, roughly half of what George and Louis Kregel had sold their KREGEL windmill for in 1879.[132]

From 1902 to 1941, George and Arthur Kregel and the Kregel Windmill Company rode the ebb-and-flow of the windmill manufacturing industry through four decades of changes and challenges. George Kregel's first major change came on March 23, 1910, when he filed the Articles of Incorporation for the Kregel Windmill Company with sons Robert and Donald.[133]

To keep pace with his contemporaries, George Kregel made several changes to the ELI over the years. First, in 1913 he received a patent for an improvement to the pitman rod on the ELI, which focused on three objectives: to provide a direct stroke; to include a swiveled joint so that the complete pitman rod could be removed while keeping the pull out chain and wire of the windmill in place, holding the mill out of gear; and, perhaps most importantly, "to provide a simple, compact, reliable and efficient wind mill pitman which is composed of relatively few parts, and these so constructed they may be readily assembled in position for use, and quickly dismantled when desired."[134] The second change to the ELI addressed a criticism from an experienced windmill owner regarding the need for routine lubrication. As self-oiling windmills came to dominate the market, in 1921 George Kregel altered the ELI to embrace the advancements in windmill design, replacing the old-style grease cup lubrication with an enclosed reservoir. In the short term, company sales jumped by nearly $2,000 from 1920 to 1921. In the long term, though, the company struggled financially. The self-oiling ELI undoubtably sold better than its previous model would have but contributed only just enough sales for the company to keep its doors open. The third change was to the company's business practice rather than to the ELI itself. To increase sales to dealers across Nebraska and neighboring states, in September 1927 the company began offering an additional 10 percent discount on wholesale orders when a cash payment was made with their order, a practice that continued until 1934.[135]

George Kregel considered adapting the ELI to meet the needs of consumers facing the agricultural recession of the 1920s and the Great Depression the following decade. With discouraging crop prospects and prices, and farmers hesitant to make costly improvements, George informed a concerned shareholder in 1926 that he planned "to make a lighter, cheaper mill and tower; this without time and money expense to the company."[136] However, no record of an alternative mill exists until 1937 when two different 10-foot mills were offered: the

[132]"He Will Build," *Nebraska City News*, April 9, 1902; George F. Kregel, "For Sale," *Nebraska City News*, April 11, 1902; "Bee Hive and Bee Keepers' Supplies. Cypress and Steel Tanks. Eli, Sampson, and other Wind Mills, with Wood or Steel Towers" [Advertisement], *Nebraska City News*, April 26, 1904; Callen and Sons to Kregel Windmill Company, March 18, 1903, Series 7, Box 54, KWCR; George Kregel to Mrs. C. Fraisher, April 18, 1904, Series 7, Box 51, KWCR.

[133]At the time of incorporation, Robert was twenty-five and Donald twenty-one. Arthur, who eventually took over the business, was twelve; Kregel Windmill Company, "Articles of Incorporation," March 23, 1910, Series 1, Box 1, Folder 2, KWCR.

[134]The pitman translates the rotary power from the wind blades to the up-and-down motion of the pumping rod. George F. Kregel, Windmill-Pitman, U.S. Patent #1,058,603, filed on September 16, 1911, and issued April 8, 1913; Baker, *A Guide to United States Patents for Windmill and Wind Engines*, 81.

[135]Lawrence Peterson to T. Lindsay Baker, October 31, 1986, T. Lindsay Baker Collection at Kregel Windmill Factory Museum, Nebraska City, NE; T. Lindsay Baker, "Historical Information," Kregel Windmill Company Factory, HAER No. NE-8 (1995), 7-8; "Self-Oiling is Now Applied to the 'Eli' Windmill" [Advertisement], *Nebraska City News*, July 22, 1921; "Profit and Loss Statement of the Kregel Windmill Co. From Dec. 31, 1919 to Dec. 31, 1920," Series 2, Subseries 6, Box 21, Folder 3, KWCR; "Profit and Loss Statement of the Kregel Windmill Co. From Dec. 31, 1920 to Dec. 31, 1921," Series 2, Subseries 1, Box 1, Folder 14, KWCR; "ELI Mill & Tower Price List," September 1, 1927, Series 3, Box 23, Folder 20, KWCR.

[136]Kregel Windmill Factory, "Form Letter #15," June 3, 1926, Series 3, Box 24, Folder 29, KWCR; Kregel Windmill Company to William H. Pitzer, March 3, 1930, Series 2, Subseries 1, Box 1, Folder 15, KWCR; Kregel Windmill Company to William H. Pitzer, March 3, 1930, Series 2, Subseries 1, Box 1, Folder 15, KWCR.

traditional 36-slat, 400 pound model and a 30-slat, 360 pound version, with the latter being only $1.50 cheaper for dealers and $2.50 cheaper when sold retail.[137] None of these adaptations led to a significant spike in sales or profits, but, collectively, they kept the company active in the windmill manufacturing field where other small firms were unable remain in business.

Financial Success and Failure

Kregel company records show a checkered financial history, with years of increased sales and profits intermixed with others of declining sales and net losses. Rather than a year-by-year description of the company's finances, the following section is designed to summarize and examine the Kregel's finances in the context of the national windmill manufacturing trends.

Specific annual records do not become available until 1910, at which time they document that the Kregel Windmill Company operated at a loss until 1916. Losses during this period ranged widely. The World War I boom in agricultural production and windmill manufacturing is directly reflected in the Kregel records. After a loss of $837.30 in 1914, profits increased to $2,184.11 in 1918. From 1915 to 1918, sales increased each year for an astounding rise in sales of 277 percent, from $6,435.26 to $17,848.21. With this upturn in sales and profit, 1918 was the first year the company was not operating at a loss and finally able to issue dividends to stockholders.[138]

The company's sales fluctuated throughout the next decade as the agricultural economy faltered. The aforementioned plan of a lighter, cheaper mill to reduce company expenses may have helped keep sales steady in the early 1920s, but the company again operated at a loss starting in 1925. The onset of the Great Depression crippled any thoughts of generating revenue similar to the previous decade. Sales of $11,401.89 in 1928 plummeted to a meager $3,342.18 by 1932, when the company experienced a loss for the eighth consecutive year. In the face of the mounting company debt, members of the Kregel family agreed to draw far less pay than they earned to keep the company's doors open, deducting multiple years' losses from the amount they were owed in wages.[139] When reviewing the first twenty years of the company, George Kregel confided to a stockholder that, "the losses are of the greatest concern to the management. It appears not to have been wise to start a manufacturing business with the limited capital we did, as it did not permit us to buy material in car lots, nor have enough suitable equipment."[140]

Windmill Sales and Prices

The Kregel Windmill Company's annual sales and profit/loss statements were influenced by, but not exclusive to, windmill and tower sales. The remainder was attributed the numerous agriculture-related goods and services they offered. Annual totals for windmill sales are elusive, but newspaper accounts point to increased production in the World War I era, when profits also soared. Not surprisingly, multiple articles appear in 1917 reporting on the flurry of activity at the factory and sales of windmills so frequent that "the company could double their [output], if they only had the capacity to enable them to turn them out."[141] Looking ahead to 1918, which would be the company's best year financially, George Kregel purchased a large supply of material to enable the

[137]Kregel Windmill Factory, "ELI Mill & Tower Price List", February 1937, Series 3, Box 23, Folder 20, KWCR.
[138]Kregel Windmill Company, "Company Financial Summary, 1910-1945," Series 2, Subseries 6, Box 21, Folder 11, KWCR; Kregel Windmill Company to Internal Revenue Service, April 17, 1919, Series 2, Subseries 6, Box 21, Folder 3, KWCR.
[139]Kregel Windmill Company to Internal Revenue Department, June 28, 1934, Series 2, Subseries 6, Box 22, Folder 15, KWCR.
[140]Kregel Windmill Company to William H. Pitzer, March 3, 1930, Series 2, Subseries 1, Box 1, Folder 15, KWCR.
[141]"Local Brevities," *Nebraska City News*, January 19, 1917; "Local Brevities," *Nebraska City News*, February 9, 1917.

company to meet the spring demand for their windmills.[142]

Sales held steady in the early and mid-1920s even as profits declined. The first estimate of annual windmill sales comes from a 1925 advertisement that forty-one and thirty-two ELIs were sold within the surrounding area in 1923 and 1924, respectively. Seventy-four ELIs were sold in 1926; yet the company lost $1,184.15. The following year they sold five fewer windmills before increasing to eighty-seven mills in 1928. Not surprisingly, sales decreased steadily over the next five years reaching a low of thirteen in 1932, with company records for windmill and tower sales for 1933 completely blank. Seventeen ELIs were sold in 1934. During these records' eight years, a seasonal pattern emerged where sales were particularly slow in November through February, increased in March and held through August, before dropping in September and October.[143]

The price of an ELI and tower was dependent on market fluctuations and, in some cases, changed within a given year. Between 1904 and 1919, a 10-foot ELI with a 30-foot wood tower more than doubled from $47 to $98. If the Kregel Windmill Company erected the mill and tower for its customer, they charged an additional $1.60 per foot. During this same period, a 10-foot AERMOTOR with 27-foot tower sold for $53.50, while the price for a Halladay STANDARD fluctuated between $70.15 and $100. Three years into the Great Depression, the price of a 10-foot ELI was reduced only slightly, to $60 retail and $40.40 wholesale, with a wholesale 8½-foot model at $35. In this context, the Kregel's ELI was a mid-priced mill amongst its competitors. In advertisements, George Kregel suggested the initial price was worth the investment in the long term by equating a cheaper mill with poor quality needing more repairs and service.[144]

Sales Area and ELI Dealers/Agents

Records indicate that while mills were sold at the higher, retail prices directly from the factory to the customer, by 1926 most mill sales were at the cheaper, wholesale price to dealers who then sold them to others at the higher, retail price. To S.S. Morgan in Wallace, Nebraska, 275 miles away in Lincoln County, a 10-foot ELI and was shipped in 1919 for the dealer's price of $40, with a note that "we would be pleased to sell you more mills at the above price and have you sell at a price that give you a profit."[145] Dealers were also encouraged to give ELI customers a thirty-day trial of the mill. If unsatisfied and the mill had to be taken down, the dealer could draw on the Kregel Windmill Company for the expense of their labor.[146] As with most small windmill manufacturers, the Kregel Windmill Company focused on serving areas close to home. In a 1911 business survey, the company estimated that 60 percent of its sales were in Nebraska. The percent which were in Iowa is not stated, but it likely consumed a large portion of Kregel's sales throughout its history.[147]

ELI dealers were most common in Otoe County, where Nebraska City is located. Along with Nebraska City, six

[142]"Turning Out Many Mills," *Nebraska City News*, November 20, 1917.

[143]Kregel Windmill Company, "Form Letter #6," April 29, 1925, Series 3, Subseries 3, Box 24, Folder 29, KWCR; "Profit and Loss Statement of the Kregel Windmill Co. From Dec. 31, 1925 to Dec. 31, 1926," Series 2, Subseries 1, Box 1, Folder 15, KWCR. Windmill sales in 1927 included fifty-five 10-foot mills and fourteen 8½ -foot mills. In 1928, sixty-five 10-foot ELIs were sold along with twenty-two 8½-foot models. Sales Books, 1927-1934, Series 3, Box 25, Folder 34, KWCR.

[144]George Kregel to Mrs. C. Fraisher, April 18, 1904, Series 7, Box 51, KWCR; Baker, "Irrigating with Windmills on the Great Plains," 221; Baker, "What Profits Earned From Manufacturing Windmills Could Buy," 6; Aermotor Company, Pamphlet, 1915, Series 6, Subseries 2, Box 33, KWCR; "Sales Book, 1932," Series 3, Box 25, Folder 34, KWCR; "ELI Mill & Tower Price List," September 1, 1927, Series 3, Box 23, Folder 20, KWCR; Kregel Windmill Factory, "Form Letter #17," November 2, 1926, Series 3, Box 24, Folder 29, KWCR.

[145]Kregel Windmill Company to S.S. Morgan, April 8, 1919, Series 2, Subseries 3, Box 8, Folder 51, KWCR.

[146]Kregel Windmill Company, "Sales Information Book," undated, p. M, Series 4, Box 25, Folder 7, KWCR.

[147]Kregel Windmill Company, "State Bureau of Labor and Industrial Statistics Report, 1911," Series 2, Subseries 6, Box 21, Folder 4, KWCR.

other towns in the county had at least one ELI agent between 1913 and 1929. The adjacent Nebraska counties of Cass, Nemaha, and Johnson also had numerous ELI agents. In Richardson County, bordering Missouri to the east and Kansas to its south, Mr. C.A Snider was a successful agent for the company, having "sold more than 100 ELI mills and less than $10.00 worth of ELI repairs," between the unspecified time he began selling them and the 1926 letter.[148]

Kregel's immediate sales area stretched into the western end of Fremont County, Iowa, just across the reiver from Nebraska City. Company records indicate that there were at least two ELI agents in Fremont County communities in 1913 and in 1927.[149]

The Kregel Windmill Company made a concentrated effort to extend sales into every corner of Nebraska. A 1926 list of potential dealers to whom they mailed circulars included 135 dealers in 133 Nebraska communities. Dealers recorded multiple ELI sales in southwestern Nebraska's Red Willow County and closer to the center of the state in Merrick County. Arthur Kregel remembered regularly shipping ELIs to western Nebraska and in the Sandhills, and dealers from Rock and Brown counties were often listed in company records.[150]

The Kregel Windmill Company sales area stretched into neighboring states as well. The company had at least one dealer in northwest Missouri as early as 1913.[151]

The presence of Kansas City- and Topeka-based firms likely minimized sales in nearby northeast Kansas. Stretching west across the Sunflower State's plains, however, ELI dealers were located at various times in Beloit, Woodston, Norton, Norcatur, Selden, and Brewster, on the Kansas-Colorado border. In central Kansas, E.L. Buffington & Son were dealers located in Langley while in Coldwater, just twenty miles north of the Kansas-Oklahoma border, ELIs were offered by the Farmers Elevator Company.[152]

In 1903, the company shipped an ELI mill to a customer in northeast Colorado. Sales in the area continued during the following decades with dealers clustered in the northeast section of the state. One dealer was identified in both Burke, South Dakota, and Casper, Wyoming, in 1927, but the company also made direct sales to customers in these states.[153]

The Great Depression profoundly impacted the Kregel Windmill Company's capacity to utilize an expanded dealer network. By 1932, the company's list of dealers was much reduced, totaling twenty-five businesses, four of which were in Colorado and just one in Iowa.[154] In 1936 they declined the proposal of working with a dealer in Lincoln: "on account of our inability to get material to enable us to manufacture mills and towers at attractive

[148]Kregel Windmill Company, "Form Letter #6," April 29, 1925, Series 3, Box 24, Folder 29, KWCR.

[149]"The Eli Wind Mill," *Nebraska City News*, February 28, 1913; "Eli Wind Mill Agents," *Nebraska City News*, April 28, 1914; "1927 Dealers List," Series 3, Box 24, Folder 29, KWCR.

[150]T. Lindsay Baker, "ELI and the Kregel Windmill Company," *Windmillers' Gazette* 3, no. 3 (Summer 1986): 5; Kregel Windmill Company, "1926 Dealers List," Series 3, Box 24, Folder 29, KWCR; "Assorted Client Contact Cards," Series 3, Box 24, Folder 27, KWCR; Tom Allan, "Nebraska Byways: Windmill Shop Still Turns Out Quality Work," *Omaha World Herald*, June 5, 1988.

[151]"1927 Dealers List," Series 3, Box 24, Folder 29, KWCR; Kregel Windmill Company to Sylvester Garst, September 22, 1936, Series 5, Box 31, Folder 302, KWCR.

[152]"Assorted Client Contact Cards," Series 3, Box 24, Folder 27, KWCR; "1927 Dealers List," Series 3, Box 24, Folder 29, KWCR.

[153]Callen and Sons to Kregel Windmill Company, March 18, 1903, Series 7, Box 54, KWCR; "1927 Dealers List," Series 3, Box 24, Folder 29, KWCR; "Assorted Client Contact Cards," Series 3, Box 24, Folder 27, KWCR; "1927 Dealers List," Series 3, Box 24, Folder 29, KWCR; Kregel Windmill Company to Chicago, Burlington, & Quincy Railroad Company, July 26, 1937, Series 5, Box 31, Folder 304, KWCR.

