History
of the
Page Base Stations

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Two long-forgotten survey monuments buried beneath the ground in the area north and northeast of Page, Nebraska, were critical in determining the physical shape of our country. Known as Page SW Base and Page NE Base, these stone monuments formed the end points of a precisely-measured line that was part of a vast system of a north-south triangulation network that stretched from Mexico to Canada.

In the late 1800's a comprehensive plan was undertaken by the United States Coast & Geodetic Survey to measure across the United States, to accurately determine the size, shape, and height of this country with absolute precision. The accuracy of the methods and equipment used during this survey still rival what is being used today including the Global Positioning System that involves the use of satellites.

For the horizontal measurement, a route was selected that paralleled closely to 39° North Latitude. This line stretched across the center of the United States and more particularly through the central area of Kansas. This line's beginning originated with a small triangulation network that had been started on the east coast near Staten Island, New York, in the year 1817. The primary goal of USC&GS at that time was to measure our nation's coastlines, which would be beneficial to our national defense. In the ensuing years this network was extended further inland with the specific goal of tying together both coasts and our northern and southern borders into one continuous system.

For vertical measurements a datum was referenced to mean sea-level. It was understood that the average height of the Atlantic and Pacific Oceans were nearly the same, but to determine this average height a tide station was developed at Sandy Hook, New Jersey. Through years of readings the average height of the ocean level was determined and accepted as a starting elevation of zero (0). A precise line of vertical levels, known as the transcontinental line, was extended westward to closely follow the route previously chosen for the triangulation network.

Two triangulation stations in the east-west network along the 39th Parallel in central Kansas, named Meades Ranch and Waldo, formed the starting points for a major north-south network that would extend southward to Mexico and northward to Canada. This survey would closely follow the 98th degree of west longitude and would become known as the 98th Meridian Survey. The placement of permanent monuments and the ensuing measuring of angles between them started north from Meades Ranch on July 8, 1897, with Frank D. Granger in charge of the operations.

The first point established in Nebraska along the 98th Meridian Survey was designated as "Blue Hill", which was located southwest from the town of that same name. To clearly see between stations, observation towers were erected over the points. The tower at Blue Hill was 66' tall, which enabled observations to be made to other points previously established in Kansas and also new ones being established in Nebraska. Angle measurements with C&GS theodolite No. 118 were begun at Blue Hill on July 1, 1898, and completed on July 20, 1898.

To determine the lengths of the sides of the triangles in the network, a line had to be measured with utmost precision approximately every one hundred miles or where the topography of the land would enable one to be placed. Together with the measured line and the measured angles the use of trigonometry solved the other lengths of the lines in the network where only angle observations had been made. These important lines were known as base lines and were of crucial importance in the 98th Meridian Survey. Two base lines were established in