[154]List of Dealers, 1932, Series 3, Box 24, Folder 29, KWCR.

wholesale prices at this time, we feel that we cannot do you or ourselves much good."[155] Kregel was not likely the only mill manufacturer struggling to produce windmills, as a bank in Clarksville, Tennessee, contacted the company about potentially purchasing a mill, as did a potential customer from north-central Iowa.[156]

Other Goods Manufactured and/or Sold

Like most windmill manufacturers, Kregel offered other agriculturally related products or, more specifically, other facets of a rural water system beyond just mills and towers. Though the proportions likely fluctuated over time, by 1939 the Kregel Windmill Company reported that only 25 percent of its business was in manufacturing and selling mills, towers, and tanks. The other 75 percent was in retail sales of pumps and pipes, and in repair work. As the area's primary maker and servicer of windmills of all types, it is not surprising that they had advertised different windmill makes and models for sale at their factory in addition to those manufactured by Kregel.[157]

A windmill and tower are relatively useless without a quality pump to bring the water to the surface. The company sold a variety of pumps, as part of a windmill set or as a stand-alone item for area farmers to use with other makes of windmills. While some mill owners constructed reservoirs, many purchased tanks to collect and hold water until use. Similar to windmill towers, by the time the Kregel Windmill Company had moved into their new building in 1902, water tanks were also undergoing the transition from wood to metal. The Kregel Windmill Company often advertised for pumps, tanks, and eventually, tank heaters, separately from their windmills, often in the same edition of the newspaper. Along with standard sizes for tanks, the company also produced custom tanks and refurbished second-hand tanks.[158]

As a sign of things to come, in February 1941 the Kregel Windmill Company ran an advertisement with the heading of "Running Water is the First Essential for Modern Living." Below that large heading was an image of an electric water pump and language promoting a McDonald Automatic Water System.[159] Although they continued to sell windmills, the Kregel Windmill Factory was embracing the transition of rural water systems away from wind energy to electric pumps.

A bit uncommon, although agriculturally related, was the Kregel Windmill Factory's involvement in the bee keeping area. George Kregel's first patent came for his own beehive, eight years before the improvement patent for the ELI's pitman rod. Kregel Windmill Company records include a ten-page beekeeping booklet that showcased the hives and supplies the company offered, more robust than any promotional material the company had for its windmills.[160] Similar to the company advertising the availability of pumps and tanks separate from their windmill, often advertisements for beekeeping supplies were given their own billing. This practice

[155]Kregel Windmill Company to Nebraska Machinery & Supply Company, October 27, 1936, Series 5, Box 31, Folder 302, KWCR.

[156]First National Bank of Clarksville (TN) to Kregel Windmill Company, June 23, 1937, Series 5, Box 31, Folder 303, KWCR; Kregel Windmill Company to O.J. Nyberg, April 18, 1940, Series 5, Box 31, Folder 309, KWCR.

[157]"Business Trend Survey," March 16, 1939, Series 3, Box 21, Folder 3, KWCR; Kregel Windmill Company "Windmills For Sale," *Nebraska City News*, November 14, 1916.

[158]Kregel Windmill Company to Red Jacket Manufacturing Company, August 4, 1909, Series 5, Box 25, Folder 6, KWCR; "Pumps" [Advertisement], *Nebraska Daily News-Press*, March 26, 1927; "Tanks & Troughs" [Advertisement], *Nebraska Daily News-Press*, March 5, 1926; Kregel Windmill Company, "Tank Heaters- - -Tanks," November 16, 1927, Series 6, Subseries 1, Box 33, KWCR; "Tanks" [Advertisement], *Nebraska Daily News-Press*, November 15, 1928; Republic Metalware Company, "Invoice 7003," March 13, 1907, Series 2, Subseries 3, Box 6, Folder E, KWCR; "Tearing Down Starch Works," *Nebraska City News*, May 19, 1908.

[159]Kregel Windmill Company, "Running Water is the First Essential for Modern Living," *Nebraska Daily News-Press*, February 23, 1941.

[160]George F. Kregel, Beehive, U.S. Patent #801,736, applied for June 7, 1904, and filed November 14, 1905; George Kregel, "G.F. Kregel: Manufacturer of Bee Hives and Supplies," c1905, Series 6, Subseries 1, Box 33, KWCR.

stretched through most the of the company's history, from as early as 1907 to as late as 1936. Though George and Arthur Kregel shared a love and knowledge of windmills, George was clearly more passionate about beekeeping than Arthur. Not only did the elder Kregel patent his own beehive and sell beekeeping supplies, but was the head of the local beekeeping group and was known to others as "a bee enthusiast of many years' experience."[161] It is unclear how long Arthur kept selling beekeeping supplies after he took over the company in 1940, but company advertisements as late as 1949 continued to mention beehives and beekeeping supplies.[162]

Employment at the Kregel Windmill Factory

Due to the volatile windmill market, stating specifically how many people worked at the Kregel Windmill Factory relies on a range of factors. Primarily, within a given year the number of workers and the hours each worked varied by season, decreasing in the winter—and occasionally in the peak of summer—when the demand for windmills and other farm supplies was lower. Over the course of forty years, the fluctuations of the windmill market resulted in inconsistent employment practices at the Kregel Windmill Company.

In 1911, seven people were listed as company employees. The workmen's wages ranged from $1.75 to $3.00 daily, most often working six ten-hour days when operating at full capacity. The company's sole female employee—George's sister, Ella Kregel—worked part-time keeping the company's books at $0.10 per hour. In 1913, fifteen-year-old Arthur Kregel is first noted in the company's books where he will work for the next seventy-eight years. Despite the surge in company sales and wages, the number of employees decreased to three full time employees in 1917 and four in 1918, respectively, as George kept labor costs to a minimum to increase profits.[163] Throughout the company's history, workmen generally came and went. A very small number of names would routinely appear on the payroll for a half-dozen years at a time, but most names appeared intermittently over the course of a few years, and no hired hands made a career working at the factory.

The decline in sales and profits at the start of the Great Depression was reflected in a decline in the number of employees. By July 1929, the company was down to only George and Arthur Kregel as full-time employees, with many of Arthur's days shortened to nine hours; this was the first in a string of employment changes to keep the company's doors open. Over the next four years Arthur received roughly one-third of his earned wages and was credited with the remaining two-thirds. George Kregel's salary, which started at $660 in 1910 and grew to $1,200 in 1920, was reduced by half in 1930 to below his original annual compensation. Part-time employees came and went at the factory throughout the Depression, working over thirty hours in consecutive weeks, followed by multiple weeks of zero recorded hours. Though no windmill sales are recorded, workers who occasionally logged upwards of sixty hours per week devoted their time to either windmill service or one of the varied goods that the company produced.[164]

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[161]"Bee Hives $2.50" [Advertisement], *Nebraska City News*, June 28, 1907; "Cold Spring Hurt Bees," *Nebraska City News*, July 22, 1921; "Bankers of Group One--This Is a Good Town!" *Nebraska Daily News-Press*, June 19, 1926; "For Sale" [Advertisement], *Nebraska Daily News-Press*, May 21, 1929; Kregel Windmill Company, "Business Service" [Advertisement], *Nebraska Daily News-Press*, May 31, 1936.

[162]Kregel Windmill Company [Advertisement], *Nebraska Daily News-Press*, July 14, 1949.

[163]Kregel Windmill Company, "State Bureau of Labor and Industrial Statistics Report, 1911," Series 2, Subseries 6, Box 21, Folder 4, KWCR; Kregel Windmill Company, Entry for June 7, 1913, "Weekly Timebook: October 26, 1912 to March 6, 1915," Series 2, Subseries 4, Box 20, Folder 1, KWCR; Kregel Windmill Company, "Special Report to the War Industries Board," September 27, 1918, Series 2, Subseries 6, Box 22, Folder 15, KWCR.

[164]Kregel Windmill Company, Entries for July 13, 19, 27, and August 27, 1929, "Weekly Timebook: June 29, 1929 to November 22, 1930," Series 2, Subseries 4, Box 20, Folder 2, KWCR; Kregel Windmill Company to Internal Revenue Department, December 23, 1935, Series 2, Subseries 6, Box 22, Folder 15, KWCR; "Profit and Loss Statement of the Kregel Windmill Co. From Mar. 1, 1910 to Jan. 1, 1913," Series 2, Subseries 1, Box 1, Folder 9, KWCR; "Profit and Loss Statement of the Kregel Windmill Co. From Dec. 31, 1919 to Dec. 31, 1920," Series 2, Subseries 6, Box 21, Folder 3, KWCR; "Profit and Loss Statement of the Kregel Windmill

The year 1938 may be one of the more consistent years for employment at the Kregel factory. In addition to George, Arthur, and Ella Kregel —none of whose hours were recorded—three employees were routinely logged working twenty to almost sixty hours, depending on the week. The company underwent a management transition in 1939. Having worked at the factory since 1913, Arthur began signing federal income tax returns as company vice president, although he was not listed as a company officer. George was listed as company president until the 1945 returns, when only Ella was listed under officers as secretary/treasurer. Wages paid and hours worked continued to fluctuate into the 1940s. Eventually, with the onset of World War II and vast majority of working-aged men preparing to disembark for Europe or the Pacific, Arthur began having trouble finding reasonably priced help.[165]

Advertising/Marketing

The Kregel Windmill Company employed several methods to promote its ELI windmill, most of which were relatively common amongst manufacturers. Advertisements in the local newspaper were common.[166] Language within the advertisements was primarily devoted to the ELI's simplicity and durability, telling prospective customers that "the famous ELI mill, a product which is 'sworn by' not 'sworn at' by hundreds of farmers who buy it."[167] Some advertisements insinuated that other mills were not of the quality of an ELI, while others were more direct in stating the competition's unreliability.[168]

The company routinely sent letters to a list of windmill dealers throughout Nebraska and surrounding states. Letters were also sent directly to area farmers, using more descriptive language than that of their newspaper advertisements to detail the benefits of buying an ELI. Sometimes these letters disparaged other makes of windmills. If they knew what make and model of mill a farmer already owned, they specifically addressed that model and its defects, but otherwise had ready-made text to insert into letters comparing an ELI to models made by Woodmanse, Perkins, Aermotor, and Halladay. Area farmers were encouraged to send Kregel the names of others who might be interested in purchasing a mill. If those names purchased a mill from Kregel, the farmer received $2.00 for their referral.[169]

The practice of showcasing their mills at the Otoe County Fair and other area festivals that began in George Kregel's early days with Louis Kregel was continued. The company also produced a float for Nebraska City's semi-centennial celebration of Arbor Day in 1917, along with participation in Home Products Week in 1931, where participating businesses arranged items they produced in window displays for visitors to view.[170]

Company. From Dec. 31, 1929 to Dec. 31, 1930," Series 2, Subseries 1, Box 1, Folder 15, KWCR; Kregel Windmill Company, Entry for March 29, 1930, "Weekly Timebook: June 29, 1929 to November 22, 1930," Series 2, Subseries 4, Box 20, Folder 2, KWCR; Kregel Windmill Company, Entry for April 24 through May 21, 1931, "Weekly Timebook: Nov. 29, 1930 to April 24, 1934," Series 2, Subseries 4, Box 20, Folder 2, KWCR.

[165]Kregel Windmill Company, Various entries from 1938, "Weekly Timebook: Oct. 1937 through July 1940," Series 2, Subseries 4, Box 20, Folder 3, KWCR; Kregel Windmill Company, "Corporation Income and Declared Value Excess-Profits Tax Return," 1938-1945, Series 2, Subseries 6, Box 21, Folder 3, KWCR.

[166]"Geo. F. Kregel" [Advertisement], *Nebraska City News*, May 1, 1908; Kregel Wind Mill Company, "The unreliability of most wind mills," *Nebraska City News*, February 20, 1912.

[167]"Bankers of Group One--This Is a Good Town!" *Nebraska Daily News-Press*, June 10, 1926.

[168]Kregel Wind Mill Company, "In buying a wind mill be sure you are right," *Nebraska City News*, June 15, 1915; Kregel Wind Mill Company, "The unreliability of most wind mills," *Nebraska City News*, February 20, 1912.

[169]Kregel Windmill Company, "Sales Information Book," undated, p. H, Series 4, Box 25, Folder 7, KWCR; G.F. Kregel, untitled form letter, no date, Series 5, Box 25, Folder 7, KWCR.

[170]"The Stock Show, Parade and Sale," *Nebraska City News*, September 20, 1907; "Nebraska City at County Fair," *Nebraska Daily News-Press*, August 22, 1929; "Semi-Centennial Arbor Day Celebration," *Nebraska City News*, April 24, 1917; "Lecture to Open

Windmill Service

Well and windmill service had always been part of the Kregel Windmill Company's business model. Following a 1909 storm the company had more windmill repairs than they could immediately address, and company records contain multiple correspondence between George Kregel and customers relating to the repair of their mills, ELIs or other models. T. Lindsay Baker believes that although they constructed windmills for another twenty years, the onset of the 1920s agricultural depression was already transitioning the Kregel Company's business model towards becoming a well maintenance business.[171] Newspaper advertisements in the 1930s focused more on windmill and pump service than attempts to sell customers new mills. In early 1941, rather than advertise the services they offered, the Kregel Windmill Company posted a "Work Wanted" notice, looking for tubular well repairing and drilling.[172]

Company History, 1942-1991

Three factors ultimately led the Kregel Windmill Company to end the manufacture of windmills. Two factors—scarcity of material and quality workmen—were direct results of World War II. Beginning in 1942, Arthur Kregel routinely wrote to customers apologizing for his inability to produce the requested mill due to these issues. In March 1942, Arthur notified Edwin D. Hahn that the company was behind on windmill work, and in June the company returned payment for an order, responding that they were "sorry we could not fill your order promptly," due an increase of defense contracts, mill repairs, and a shortage of workmen.[173] An order for an 8½-foot ELI in May 1943 was never filled and the initial payment was returned to the now-deceased customer's son in 1947. Arthur explained that the inability to produce the ordered mill was "owing to scarcity of material and experienced help…[and]the demand for other work…has nearly crowded out the windmill manufacturing."[174]

The third, and perhaps the most important reason for ending windmill manufacture, was Arthur Kregel's unwillingness to take on debt to allow him to order enough material to produce enough ELIs to sell them for profit. To make windmill manufacturing a viable aspect of the company, castings needed to be ordered in batches of between five and fifty at a time, which the company was unable to do due to inadequate capital.[175] Arthur's view on the future of the company's windmill production is best summed up in a letter that Ella Kregel wrote to their brother, Mark, in September 1945:

> We have not made any mills for several years because of the scarcity of labor and inabillity [sic] to get material. We had half way decided to stop making them altogether, and just supply repairs until the whole thing played out. We cannot make any more without capital; that is evident by the enclosed showing since the place started way way back. And Art said he has no ambition to try to build up a large business on borrowed money; it just can't be done.[176]

Products Display," *Nebraska Daily News-Press*, April 1, 1931.

[171]Kregel Windmill Company to A.D. Richards, October 4, 1909, Series 5, Box 25, Folder 6, KWCR; T. Lindsay Baker, in Patti Jo Peterson, "Windmill Museum undergoes clean up," *Nebraska City News-Press*, June 30, 1995.

[172]Kregel Windmill Company, "Business Service" [Advertisement], *Nebraska Daily News-Press*, September 2, 1934; Kregel Windmill Company, "Business Service" [Advertisement], *Nebraska Daily News-Press*, May 31, 1936; Kregel Windmill Company, "Work Wanted," *Nebraska Daily News-Press*, February 7, 1941.

[173]Kregel Windmill Company to Charles G. Heese, November 28, 1944, Series 5, Box 31, Folder 315, KWCR; Kregel Windmill Company to Edwin D. Hahn, March 6, 1942, Series 5, Box 31, Folder 311, KWCR; Kregel Windmill Company, Letter Addressed to E.C. Wilson, June 10, 1942, Series 5, Box 31, Folder 311, KWCR.

[174]Kregel Windmill Company to Charles G. Heese, March 18, 1946, Series 5, Box 31, Folder 315, KWCR.

[175]Ibid.; Kregel Windmill Company to Charles G. Heese, November 28, 1944, Series 5, Box 31, Folder 315, KWCR.

[176]Ella Kregel to Mark Kregel, September 2, 1945, Series 5, Box 31, Folder 315, KWCR.

Exactly what year the last ELI windmill was built is unclear. Employee time sheets for 1942 and 1943 list the tasks to which the workmen were devoting time. Those entries included the vague entry of "mill work" as well as more specific descriptions such as windmill repair, taking down, putting up, repair, cleaning, windmill fans, and tower work, without any specific mention of manufacturing a new mill. Kregel's 1944 query to the Dempster Mill Manufacturing Company regarding their ability to provide mills was met with a response asking if Kregel had ceased to manufacture its ELI mill and an offer to provide a supply of Dempster mills should Kregel be interested in being a Dempster dealer. In 1944, Arthur Kregel even had to deny his cousin, George Petring, a windmill because "we have been unable to get help and castings," before recommending he look into purchasing a mill from Dempster or the A.Y. McDonald Manufacturing Company in Omaha.[177]

If Arthur Kregel wanted to keep the Kregel Windmill Company in the windmill manufacturing business, he had ample opportunity toward the end of World War II. Dozens of letters were received from domestic and foreign companies inquiring about the availability of windmills to be exported as aid to developing countries. Kregel turned down an Albuquerque hardware company which offered to represent the company in the New Mexico-Arizona market, and told a company in Rock County, Nebraska, that "we cannot do much for you at this time," and "we simply are not in a position yet to ship mills."[178] Whether it was due to the shift away from making windmills or the unspecified government orders the company was taking, from 1941 to 1945 the company posted five straight years of profits, the first stretch of its kind recorded in company history. The $970.12 profit of 1945 erased the company's deficit, allowing Arthur and Ella Kregel to pay off all remaining stockholders. Although no longer managing the company, knowing the company he founded was finally in the black after eighteen years of indebtedness must have been welcomed news to George Kregel, who passed away the following year on September 28, 1946.[179]

Over the next forty-five years Arthur Kregel continued to manage the factory, providing many of the same products and services the company had been the previous four decades, with the glaring exception of manufacturing ELI windmills. The company's emphasis remained on providing rural residents with a reliable water supply. Price lists were still issued for ELI repair parts and services, Dempster windmills were available for customers for purchase, and towers by the Kregel Windmill Company's former competitors—Fairbury, Dempster, and Aermotor—were advertised. In 1988, at ninety years old, Arthur Kregel was still managing the Kregel Windmill Factory and repairing windmills, with his wife, Louise, explaining that "if he can't get the parts or know where the customer can get them, he makes them. And it must be a precision job or it doesn't leave the premises."[180] Although windmill service remained an aspect of the company's business, the focus was

[177]Various time sheets from 1942 and 1943, Series 2, Subseries 4, Box 20, Folder 5, KWCR; Dempster Mill Manufacturing Company to Kregel Windmill Company, January 20, 1944, Series 5, Box 31, Folder 313, KWCR; George Petring to Kregel Windmill Company, October 12, 1944, Kregel Windmill Company to George Petring, October 26, 1944, Series 5, Box 31, Folder 311, KWCR.

[178]Miscellaneous Windmill Requests, 1945, Series 5, Box 31, Folder 314, KWCR; Miscellaneous Windmill Requests, 1945, Series 5, Box 31, Folder 315, KWCR; Freed's Store to Kregel Windmill Company, October 9, 1945, Series 5, Box 31, Folder 314, KWCR; Ben Ammon to Kregel Windmill Company, April 13, 1946, and Kregel Windmill Company to Ben Ammon, May 24, 1946. Series 5, Box 31, Folder 315, KWCR.

[179]Kregel Windmill Company, "Sales, Profit, & Loss Summary, 1910-1945," Series 2, Subseries 6, Box 21, Folder 11, KWCR; Arthur Kregel to Mary Jane (Kregel) Newton, 1972, Copy on file at Kregel Windmill Company Museum, Nebraska City, Nebraska; "Memorial" Bulletin from the Funeral of George Frederick Kregel, Porter Funeral Home, Nebraska City, NE, October 1, 1946; "Noted Business Man Dies Saturday," *Nebraska Daily News-Press*, September 29, 1946.

[180]"Repair Parts Price List," July 29, 1949, Series 3, Box 24, Folder 23, KWCR; Kregel Windmill Company to Paul Finke, February 17, 1947, Series 5, Box 31, Folder 317, KWCR; Kregel Windmill Company, "Prices on Towers," July 12, 1956, Series 3, Box 24, Folder 23, KWCR; Tom Allan, "Nebraska Byways: Windmill Shop Still Turns Out Quality Work," *Omaha World Herald*, June 5, 1988.

on more modern forms of rural water systems, including electric pumps, plumbing, and wells.[181] Similar to its era of producing windmills, a sampling of the company's financial records from the 1960s demonstrates that the company was barely profitable. Between 1961 and 1966, company profit reached its peak at $166.30 in 1966. Arthur's $1,200 salary was the same as his father's over thirty years prior.[182]

Development into the Kregel Windmill Factory Museum, 1991-Present

Arthur Kregel worked at the factory on the morning of July 28, 1991. He went home for lunch and never returned, passing away from a heart attack. In December, just five months later, Louise Kregel passed away.[183]

The movement for the Kregel Windmill Company Factory to be preserved as a museum started in advance of Arthur and Louise Kregel's passing. In February 1984, niece Mary Jane (Kregel) Newton wrote to the director of the Nebraska State Historical Society (NSHS) of her efforts to convince her uncle to will the factory to the NSHS, but to which Arthur never responded.[184] Three years later, Robert M. Vogel from the Division of Engineering & Industry, National Museum of American History, wrote NSHS of the factory's rarity. He suggested that NSHS eventually consider acquiring the property as a branch museum due to its ability to convey the "importance of small industries in the development of the nation."[185] After Arthur and Louise's passing, reports surfaced of the potential transfer of the property to the NSHS; the agency expressed interest, but only if the local community was supportive of State involvement.[186]

While supportive of the building's preservation, the State's direct involvement was never necessary. Just two months before Arthur Kregel's passing, Mary Jane Newton contacted windmill historian T. Lindsay Baker and Carl Satterfield, Jr., who held the family's power-of-attorney, regarding the eventual fate of the Kregel Windmill Company Factory. By September, Baker, Hanson, and representatives from the National Trust for Historic Preservation were in Nebraska City touring the property. Baker remarked that throughout his twenty-six years of travel and research, the Kregel Windmill Company Factory is the only intact windmill factory remaining from the more than a thousand that once existed.[187]

Preservation work began in 1992 when a $10,000 donation allowed a group of local preservationists to acquire the factory property from the Kregel estate. The Kregel Windmill Museum Company was incorporated as a 501(c)3 to educate the public on the significance of windmill manufacturing and to preserve the factory building. Over the next year the building was listed in the National Register of Historic Places and recorded in

[181]"How Heavy is Water?" [Advertisement], *Nebraska Daily News-Press*, March 20, 1949; "How Much Does a Water System Cost?" *Nebraska Daily News-Press*, May 15, 1949; Kregel Windmill Company, "Advertisement Flyer," 1956, Series 3, Box 24, Folder 23, KWCR; Kregel Windmill Company, "Help Wanted," [Advertisement], *Nebraska City News-Press*, March 10, 1963.

[182]"Profit and Loss Statement of the Kregel Windmill Co. From Dec. 31, 1960 to Dec. 31, 1961," Series 7, Box 51, KWCR; "Profit and Loss Statement of the Kregel Windmill Co. From Dec. 31, 1961 to Dec. 31, 1962," Series 7, Box 51, KWCR; "Profit and Loss Statement of the Kregel Windmill Co. From Dec. 31, 1962 to Dec. 31, 1963," Series 7, Box 51, KWCR; "Profit and Loss Statement of the Kregel Windmill Co. From Dec. 31, 1963 to Dec. 31, 1964," Series 7, Box 51, KWCR; "Profit and Loss Statement of the Kregel Windmill Co. From Dec. 31, 1965 to Dec. 31, 1966," Series 7, Box 51, KWCR.

[183]"Arthur M. Kregel," *Nebraska City News-Press*, July 29, 1991; "Longtime Resident Dies," *Nebraska City News Press*, December 20, 1991.

[184]Mary Jane (Kregel) Newton to Marvin Kivett, February 9, 1984, Nebraska State Historic Preservation Office Site File OT06-A-016, Lincoln, NE.

[185]Robert M. Vogel to Dr. James Austin Hanson, August 27, 1987, T. Lindsay Baker Collection at Kregel Windmill Factory Museum, Nebraska City, NE.

[186] Lawrence Sommer, NSHS, to Nancy Hoch, River Country Industrial Development Corp., January 13, 1993, Copy on file at Kregel Windmill Company Museum, Nebraska City, Nebraska. The Kregel Wind Mill Company was listed in the National Register of Historic Places on February 25, 1993.

[187]Dan Swanson, "City Rallies to Save Kregel Windmill Factory," *Nebraska City News-Press*, September 29, 1991.

the National Park Service's Historic American Engineering Record (HAER). T. Lindsay Baker and John Bowditch, former curator of industry at Henry Ford Museum in Dearborn, Michigan, prepared a Long-Range Interpretive Plan for the museum. The company's records—which are the only collection of windmill manufacturing records available for public research—were sorted, organized, and donated to the NSHS Archives in Lincoln. Donations and grants continued to move the preservation efforts along. Interpretive videos were made regarding the company's history and machinery; a grant allowed for a Comprehensive Facilities Plan to be prepared; wood and steel ELIs were donated to the Company; and an ELI windmill was donated, restored, and erected north of Nebraska City on the grounds of the Kimmel Orchard.[188] The Kregel Windmill Factory Museum, however, remained closed.

In 2010, an amendment to the Articles of Incorporation renamed the "Kregel Windmill Museum Company" the "Kregel Windmill Factory Museum," and a new board of directors was installed. The new board made an immediate impact, updating the Long-Range Interpretive Plan, purchasing a two-bedroom house west of the factory to be used as the museum offices, and erecting a restored ELI mill just opposite the museum on Central Avenue.[189]

A major rehabilitation project was undertaken throughout 2012. Support columns were set to support steel trusses, forming a structural skeleton that protects the historic roof of the factory building without making any recognizable changes to the building's appearance. Exterior siding was removed, the building insulated and wrapped in a protective barrier, and the exterior metal siding was straightened, cleaned, and reinstalled. This rehabilitation and its effect on the property's integrity is discussed in more detail in Section 6. On the building's interior, the recommendations of the Long-Range Interpretive Plan were implemented, creating an interior space that reflects the historic layout of the machinery and materials while allowing for visitor pathways and barriers to be installed. In December 2012 the hiring of a museum manager was announced; four months later, on April 26, 2013, the Kregel Windmill Factory Museum held its long-awaited grand opening.[190]

Comparison with Related and Similar Properties

By illustrating the development of windmill manufacturing in the United States, the Kregel Windmill Company Factory introduces this specific property type into the National Historic Landmark (NHL) program for its

[188]"A First Look," Photo Caption, *Nebraska City News Press*, June 19, 1992; "Gift Will Fund Facilities Plan for Kregel Windmill Museum," *Nebraska City News-Press*, July 17, 1996; "Notice of Incorporation," *Nebraska City News Press*, June 28, 1993; "Museum Company Formed," *Nebraska City News-Press*, July 1, 1993; Historic American Engineering Record, "Kregel Windmill Company Factory," No. NE-8 (1995); "Windmill Factory Documents Prepared for Historical Archives," *Nebraska City News-Press*, October 10, 1994; T. Lindsay Baker and John Bowditch, "Long-Range Interpretive Plan: Kregel Windmill Museum Company" (July 16, 1994), 8; T. Lindsay Baker, "Kregel Windmill Company Papers Find Archival Home," *Windmillers' Gazette* 14, no. 1 (Winter 1995): 7; "Windmill Machines Powered Up," *Nebraska City News-Press*, October 27, 1995; "Gift Will Fund Facilities Plan for Kregel Windmill Museum," *Nebraska City News-Press*, July 17, 1996; "Wirth Family Gives $7,500 for Video on Windmill Museum," *Nebraska City News-Press*, June 21, 1997; "Windmill Evolution," *Nebraska City News-Press*, August 22, 2008; Dan Swanson, "ELI Windmill Returns to Nebraska City Skyline," *Nebraska City News-Press*, August 5, 2002.

[189]"Notice of Amendment to the Articles of Incorporation of Kregel Windmill Museum Company," *Nebraska City News-Press*, August 6, 2010; T. Lindsay Baker and John Bowditch, "Long-Range Interpretive Plan: Kregel Windmill Museum Company" (revised November 1, 2010); Dan Swanson, "School, Museum Grounds Made Tax-Exempt," *Nebraska City News-Press*, February 15, 2011; Dan Swanson, "What's Going On?" *Nebraska City News-Press*, September 6, 2011; Dan Swanson, "Trusses Form Base for Roof," *Nebraska City News-Press*, April 10, 2012.

[190]Dan Swanson, "What's Going on Here?" *Nebraska City News-Press*, March 13, 2012; Dan Swanson, "Museum Seeks Kregel Artifacts, People's Stories," *Nebraska City News-Press*, April 10, 2012; Dan Swanson, "Curator Adds Gust of Wind for Kregel Factory," *Nebraska City News-Press*, December 28, 2012; Brian Volkmer, "Opening for the Season for the First Time: The Kregel Windmill Factory Museum," *Nebraska City News-Press*, April 16, 2013; Dan Swanson, "Museum Opens with Fresh Look at America's Industrial Past," *Nebraska City News-Press*, May 3, 2013.

nationally significant association with developing the American economy and with the history of windmill manufacturing in the United States. There are no properties designated as NHLs that are associated with the manufacturing of windmills, a nationally significant area that should be recognized for its contribution to the history of agriculture, ranching, settlement, and railroad transportation. The Kregel Windmill Company Factory is also notable as a rare survivor of a small-scale workshop. Although there are several large factories which have been designated as NHLs, the W.A. Young & Sons Foundry and Machine Shop NHL (Rices Landing, Pennsylvania) and the Sampson-White Joiner Shop (NHL designation pending; Duxbury, Massachusetts) are the only NHLs that are associated with this once-common property type.[191]

Of the three windmill manufacturing-related properties listed in the National Register of Historic Places, the Kregel Windmill Company Factory is the only building where windmill manufacturing occurred and which retains its integrity as it pertains to its period of manufacturing. As a result, it conveys the process of windmill manufacturing during the first four decades of the twentieth century. Moreover, the Kregel Windmill Company Factory is the only windmill factory to retain original workspace, machinery, tools, and supplies, along with complete factory records housed at the Nebraska State Archives in Lincoln.

Windmill-related Properties Listed in the National Register of Historic Places

The Kregel Windmill Company Factory was listed in the National Register of Historic Places in 1993 at the state level of significance, although the nomination states that it is "potentially eligible at the national level…as a unique example of what was once an important part of the nation's history."[192] The property was nominated shortly following the deaths of both Arthur and Louise Kregel in 1991, when the fate of the factory building and its contents were in question. The desire to quickly list the property in the National Register to increase awareness for its preservation and access potential funding opportunities outweighed the time and effort needed to document the Kregel Windmill Company as significant within a national context.[193]

The two other properties related to windmill manufacturing and distribution that are listed in the National Register are in Cedar Rapids, Iowa, and are listed at the local level of significance. **The Cedar Rapids Pump Company Factory and Warehouse** (National Register, 2012) was listed for its association with Cedar Rapids' industrial history. This property was never involved with the manufacturing of windmills, but rather stocked and distributed them while manufacturing pumps and other water-system parts. The listed property includes the factory, warehouse, and a non-contributing pole barn; the factory interior has been rehabilitated into one- and three-bedroom apartments.[194] The interior rehabilitation lessens the integrity of the property as compared to the Kregel Windmill Company Factory, and it is not directly associated with windmill manufacturing.

Windmills were produced by the **Iowa Windmill and Pump Company** for the parent-company Flint & Walling (Kendallville, Indiana), but the windmill factory in Cedar Rapids is not extant. The Iowa Windmill and Pump Company Office and Warehouse (National Register, 2012) contains the office/warehouse building, two railroad spurs, and the overall site. The office/warehouse was rehabilitated for commercial and residential use

[191]Michael J. Emmons Jr. and Catherine Morrissey, "Sampson-White Joiner Shop," National Historic Landmark Nomination (pending), June 2019; Gerald M. Kuncio, "W.A. Young & Sons Foundry and Machine Shop," National Historic Landmark Nomination, December 2016.

[192]Greg Miller and David Murphy, "Kregel Wind Mill Company," National Register of Historic Places Nomination, (January 26, 1993), 8/1.

[193]Bob Puschendorff, former Nebraska Deputy State Historic Preservation Officer, interview by David Calease, Omaha, NE, December 5, 2022.

[194]Alexa McDowell, "Cedar Rapids Pump Company Factory & Warehouse," National Register of Historic Places Nomination, (November 6, 2012), 8/7, 7/1. The building is located at 605 G Avenue NW, Cedar Rapids, Iowa.

via both the federal and Iowa historic tax credit programs, meeting *The Secretary of the Interior's Standards for Rehabilitation*, but the extant buildings are not associated with windmill manufacturing and the property does not retain as high a degree of integrity as the Kregel Windmill Company Factory.[195]

There are six American-style windmills listed in the National Register of Historic Places, along with hundreds of others that remain across the American landscape—including ELIs—that are integral pieces of historic properties and landscapes. All are listed at the local level of significance. These resources illustrate the engineering and design of windmills, but by themselves, they cannot convey the national significance of windmill manufacturing and the collective impact of the thousands of windmills that were produced at the Kregel Windmill Company Factory and similar factories. They are included here to document the sampling of windmill structures recognized by the National Register.

An original **IRON TURBINE windmill** is listed in the National Register of Historic Places (1980) in Arizona. Manufactured and erected on a ranch in 1885, it was moved twenty-five miles to the Prescott Historical Society grounds in 1973.[196] Since its listing, a small number of other examples have been identified, including one on exhibit at the American Windmill Museum in Lubbock, Texas.

A 22 ½-foot railroad pattern **ECLIPSE windmill** is listed in the National Register of Historic Places (1976). Originally located on the Charles C. Canon Ranch west of Sheffield, Texas, the railroad pattern mill was used as the primary water source at the ranch headquarters. Erected in 1898, the mill sat upon a 1915 tower and contains 232 wood blades and two tails—one for speed control and another for on-off control.[197] Since its listing, the windmill has been moved to the National Ranching Heritage Center in Lubbock, Texas.

Both the **Bronson Windmill** (Fairfield, CT; National Register, 1971) and the **Bailey Farm Windmill** (North Anson, ME; National Register, 1988) are mills mounted on octagonal, enclosed towers and are more notable for the unique tower design than for their ability to represent the significance of the American windmill and the impact it had on the settlement of the United States' interior. The Bronson Windmill no longer has a mill and vane atop its tower, while only remnants of the mill remain atop the Bailey Farm Windmill tower.[198]

Neither the **Moriarty Eclipse Windmill** (Moriarty, NM, National Register; 1979) nor the **McKenzie Windmill** (Georgetown, TN; National Register, 1982) are extant.[199]

Extant Windmill Factories

Of the more than one thousand factories that once produced wind machines in the United States, the Kregel Windmill Company Factory survives as the last known intact example. The majority of other surviving windmill factory resources were parts of large manufacturing complexes and substantially different from the smaller, single building operations that dotted the Midwest and Great Plains. None of the properties listed below retains a high degree of historic integrity when compared with the Kregel Windmill Company, and they do not illustrate the operations of a small-scale factory.

[195]42 7th Avenue NW, Cedar Rapids, Iowa. Rogers and Allen, "Iowa Wind Mill and Pump Company Office and Warehouse."
[196]T. Lindsay Baker, "Iron Turbine Windmill," National Register Nomination, July 22, 1980.
[197]William L. Cumiford and Paul D. Hutchison, "Canon Ranch Railroad Eclipse Windmill," National Register of Historic Places Nomination, October 11, 1976.
[198]William B. Ely, III. "Bronson Windmill," National Register of Historic Places Nomination, December 29, 1971; Kirk F. Mohney, "Bailey Farm Windmill," National Register of Historic Places Nomination, June 28, 1988.
[199]William L. Cumiford and T. Lindsay Baker, "Moriarty Eclipse Windmill," National Register of Historic Places Nomination, June 4, 1979; Toplovich, "McKenzie Windmill."

The remnants of large manufacturing complexes are more prevalent today compared to smaller manufacturing buildings. Nebraska's most notable large-scale windmill manufacturer was **Dempster Industries**, located in Beatrice, just fifty-five miles southwest from Nebraska City. Dempster was a national brand and continued to manufacture windmills into the twenty-first century. With this longstanding success, Dempster modernized its factory complete with a façade improvement in the 1940s. This resource was determined eligible for listing in the National Register in 2009, related to mid-century commerce and industry; however, it does not retain the same outstanding integrity as evident with the Kregel Windmill Company Factory as it relates to the peak of windmill manufacturing during the first half of the twentieth century. In addition to the east-facing façade change, various portions of the works that were present in the early twentieth century have been razed, including the foundry, galvanizing room, tower room, multiple storage rooms, and various outbuildings.[200]

Batavia, Illinois, was once home to six different windmill manufacturers; buildings from three of these survive within the locally designated Batavia Downtown Historic District. All have been subject to major changes, keeping the exteriors largely reflective of their historic appearance as factories, while altering the interiors to allow for a variety of contemporary uses. Much of the **U.S. Wind Engine and Pump Company's** multi-block campus has been razed and infilled with new construction. What remains has been renovated for office and commercial space, as have the remaining buildings associated with the **Challenge Company**.[201] The **Appleton Manufacturing Building** now serves as the City of Batavia's Municipal Center and Police Department. Rehabilitations have largely retained the historic exterior appearances while altering the interiors have left each of these properties short of the high degree of integrity possessed by the Kregel Windmill Factory.

The **Baker Manufacturing Company** continues to operate a large campus at 101 Enterprise Street in Evansville, Wisconsin, although windmill production ceased in 1958. Nearly all the late nineteenth and early twentieth century buildings have been substantially altered to accommodate current manufacturing, rendering this collection of resources unable to convey Baker's early twentieth-century significance related to windmills.

Small windmill production facilities have been harder to identify. The **Currie Windmill Company** operated out of a small brick building on SE 7th Street in Topeka, Kansas, roughly from 1900 to the late 1940s. More than half of the building has been demolished and infilled with contemporary one-story industrial buildings as part of the evolving complex for the Steel Manufacturing Company. What remains of the Currie building includes a primary (south) façade with a single garage opening and office window with the west wall possessing an entry door and a series of smaller windows; the rooftop monitor has been removed and all windows and doors have been replaced, giving the current building only the slightest resemblance of its historic appearance.[202]

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[200]The Dempster Industries complex is located at 711 S 6th Street. "Then and Now: The Dempster Manufacturing Company," *Windmillers' Gazette* 36, no.4 (Autumn 2017): 10; Sanborn Map Company, *Insurance Maps of Beatrice, Gage County, Nebraska* (New York: Sanborn Map Company, 1913), Sanborn Fire Insurance Map Collection, Library of Congress, http://hdl.loc.gov/loc.gmd/g4194bm.g051471913; Jill Dolberg (Nebraska State Historic Preservation Office), to Steve McMasters (Nebraska Department of Natural Resources), May 12, 2009, Nebraska State Historic Preservation Office Site File GA03-076, Lincoln, NE.

[201]Buildings in Batavia, Illinois, remaining from the US Wind Engine & Pump Company are located at 140 1st Street; Challenge Company at 401 North River Street; Appleton Company at 100 North Island Avenue. A district description and building inventory can be found on the City of Batavia's website: http://www.cityofbatavia.net/578/About-the-Downtown-Historic-District (accessed March 22, 2021). None of the sixteen windmill-associated properties within the 201-property district are listed in the National Register of Historic Places; Sanborn Map Company, *Insurance Maps of Batavia, Kane County, Illinois* (New York: Sanborn Map Company, 1916), Sanborn Fire Insurance Map Collection, Library of Congress, http://hdl.loc.gov/loc.gmd/g4104bm.g017241916.

[202]The Currie building no longer has its own address and has been incorporated into the complex at 612 SE 7th Street, Topeka; Sanborn Map Company, Insurance Map of Topeka, Shawnee County, Kansas, (New York: Sanborn Map Company, 1913), Sanborn

Located at 702 North King Street in Ottawa, Kansas, the **Ottawa Manufacturing Company** building's façade still retains some of its historic appearance with four large arched openings flanking a centered garage entrance. While a building expansion dates to the company's occupation of the property, a gabled roof has been added to the entire building, and contemporary siding appears in the front gable and on each secondary wall. Similar to the Kregel Windmill Company Factory, this building is representative of a small-scale windmill manufacturer. However, the Ottawa Manufacturing Company building has been subject to numerous alterations, severely compromising its integrity to the early twentieth century.

The **Fairbury Windmill Company** complex was located at 201 F Street in Fairbury, Nebraska. Today a string of buildings remains that historically housed the machine shop, printing and woodworking, storage, and office space along F Street. This group, however, has seen several modifications to its exterior, including a complete covering in metal siding and the reconfiguration of openings, rendering it unrecognizable compared to its days as a windmill manufacturing facility. To the west, buildings which housed the lathe room, moulding rooms, foundry, and sheet metal work have been razed. Former company buildings on the east side of F Street were constructed ca.1950 and have been modified for a meat packaging company.[203]

Conclusion

The Kregel Windmill Company Factory is the best surviving representative property of an early twentieth-century windmill factory in the country. T. Lindsay Baker, who has spent a considerable portion of his professional career as a historian and museum curator traveling the United States to study American windmills and their manufacturers, says the Kregel Windmill Company Factory is "the last such preserved historic windmill factory in the United States, all of the others being so modernized as to have lost their historic character."[204] Windmills are still heavily used to pump water in Australia, which has five windmill manufacturers in operation. "We have nothing like this in Australia," according to Helen Walter, editor of *The Windmill Journal of Australia and New Zealand.* "This is an amazing historic resource. It's just too valuable not to preserve. It's a snapshot into history."[205] William E. Worthington, Jr., Museum Specialist in the History of Mechanical and Civil Engineering at the Smithsonian Institution's National Museum of American History has further testified to the rarity of the property:

> This unique time capsule of American industry certainly deserves to have every possible effort made toward its preservation. The site is important not only because it is likely the last traditional windmill factory in this country, but it is an exquisite example of late nineteenth and early twentieth century manufacturing techniques. With so much of our industrial heritage dispersed or destroyed altogether, it takes on added meaning because it is so complete and remains basically untouched.[206]

Fire Insurance Map Collection, Library of Congress, https://www.loc.gov/resource/g4204tm.g4204tm_g030941913/?st=gallery. Sanborn Map Company, Insurance Map of Topeka, Shawnee County, Kansas, (New York: Sanborn Map Company, 1950), Sanborn Fire Insurance Map Collection, Library of Congress, http://hdl.loc.gov/loc.gmd/g4204tm.g4204tm_g03094195001; "Then and Now: The Currie Wind-Mill Company," *Windmillers' Gazette* 36, no.2 (Spring 2017): 10.

[203]Sanborn Map Company, *Insurance Map from Fairbury, Jefferson County, Nebraska*, (New York: Sanborn Map Company, 1921), Sanborn Fire Insurance Map Collection, Library of Congress, https://www.loc.gov/resource/g4194fm.g051801921/?sp=18; "Then and Now: Fairbury Windmill Company," *Windmillers' Gazette* 37, no.1 (Winter 2011): 10.

[204]T. Lindsay Baker to Mary Jane Newton, June 1, 1991, Copy on file at Kregel Windmill Company Museum, Nebraska City, Nebraska.

[205]Algis J. Laukaitis, "Factory Fossil," *Lincoln Journal Star*, June 20, 2012.

[206]William E. Worthington, Jr, National Museum of American History, to Nancy Hoch, River Country Development Corporation, October 16, 1991, Copy on file at Kregel Windmill Company Museum, Nebraska City, Nebraska.

The Kregel Windmill Company Factory is nationally significant under NHL Criterion 1, Theme I: Peopling Places, for its association with the American windmill's impact on facilitating late nineteenth-century railroad expansion and settlement of the Great Plains. It is also nationally significant under NHL Theme V: Developing the American Economy as the sole remaining intact factory related to windmill manufacturing, reflecting the process, tools, and materials used in the small-scale manufacturing of American windmills.

Over the course of the period of significance, 1902 to 1941, the Kregel Windmill Company Factory illustrates broad national patterns in windmill manufacturing, from peak decades of the 1900s and 1910s, through economic downturns in the 1920s and 1930s, and, finally, the end of large-scale windmill manufacturing in the early 1940s. From the patent and production of its own windmill model to advertising efforts and the production of related goods and equipment, the Kregel Windmill Company Factory reflects the key aspects and patterns of twentieth-century American windmill manufacturing.

The factory is the last surviving intact windmill manufacturing building from an industry that once numbered in the thousands. The property retains a high degree of historic integrity for the period 1902 to 1941, with the interior retaining the full complement of machinery, tools, and materials used in the early twentieth century to manufacture windmills and other items provided by the company. Multiple windmill historians and engineering experts have acknowledged this property as the only known windmill factory to retain such a high level of integrity and machinery. Stewards have preserved the property in accordance with the *Secretary of the Interior's Standards for the Treatment of Historic Properties*, completing a rehabilitation project in 2012 which allowed the factory to be opened as a museum.

The Kregel Windmill Company Factory is nationally significant for its unparalleled association with windmill production and the windmill's integral role in railroad expansion across the country, connecting the east and west coasts and furthering the settlement and development of the Great Plains.

6. PROPERTY DESCRIPTION AND STATEMENT OF INTEGRITY

Ownership of Property	Category of Property
Private: X	Building(s): X
Public-Local:	District:
Public-State:	Site:
Public-Federal:	Structure:
	Object:

Number of Resources within Boundary of Property:

Contributing	Noncontributing
Buildings: 2	Buildings: 0
Sites: 0	Sites: 0
Structures: 0	Structures: 0
Objects: 0	Objects: 0
Total: 2	Total: 0

PROVIDE PRESENT AND PAST PHYSICAL DESCRIPTIONS OF PROPERTY
(Please see specific guidance for type of resource[s] being nominated)

Summary Description

Located in Nebraska City, Otoe County, in southeast Nebraska, the Kregel Windmill Company Factory is a single-story, early twentieth-century light industrial building which served as the office and factory for the Kregel Windmill Company from its construction in 1902 until 1991. The building is located on Nebraska City's main street at 1416 Central Avenue. The Kregel Windmill Company Factory stands between a small, ca. 1910 residence to its west and an abutting 1967 commercial building to the east, neither of which are historically associated with the Kregel Windmill Company.

The building's exterior is relatively unchanged from its original appearance. The primary façade is clad in its original brick-impressed sheet metal capped with a metal cornice and retains its mix of large windows and double-door openings that allow for the movement of materials and products in and out of the factory. The east side is obscured due to the adjoining commercial building, and rehabilitation work done to the rear (north) of the building in 2012 was sympathetic to the historic design of the north wing of the building. There is no record of the architect or builder of the 1902 factory.

The interior of the factory is an outstanding example of a small twentieth-century windmill factory. The large open factory is supported by a row of columns running down the center of the interior space. The factory contains all the equipment, tools, and materials that were used in the manufacturing of windmills during the factory's peak operational period. This space has minimal interior finishes and contains a wide variety of built-in shelving, designated workspaces, and material storage. Slight alterations have been applied for the building's use as a museum. The building and its machinery illustrate the manufacturing process of the American windmill. Following the recommendations of the Long-Range Interpretation Plan, the interior configuration of the machinery and materials is arranged to mirror the shop's 1939 layout. In the southeast corner is a small

office which retains furniture and materials from the Kregel Windmill Company's period of operation. At the rear of the property is the factory's outhouse, which contributes to the property's significance.

Site and Setting

The Kregel Windmill Company Factory is located on the north side of Central Avenue in downtown Nebraska City, Nebraska, four blocks west of the city's courthouse square and the heart of the town's commercial core.

The primary (south) façade of the Kregel Windmill Company Factory is set back slightly from a brick sidewalk. The entrance hardscaping was rehabilitated in 2012, retaining the brick sidewalk while making an ADA-compliant approach to the factory entrance. West of the entrance the sidewalk and factory are separated by a strip of grass which includes a Nebraska State Historical Marker summarizing the factory's history; east of the entrance the strip is filled with river rock.

The area surrounding the factory is a mix of residential and public service buildings. To the west of the factory is a single-family dwelling that Sanborn maps indicate was constructed between 1906 and 1913. Today the house is the office for the Kregel Windmill Factory Museum. East of the factory is an abutting commercial building from 1967 that occupies several lots. When the Kregel factory was constructed, these lots were either vacant or held single-family dwellings. In 1914-15, a Seventh Day Adventist Church was constructed on the lot directly east of the factory. By 1928, the church relocated, its building and the neighboring houses were sold, allowing the eastern half of the block to be developed as a Buick dealership.[207] The lots were then redeveloped in the 1960s as a grocery store abutting the Kregel factory. Today the building serves as a remote campus for a community college based in Lincoln. Across Central Avenue to the south, Nebraska City's City Hall and volunteer fire department complex consume the lots which housed the Nebraska City Manufacturing Company. The City Hall parking lot, directly south of the factory across Central Avenue, includes an interpretive wayside with a restored 1927 ELI windmill. Used for decades in southeast Iowa, the 10-foot mill on a 36-foot tower was donated, restored, and erected in its current location in 2011. The neighboring areas to the north and west are residential, as they were historically, save for the Nebraska City Police Department building, which stands west of the factory across 15th Street on a half-block that was historically in commercial use.

Exterior

The single-story building possesses a rectangular footprint and was constructed of light wood-frame materials with a flat roof that gently slopes toward the rear. The south (primary) façade consists of four bays with large round-arched windows set within rectangular panels, the middle two of which include broad door openings. These openings each have a double door, with each door having a two-over-two window above a single wood panel occupying the bottom third of the door. Over each of the door openings is a three-light rounded arch transom. The outer two bays contain a three-over-three window with a three-light rounded transom. A fabric awning similar to one that was present historically covers the upper two-thirds of the easternmost window. The awning is yellow and has "KREGEL" in black lettering along its bottom. The front of the building is clad in sheet metal pressed with a brick pattern and capped with a pressed metal, stepped cornice that is intended to mimic stone. The lowermost band is embellished with a running garland. The uppermost band features stylized anthemia. The ends of the cornice are finished with shallowly projecting brackets, the faces of which are finished with a stylized anthemion. Atop each bracket sit a single, free-standing finial.

[207] "Will Build at Once," *Nebraska City News*, December 4, 1914; "Holberg Buys Lot Occupied By Church," *Nebraska Daily News-Press*, October 3, 1928; "Ready for Business in New Home Monday," *Nebraska Daily News Press*, February 24, 1929.

Below the cornice and over the two broad door openings is a company sign reading "KREGEL WIND MILL CO." in black, with a yellow border enclosing the white sign. The sign likely appeared following the company's 1910 incorporation as the Kregel Windmill Company, as it is not visible in the earliest photographs of the factory. The original sign was removed at an unknown date, and the current one is a reproduction based on historic photographs. A single door opening is between the first and second bays from the east with a single light set over three panels and enters directly into the factory office. The original door has been rehabilitated and sealed in place as the museum's point of entry is via the eastern double-door opening. The original double doors that swing into the factory remain in place and have been propped open on the inside of the factory, and new doors mimicking the originals have been added to the exterior and swing out to meet code requirements for the museum.

The west wall is covered in vertically oriented historic galvanized corrugated steel with a single window opening at roughly two-thirds of the building's length from the south. During the 2012 rehabilitation, all the sheet metal was removed, treated and reinstalled over a new insulating wall that is minimally visible from the exterior. A replica wood window is set in the extended wall window opening, effectively serving as a storm window while the original window remains in place and visible on the interior. The building's east wall adjoins the neighboring building.

A shed-roof wing is located on the north (rear) of the building. Identified on the 1906 Sanborn Fire Insurance Map, it has long been considered an addition to the building shortly after its completion due to the wing's change in roof pitch, drop in floor grade (dirt floor for vehicle drive-in), and change in interior siding orientation. Also, the roofing agreement for the 1902 construction of the building specifies only an area matching that of the main building. Primarily associated with Kregel's pump service business or used for vehicle storage, the wing extends nearly the full width of the building, is covered with siding identical to that on the sides of the building, and has a small four-light window on its west side.[208] At some point, this wing was extended to the north to allow for a service truck to be parked within, accessing the wing from the alley north of the building. During the 2012 renovation project, the entirety of the wing was dismantled, an appropriate foundation installed, and the wing rebuilt on the existing layout to include a concrete floor and allow for suitable climate controls to be installed, air handlers for which are on the roof. A set of double doors were placed where similar style doors existed for the garage opening, creating what is used as the loading dock today. The reconfigured wing now contains a work bench and tools, a kitchenette with cabinetry, sink, and small refrigerator, plus an ADA-compliant restroom. The north side has three separate entrances—double doors at the loading dock, a single door at the east end of the shed-roof wing, and a single door leading directly into the rear of the factory. Next to this final door is the original wood four-over-four, double hung window. Due to its dismantling and extensive rehabilitation, the north wing is considered a non-historic addition.

As part of the 2012 rehabilitation, four 10″ × 10″ support columns were set in the factory space roughly twelve feet from the east and west walls. Painted brown, these columns are visible on the interior, but largely blend into the factory's mix of original support columns, machinery, shelving, supplies, and clutter. They support two trusses that run the length of the building north-to-south and support a new roof that was installed above the historic roof. The space between the two roofs contains the fire sprinkler lines and HVAC ductwork that allow the building to now serve as a museum. The historic roof monitors are protected by new arched monitors, continuing to allow for natural lighting into the factory interior as they did historically. The historic and protective roofs are both flat and not visible from public sight lines, except for the monitor covers when the building is viewed from an angle from the opposite side of Central Avenue.

[208] "Agreement: G.F. Kregel and Overland Roofing Company," Series 9, Box 54, KWCR; Historic American Engineering Record, "Kregel Windmill Company Factory," No. NE-8 (1995).

Between the back of the building and the east-west alley is a small grassy area, intersected with a poured concrete loading dock driveway and sidewalk to the northern entrances, added during the 2012 rehabilitation project. On the eastern edge of the property is a large utility box along with the outhouse used by the Kregel Windmill Company's workers during its period of operation. A small building, the outhouse is covered in metal siding, has a shed roof, no windows, and a door centered on the west side. Small buildings were located behind the factory in different locations on both the 1906 and 1913 Sanborn maps. The factory's 1919 insurance appraisal identifies the extant outhouse as an "oilhouse" and a toilet located in the building's northwest corner, suggesting a dual purpose for the building. The outhouse is a contributing resource to the NHL designation due to its association with the Kregel Windmill Company Factory during its period of national significance.

Interior

The interior of the factory is a single large, unfinished space, except for a small office separated from the workshop in the building's southeast corner. The northwest corner of the office is canted to provide its entry point through a half-lite wood door that swings into the office. Vertical one-inch wood paneling covers the east, north, and west walls. The south wall contains a small section of paneling between the large, arched window on the east end of the façade and a single-entry door. Above the door and around the window's arch is a mix of unfinished drywall and a large piece of thin wood paneling, and below the windows are shelving and cabinetry. On the west wall, two large windows look out over the entry space to the shop, before which are situated George Kregel's drafting table and an original cabinet. A large cabinet consumes roughly half of the east wall, next to which is a roll top desk. A second desk is centered on the north wall and surrounded by cabinetry and shelving, while the company safe is tucked into the office's northeast corner. A single pendant light hangs from the ceiling slightly east of center, as centered on the office's green rolled linoleum floor is a potbelly stove that heated the office, with an exhaust pipe running out the office's north wall. Additional lighting has been sympathetically added as part of the 2012 rehabilitation.

In the main factory space, unfinished walls are lined with rudimentary shelves holding bins for windmill and supplementary product parts and hardware, as well as brackets for the storage of long pieces of lumber or metal. The space retains virtually all the materials, equipment, and belt-powered machinery used to manufacture windmills. This includes the bison-hide belts of the power transmission system, which is still operable but not activated due to lack of contemporary safety guards. Punched into the ceiling about two-thirds to the north from the building's front wall are two monitors. Measuring roughly 12′ × 15′ and two feet tall, these monitors would have been the factory's primary lighting and ventilation system, along with the factory's doors and windows.

The construction of the abutting 1967 commercial building covered up multiple openings along the east wall. The southernmost window was positioned within the office at the front of the building and is now a recessed cavity with wood planking, adorned with a wall clock. The location of two more windows and a door opening are identifiable from physical remnants visible on the factory interior, having been infilled with wood 1′ × 10′ planks. On the east side of the north interior wall are two single door openings, both of which are present in a ca. 1925 photo of Arthur Kregel and other factory workers (Figure 6). The eastern door continues to give direct access to the outside from the shop floor; the western door now leads into the north wing.

The building's development into the Kregel Windmill Factory Museum in 2012 led to the placement of metal, waist-high railings to create corridors for patrons to traverse while viewing the equipment and interactive interpretive exhibits throughout the space. The railings were made from same material that would have been used to make steel windmill towers at the factory. The floor surface within the walking path is covered with carpet, while the workspace shows its historic wood flooring. The rehabilitation of the factory for use as a

museum also included securing the roof, insulating the building, and installing heating, cooling, advanced lighting, and humidity control equipment as well as an electronic security system, all without negatively impacting the integrity of the resource.

A major component of the factory's high level of historic integrity is the retention of the Kregel Windmill Company's original machinery used to manufacture windmills, along with the additional parts and material that remained in the building throughout its history. The following is a list of major pieces of machinery that remain in the factory, their approximate date of manufacture, a description of their use, and interpretive text from the exhibit in the Kregel Windmill Factory Museum.[209]

Punch Press (ca. 1900): Used to punch holes quicky in part of windmills and other products.

> In operation, the large flywheel at the rear of the machine rotated continuously. The operator activated the punch by depressing the small foot pedal near the floor. While quite dangerous to operate, this press made the job of punching hundreds of bolt and rivet holes needed in each windmill and tower quick and easy. Maker: Michigan Machinery Manufacturing Company, Ypsilanti, Michigan

Reciprocating Hacksaw (ca. 1910): Made cutting steel and iron bar used in windmill manufacturing easy.

> This saw eliminated most hand cutting of heavy bar stock, saving time and money. Maker: "The Racine," Racine, Wisconsin

Turret Lathe (ca. 1920): This production lathe allowed the Kregel Windmill Company to make the many turned metal parts of the mills very quickly. This saved both time and money.

> Turret lathes like this one have a turret mounted on the tailstock which holds up to six preset cutting tools like drills, reamers, or boring tools. The operator can instantly change from one tool to the next by moving the four-arm turret activator. The lathe is shown holding a crank plate casting from an ELI windmill. This lathe made boring the center hole of the plate a quick and easy job. Maker: Cincinnati Ames Manufacturing Company, Cincinnati, Ohio

Power Shear, Punch, and Riveting Machine (ca. 1875) This triple-purpose, heavy-duty machine was used to shear metal, punch bolt and rivet holes, and rivet parts of the windmills together.

> This is a "two-level" machine with the shear mounted on top and the punch and rivet driving unit mounted below. At present it is set up to drive the rivets used to hold together the elements of the wheel arms. This very early machine was most surely purchased used. Note the clever repair made to the upper shear casting after it cracked during use. Also observe how the machine was set on the ground with its base below the floor. This arrangement made it easier to slide heavy angle steel tower legs along the floor for bolt hole punching. Mounting the machine on the ground also lessened the floor vibration. Maker: unknown

Metal-Turning Lathe (ca. 1865): This Civil War-era machine was used to make all types of turned metal parts used in the windmill. It also was used to make repairs parts and for general machinery production.

> Metal-turning lathes like this one were an essential part of any machine shop, whatever its product might be. Maker: unidentified but possibly the Ames Manufacturing Company, Chicopee, Massachusetts

Drill Presses (ca. 1900): Both of these moderately large drill presses were used to drill holes in a variety of

[209]Lindsay Baker and John Bowditch, "Long-Range Interpretive Plan: Kregel Windmill Museum Company," revised November 1, 2010, Appendix D.

parts. Note that a few of these holes went too far and damaged the machinists' tables. Drill presses like these were essential to every machine shop, whatever its product might be.

Maker (right): Champion Blower and Forge Company, Lancaster, Pennsylvania

Maker (left): W.F. and J. Barnes Company, Rockford, Illinois

Broaching Machine (ca. 1910): This essential machine was used to cut the keyways in such cast iron parts as the crank plates which had been previously machined on the turret lathe.

Maker: unknown

4-Spindle Production Drill Presses (ca. 1900): These tools allowed the worker quickly to drill holes in exactly the right places.

On the drill press at the right, the spindle on the far left holds a "center drill" to make a small drill guiding hole in the right location. Because the center drill is short and stiff, it will not wander to one side or the other. The two middle spindles carry regular drills used to make two different sizes of holes. The spindle on the far right holds a reamer used to finish accurately the inside of a previously drilled hole. The operator would first drill the needed centering holes. Next, he would drill the final holes through the part using the two middle spindles. Finally, he might shape one or more of these holes using the reamer on the right. Because the machine never had to be stopped to change the drills, the operation was much quicker than would have been the case with an ordinary drill press.

Pedestal Grinder (ca. 1910): General grinding purposes and for sharpening drills and cutting tools used in the two lathes.

Maker: unknown

Internal Grinder (ca. 1910): Smooth the inside ends of the steel mast pipes used inside the top of the [windmill] tower.

Without this machine, these parts would have had to be filed by hand, a very difficult and slow process. Maker: unknown

Drop Hammer (ca. 1900): Used to shape the vane hinges. Use of the rotating power of the pulley at the top made lifting the hammer head comparatively quick and easy.

In operation, the strap handle near the top of the machine was pulled down. This tightened the strap around the continuously rotating pulley, lifting the hammer head. When the strap was released, the weight of the head carried it back down to where it hit the work piece, shaping it. This job required fast action and skill because the work piece had been previously heated in the forge several feet away until it was red hot and soft. The metal could only be shaped while it was hot. The worker had to know how high to lift the hammer head; the higher it rose, the harder the blow. Maker: unknown

Snag Grinder (ca. 1900): Heavy-duty grinder was used to smooth out or "snag" the rough edges of the castings that the Kregel firm purchased for use on their windmills.

This was unpleasant and hard work. It probably was done by a young, relatively unskilled person. Maker: Western Grinder, St. Louis, Missouri

Cross-Cutoff Circular Saw (ca. 1900): Used to cut boards to length.

Maker: possibly Kregel Windmill Company personnel

Table Saws (ca. 1900): Used to cut boards to width.

Maker: possibly Kregel Windmill Company personnel

Thickness Planer (ca. 1900): Used to make boards the right thickness and to smooth the top and bottom.

Maker: Egan Company, Cincinnati, Ohio

Joiner (ca. 1900): Used to make the edges of boards straight and smooth.

Maker: Louis E. Rechtin, Cincinnati, Ohio

Sheet Metal Rolls (ca. 1900): Bend the correct curve into the metal blades of the windmill. Originally, hand powered, these rolls were converted to power operation by replacing the crank with a large wooden drive pulley.

Maker: unknown

Beading Machine (ca. 1900): Used to roll stiffening creases in the edges of the sheet metal parts like [windmill] blades.

Maker: unknown

Sheet Metal Brake (ca. 1900): This long machine was used to bend sheet metal to exact angles.

Operated by hand, this machine was especially important to the manufacture of galvanized steel water tanks. Maker: unknown

Sheet Metal Shear (ca. 1900): This small "steel shear" was used to cut the sheet metal used in windmills and water tanks.

The worker operated the shear by placing the metal in it and then by depressing the foot pedal at the bottom of the machine. Maker: Peck, Stow and Wilcox, Connecticut

Power Transmission System (ca.1900): All power-driven machinery in the shop was operated by leather belts that form the long transverse line shaft located near the ceiling.

The line shaft would run all day, continuously. Individual machines could be started and stopped at will by the use of the "shipper" levers. The line shaft has been operated by two electric motors since the 1920s. Before that time, a noisy and undoubtedly troublesome gasoline engine furnished the power. Line shafts were once the only way to operate powered shop machinery. After 1900, electric motors began to be used to drive individual machines. Many shops, however, continued to use line shafts into the 1970s, proving that while cumbersome and somewhat dangerous, this was still an effective way to run a factory.

Evaluation of Integrity

The Kregel Windmill Company Factory retains an outstanding level of integrity. The building's location remains unchanged since George F. Kregel erected the building on the site in 1902. The setting of the factory has changed slightly over the past century as City services buildings were erected to the south and west on lots that were historically commercial. Dwellings to the east have been removed for a commercial building and parking lot. The remainder of the surroundings, however, continues to contain single-family dwellings, many of which were present during the period of significance.

The building possesses an unparalleled association with the history of windmill manufacturing. Its connection with the Kregel Windmill Company's manufacturing and office work is fully intact, and the building retains the

machinery, supplies, and parts for the manufacturing and repair of windmills from the period of significance. When first seeing the Kregel Windmill Company Factory, former Henry Ford Museum curator John Bowditch "was struck by the incredible time capsule we had here. It was as if they had walked out and shut the door. You had 70 or 80 years of artifacts just scattered around…so, when you look at this factory, realize you have a gem of national significance."[210]

Overall, the building retains a high level of integrity of design, materials, and workmanship. The rehabilitated north wing that houses the museum's restroom, mechanical and security equipment, and receiving area, matches the original wing's footprint and is unnoticeable from the public right of way or from the factory's historic interior. Historically used primarily for storage, the space was related, but not integral, to the company's windmill manufacturing. The support columns that hold the new protective roof are visible in the factory interior and puncture both the historic floor and ceiling. However, the loss of historic fabric to install the columns and their visual intrusion into the workspace is minimal and does not disrupt the historic feeling of the factory. The exterior siding, roof configuration, and fenestration remain largely unaltered. The construction of the abutting building to the east is out of character for the Kregel Windmill Company Factory as it obscures what historically was a visible side of the building. That side, however, was similar to the exposed west side as they are void of detail outside of a single window. With the inclusion of the original manufacturing material and machinery, the aspect of feeling is particularly strong on the building's interior. Aside from the incorporation of a walkway and video screens for museum interpretation use, the interior of the factory has changed little since the end of the period of national significance.

[210]Dan Swanson, "Museum Opens with Fresh Look at America's Industrial Past," *Nebraska City News-Press*, May 3, 2013.

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Previous Documentation on File (NPS):

_X_ Previously listed in the National Register (fill in 1 through 6 below)
__ Not previously listed in the National Register (fill in **only** 4, 5, and 6 below)

1. NR #:	93000061
2. Date of listing:	February 23, 1993
3. Level of significance:	State
4. Applicable National Register Criteria:	A _X_ B__ C__ D__
5. Criteria Considerations (Exceptions):	A__ B__ C__ D__ E__ F__ G__
6. Areas of Significance:	Industry, Agriculture

__ Previously Determined Eligible for the National Register:	Date of determination:
__ Designated a National Historic Landmark:	Date of designation:
__ Recorded by Historic American Buildings Survey:	HABS No.
_X_ Recorded by Historic American Engineering Record:	HAER No. NE-8
__ Recorded by Historic American Landscapes Survey:	HALS No.

Location of additional data:

State Historic Preservation Office: Lincoln, Nebraska
Other State Agency:
Federal Agency: National Park Service, DOI Regions 3, 4, 5, Omaha, Nebraska
Local Government:
University:
Other (Specify Repository): Kregel Windmill Factory Museum, Nebraska City, Nebraska; Garnavillo Historical Society, Garnavillo, Iowa

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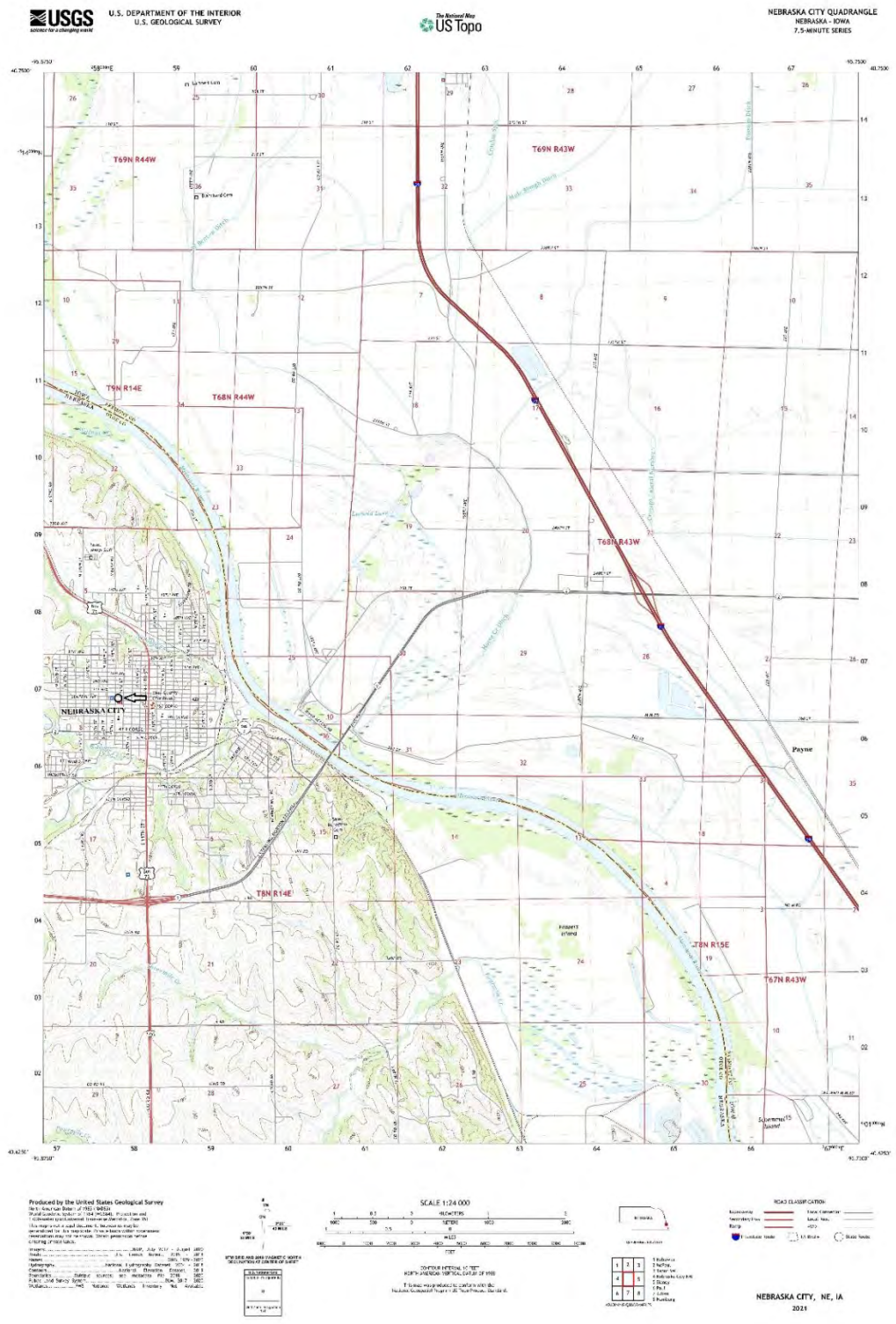


Map 1: USGS Map noting location of the Kregel Windmill Company Factory in Nebraska City, Nebraska.

Map 2: The nominated area is outlined in red; imagery from September 2022.

Coordinates (latitude, longitude):

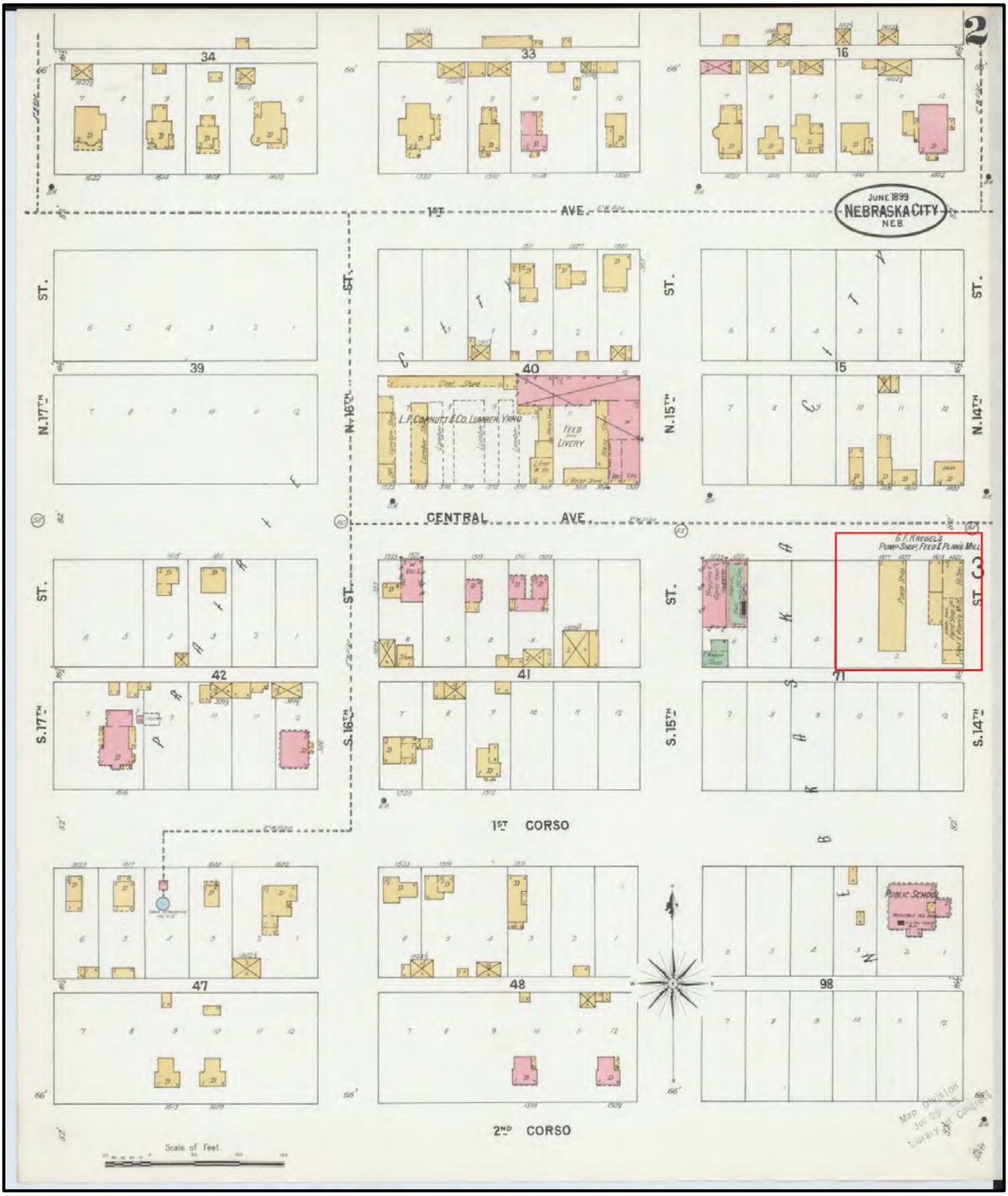
A. 40.676841, -95.863553

B. 40.676841, -95.863751

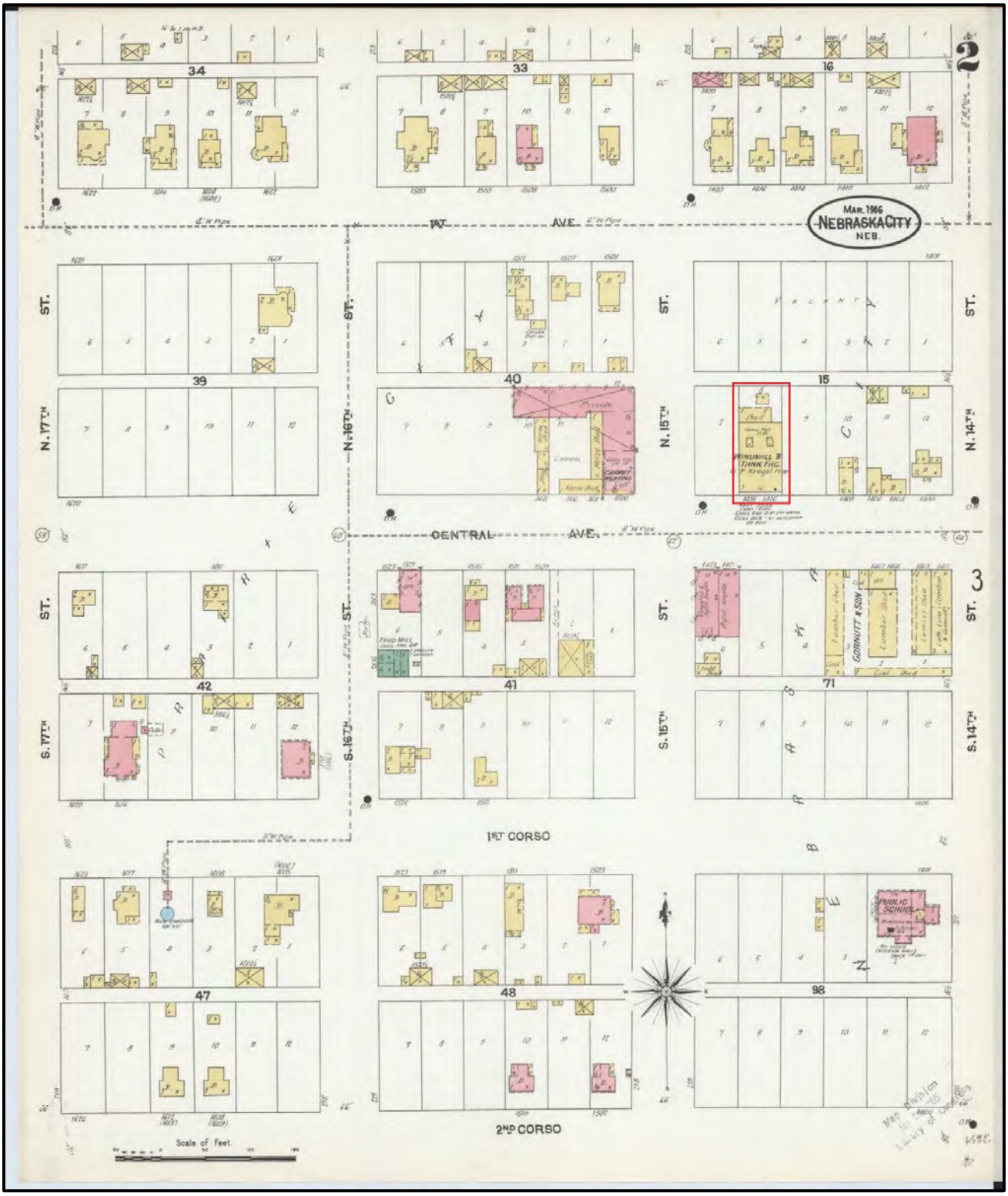
C. 40.677189, -95.863751

D. 40.677189, -95.863553

Datum: WGS84



Map 3: 1899 Sanborn map of Nebraska City. Area outlined in red is site of Nebraska City Manufacturing Company where Geroge first started producing ELI windmills. Insurance Map of Nebraska City, Otoe County, Nebraska. Sanborn Map Company, June 1899. https:// www.loc.gov/item/sanborn05220_004/.



Map 4: 1906 Sanborn map of Nebraska City. Location of Kregel Windmill Company Factory outlined in red. Insurance Map of Nebraska City, Otoe County, Nebraska. Sanborn Map Company, May 1906. https://www.loc.gov/item/sanborn05220_005/.

Photograph List

Location: 1416 Central Avenue, Nebraska City, NE
Date: January 2021
Photographer: David Calease

Photograph 1
Exterior, south façade; view north.

Photograph 2
Setting, house to left is now museum office; view northeast.

Photograph 3
Exterior, south façade; view northeast.

Photograph 4
Exterior, west side; view northeast.

Photograph 5
Exterior, north side; view south.

Photograph 6
Outhouse; view east.

Photograph 7
Interior, entrance and office; view east.

Photograph 8
Interior, company office; view north.

Photograph 9
Interior, factory – east side; view north.

Photograph 10
Interior, factory – east side; view south**.**

Photograph 11
Interior, factory – north side; view west.

Photograph 12
Interior, factory – center; view south.

Photograph 13
Interior, factory – west side; view southwest.

Photograph 14
Interior, monitor and pully-driven equipment.

Photograph 1:
KREGEL WINDMILL COMPANY FACTORY
Nebraska City, Nebraska
Exterior, south façade; view north
Photo by David Calease, January 2021

Photograph 2:
KREGEL WINDMILL COMPANY FACTORY
Nebraska City, Nebraska
Setting, house to left is now museum office; view northeast
Photo by David Calease, January 2021

Photograph 3:
KREGEL WINDMILL COMPANY FACTORY
Nebraska City, Nebraska
Exterior, south façade; view northeast
Photo by David Calease, January 2021

Photograph 4:
KREGEL WINDMILL COMPANY FACTORY
Nebraska City, Nebraska
Exterior, west side; view northeast
Photo by David Calease, January 2021

Photograph 5:
KREGEL WINDMILL COMPANY FACTORY
Nebraska City, Nebraska
Exterior, north side; view south
Photo by David Calease, January 2021

Photograph 6:
KREGEL WINDMILL COMPANY FACTORY
Nebraska City, Nebraska
Outhouse; view east
Photo by David Calease, January 2021

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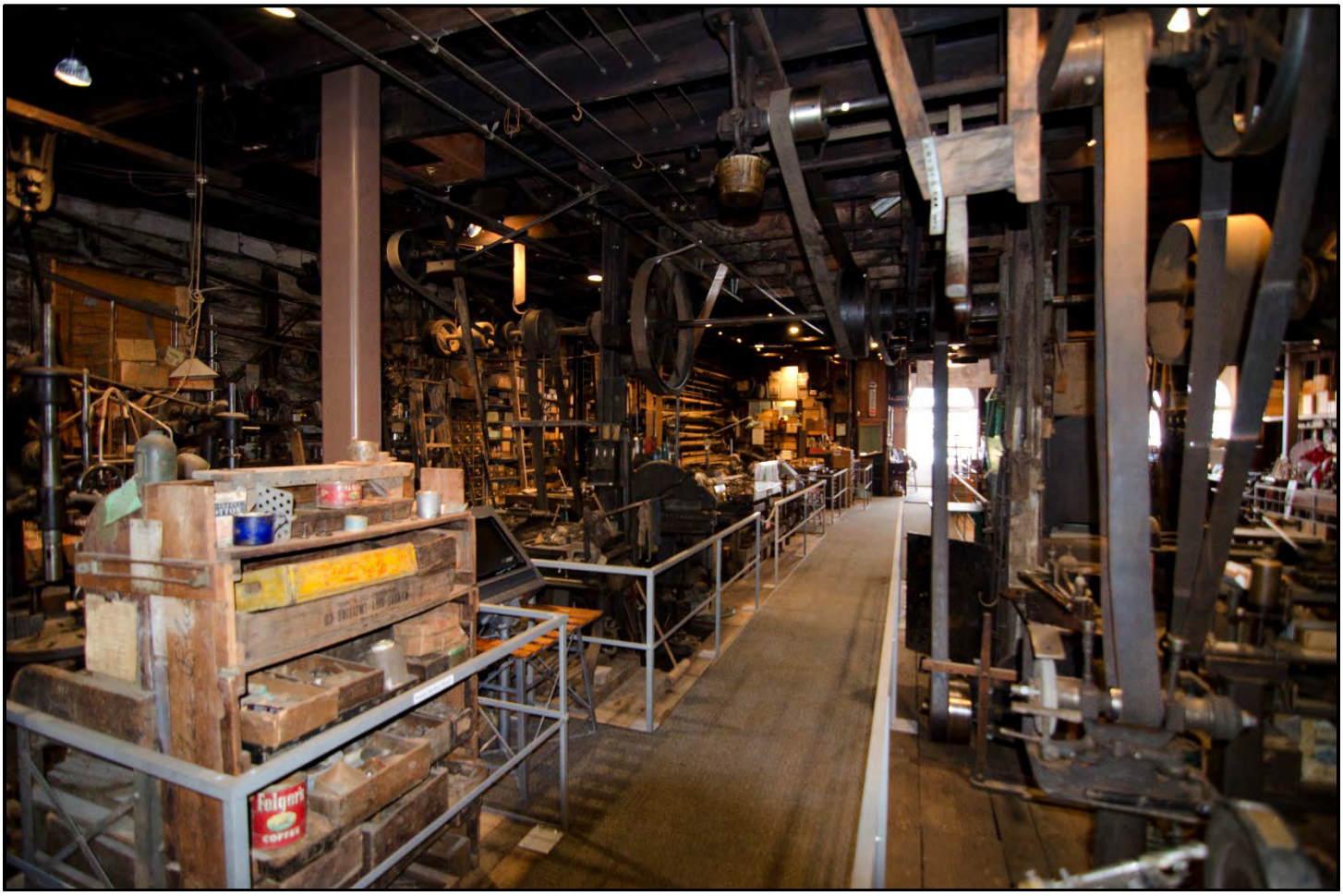
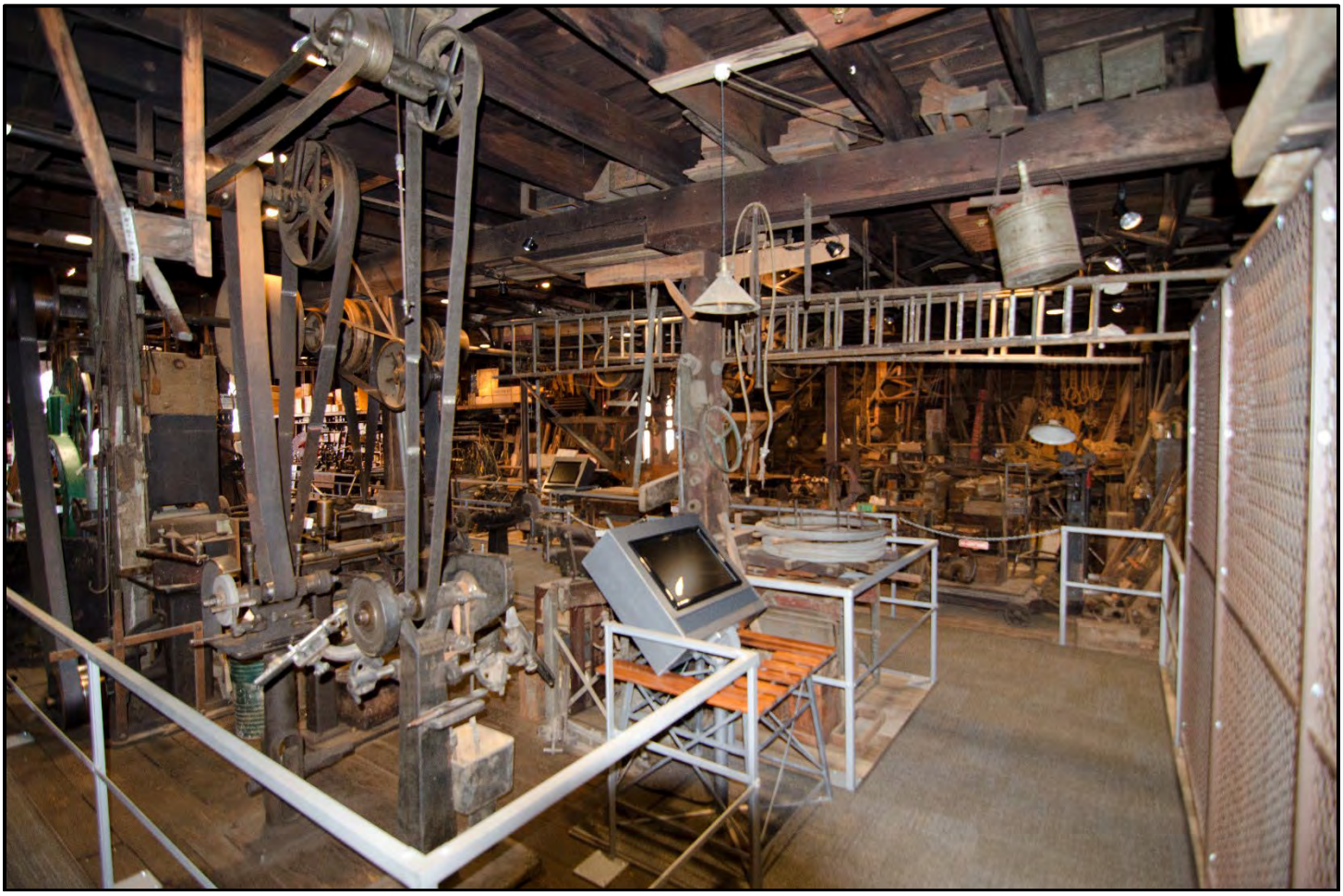
Nebraska City, Nebraska
Interior, entrance and office; view east
Photo by David Calease, January 2021

Photograph 8:
KREGEL WINDMILL COMPANY FACTORY
Nebraska City, Nebraska
Interior, company office; view north
Photo by David Calease, January 2021

Photograph 9:
KREGEL WINDMILL COMPANY FACTORY
Nebraska City, Nebraska
Interior, factory – east side; view north
Photo by David Calease, January 2021



Photograph 10:
KREGEL WINDMILL COMPANY FACTORY
Nebraska City, Nebraska
Interior, factory – east side; view south
Photo by David Calease, January 2021



Photograph 11:
KREGEL WINDMILL COMPANY FACTORY
Nebraska City, Nebraska
Interior, factory – north side; view west
Photo by David Calease, January 2021

Photograph 12:
KREGEL WINDMILL COMPANY FACTORY
Nebraska City, Nebraska
Interior, factory – center; view south
Photo by David Calease, January 2021

Photograph 13:
KREGEL WINDMILL COMPANY FACTORY
Nebraska City, Nebraska
Interior, factory – west side; view southwest
Photo by David Calease, January 2021

Photograph 14:
KREGEL WINDMILL COMPANY FACTORY
Nebraska City, Nebraska
Interior, monitor and pully-driven equipment
Photo by David Calease, January 2021

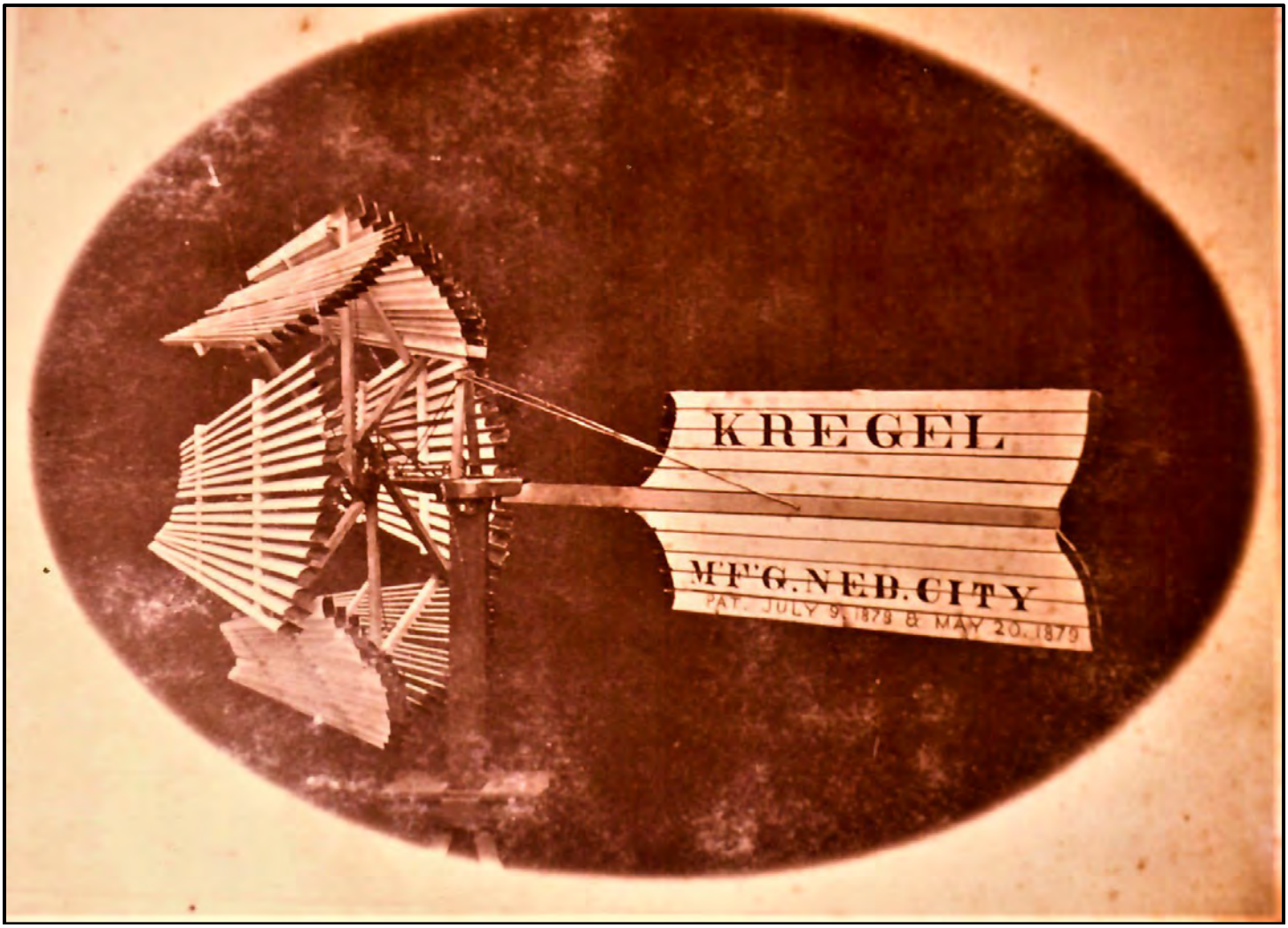


Figure 1: Advertisement card for Kregel Windmill, Nebraska City Manufacturing Company, ca. 1880. Courtesy of Kregel Windmill Factory Museum.

Figure 2: Kregel Windmill Company Factory, south façade, unidentified workmen, ca. 1903. Courtesy of Kregel Windmill Factory Museum.

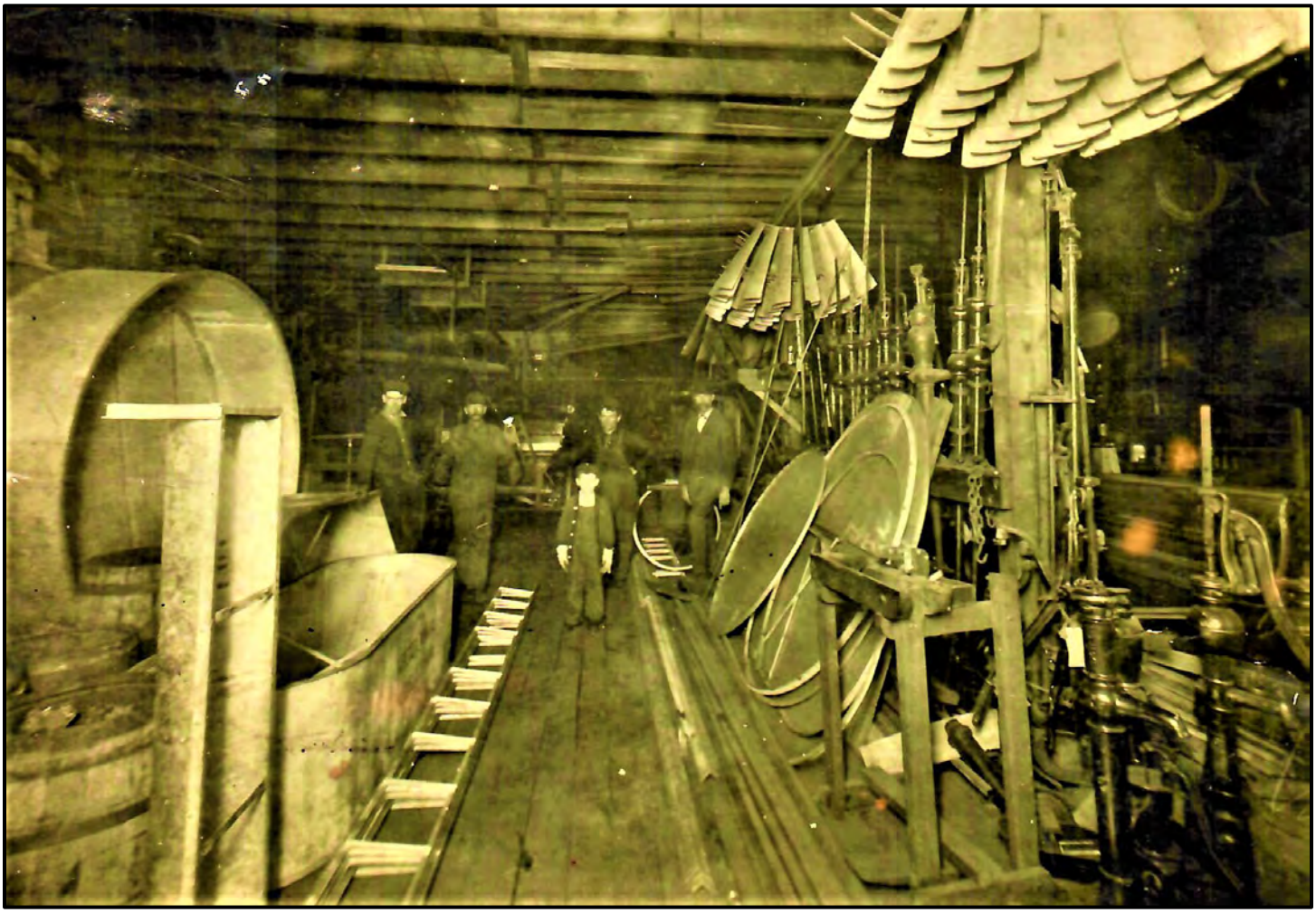


Figure 3: Kregel Windmill Company Factory, interior, unidentified workmen with young Arthur Kregel (foreground); ca. 1905. Courtesy of Kregel Windmill Factory Museum.

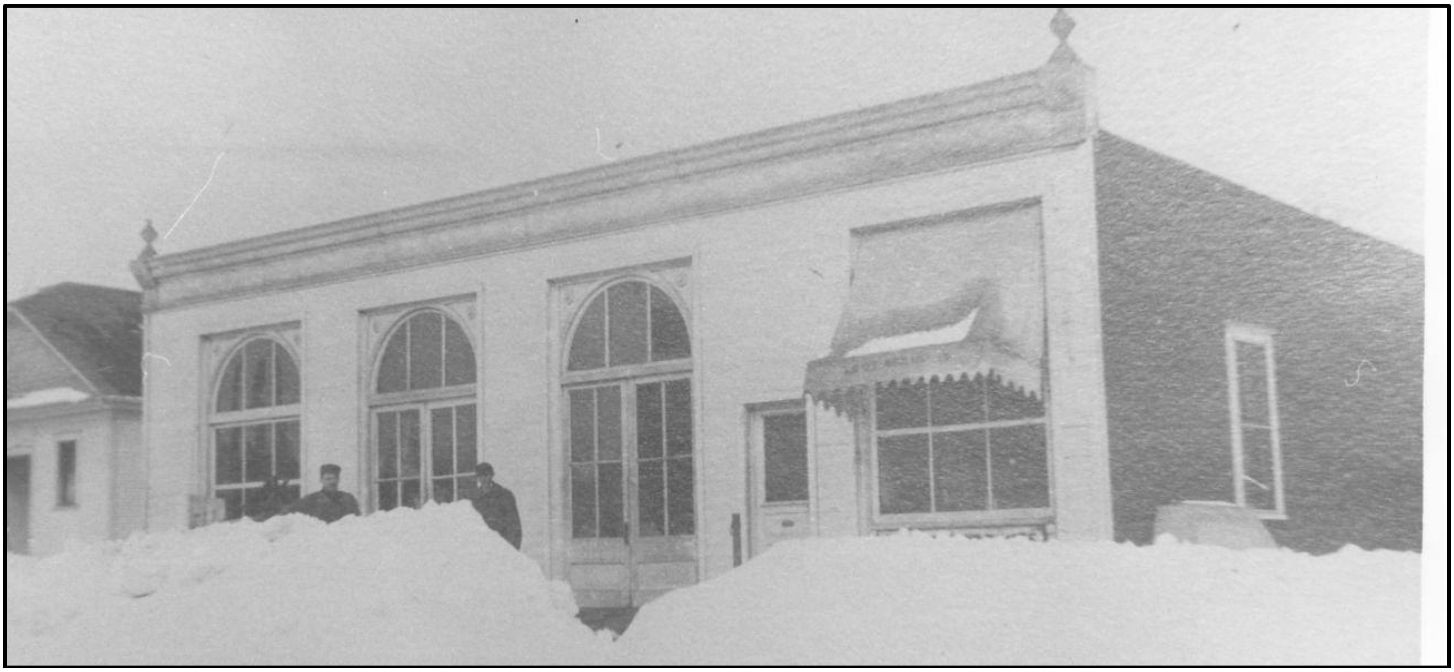


Figure 4: Kregel Windmill Company Factory, south and east façade exterior, unidentified workmen with large snowdrifts; ca. 1910. Courtesy of Kregel Windmill Factory Museum.

Figure 5: Kregel Windmill Company Factory, south façade, unidentified workman in company truck; ca. 1920. Courtesy of Kregel Windmill Factory Museum.

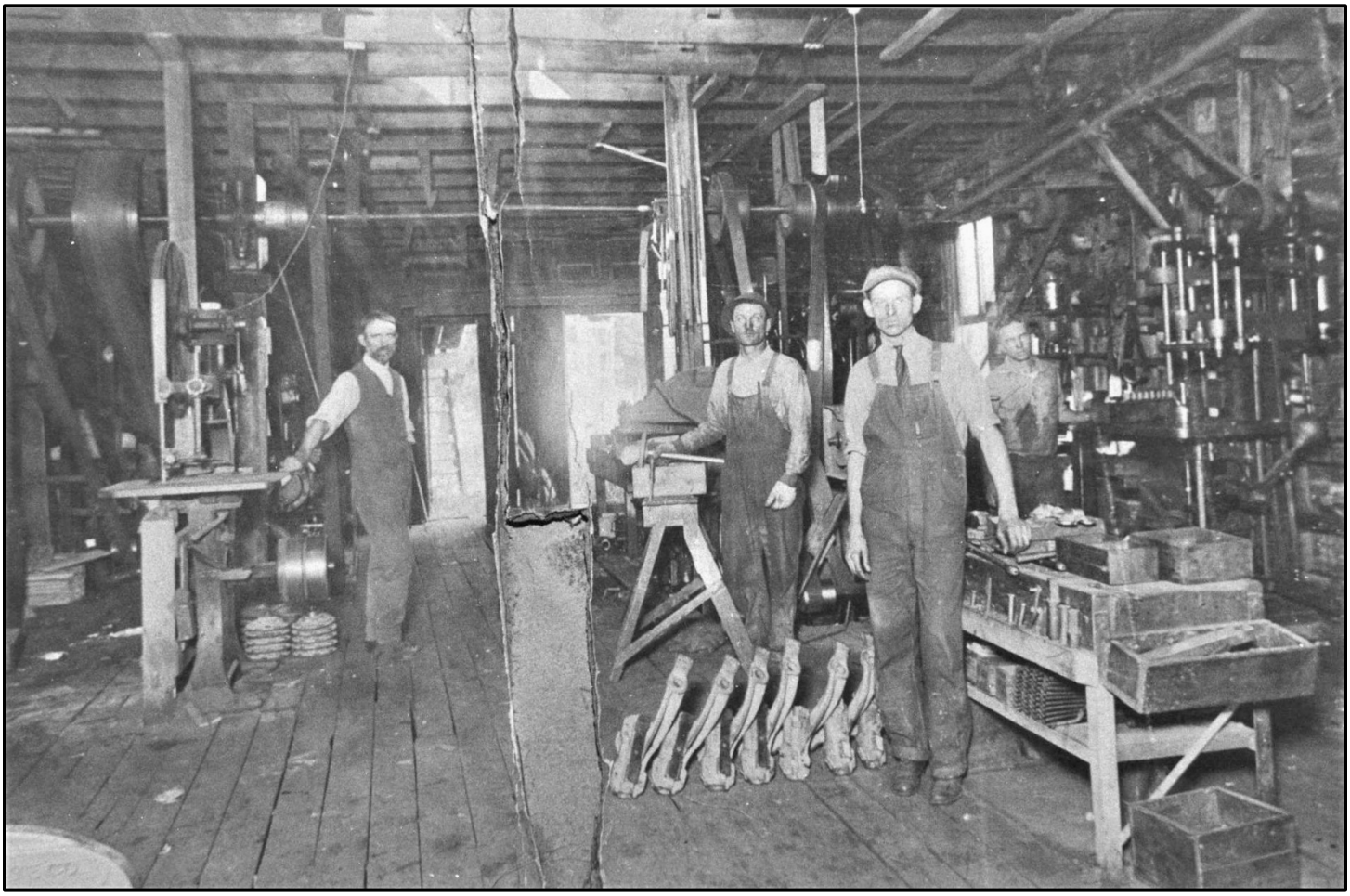


Figure 6: Kregel Windmill Company Factory, interior, unidentified workmen with Arthur Kregel (foreground, in tie), ca. 1925. Courtesy of Kregel Windmill Factory Museum.

Figure 7: ELI windmill on farmstead in eastern Iowa, woodpile nearby possibly created via wind power, ca. 1898. Courtesy of Garnavillo Historical Society, Garnavillo, Iowa.

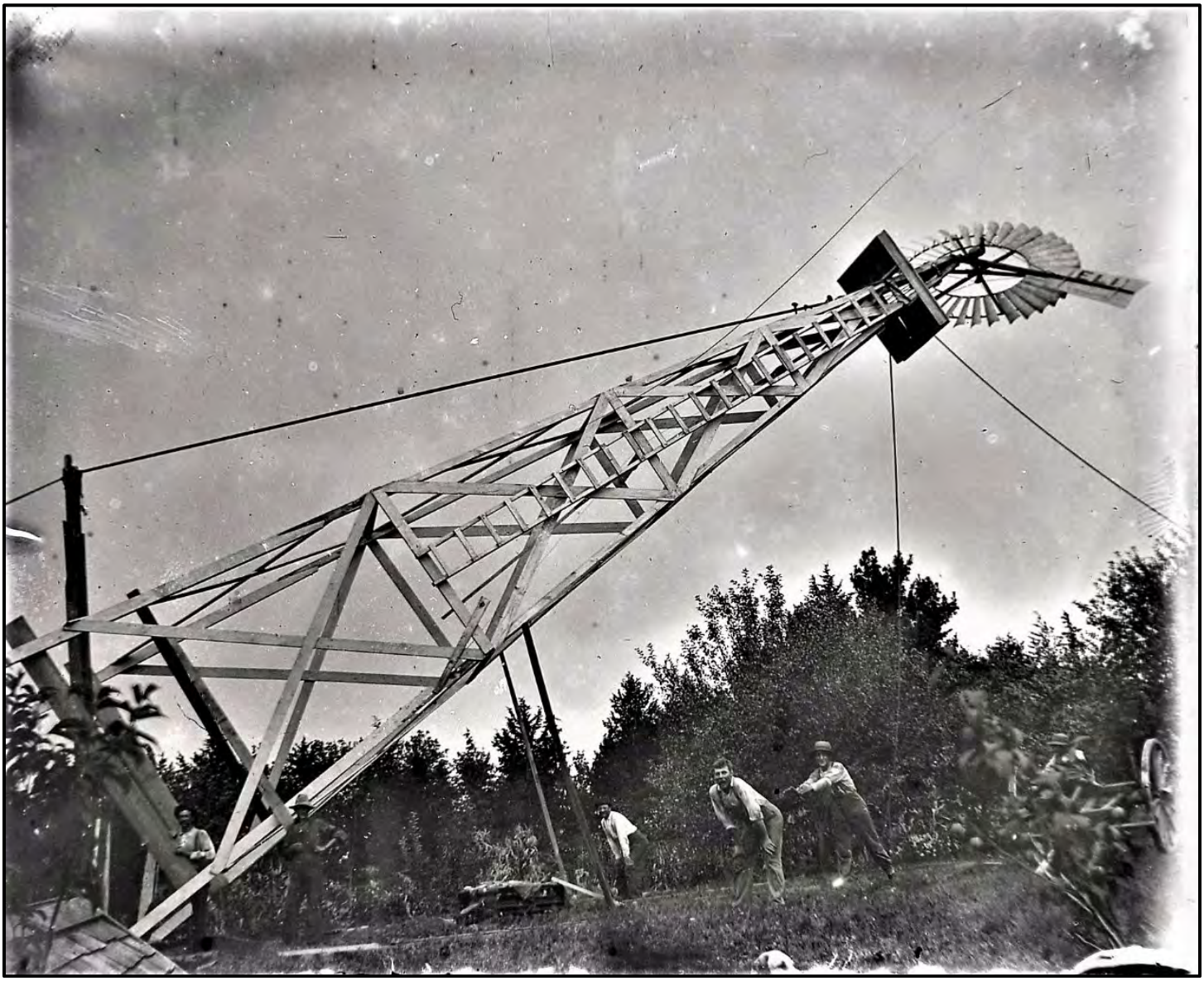


Figure 8: ELI windmill raising on eastern Iowa farmstead, ca. 1898.
Courtesy of Garnavillo Historical Society, Garnavillo, Iowa.

Figure 9: All steel ELI windmill on southeast Nebraska farmstead, ca. 1910. Courtesy of Kregel Windmill Factory Museum.

Figure 10: ELI windmill on farmstead south of Nebraska City, 2020. Courtesy of Isaiah Yott, Kregel Windmill Factory Museum.

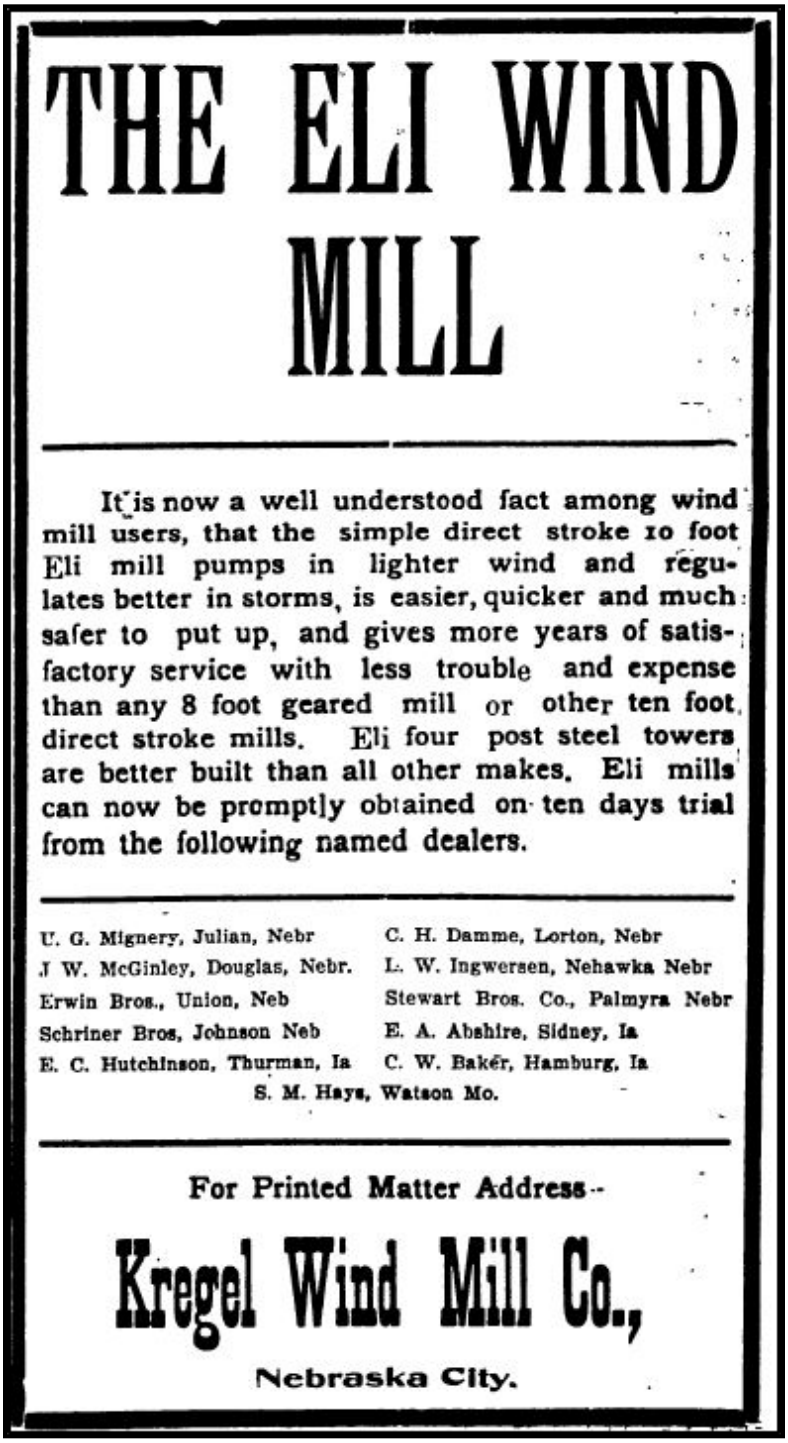
Figure 11: George Kregel's ELI windmill advertisement. *The Weekly News* (Nebraska City, NE), May 1, 1908.

Transcription of promotional text in image:

This mill has no weights or springs to govern it, yet regulates better than others. It has no rocker arm or overhead guides or slides. Has no set screws. Bolts cannot turn in tightening up. It has no shields or other parts that can come off. It has no dangerous gears.

I sell and repair all makes of mills. Make and repair tubular wells, make wood and steel tanks and dipping tanks, and sell dip. Make bee hives and sell bee-keepers' supplies, Red Jacket and other makes of pumps.

Quality is the first consideration in all my goods.



THE ELI WIND MILL

It is now a well understood fact among wind mill users, that the simple direct stroke 10 foot Eli mill pumps in lighter wind and regulates better in storms, is easier, quicker and much safer to put up, and gives more years of satisfactory service with less trouble and expense than any 8 foot geared mill or other ten foot direct stroke mills. Eli four post steel towers are better built than all other makes. Eli mills can now be promptly obtained on ten days trial from the following named dealers.

U. G. Mignery, Julian, Nebr
J W. McGinley, Douglas, Nebr.
Erwin Bros., Union, Neb
Schriner Bros, Johnson Neb
E. C. Hutchinson, Thurman, Ia
C. H. Damme, Lorton, Nebr
L. W. Ingwersen, Nehawka Nebr
Stewart Bros. Co., Palmyra Nebr
E. A. Abshire, Sidney, Ia
C. W. Baker, Hamburg, Ia
S. M. Hays, Watson Mo.

For Printed Matter Address--

Kregel Wind Mill Co.,

Nebraska City.

Figure 12: Advertisement for ELI windmill and list of agents in Nebraska, Iowa, and Missouri. *Nebraska City News*, February 28, 1913.

Transcription of product description in image:

It is now a well understood fact among wind mill users, that the simple direct stroke 10 foot Eli mill pumps in lighter wind and regulates better in storms, is easier, quicker and much safer to put up, and gives more years of satisfactory service with less trouble and expense than any 8 foot geared mill or other ten foot direct stroke mills. Eli four post steel towers are better built than all other makes. Eli mills can now be promptly obtained on ten days trial from the following names dealers.

Figure 13: Advertisement for new, self-oiling ELI windmill. *Nebraska City News*, July 22, 1921.

Windmill Service

—Is best when complication is least. The simply constructed gearless Eli Mill has long been known to give a pumping service not equaled by any other mill and does it with less parts, in less wind.

A number of 10 ft. Eli Mills are pumping wells 240 ft. deep. One did that for 35 years out of a well 240 ft. to the water line. One 10 ft. Eli Mill has now pumped for 10 years out of a 345 ft. well, the water level being at 270 ft., to the complete satisfaction of it owner. A number of owners have 8 Eli Mills and the Ottes, near Sidney, Iowa, have 14 Eli Mille. A 10 ft. Eli Mill took the place of a new 10 ft. GEARED MILL on a deep well and the Eli is giving real satisfactory service. In the west end of Fremont County, Iowa, are more than 500 Eli Mills at work.

Determination to give the utmost in good mills, strong towers and correct erecting made it easy and natural to place 123 Eli Mills in Wyoming Precinct, mostly on deep wells, on which 8 ft. geared mills fail to make a saltsfactory showing.

KREGEL WINDMILL CO.

NEBRASKA CITY, NEBRASKA

Figure 14: Advertisement for windmill service. ***Nebraska Daily News-Press,*** **July 25, 1931.**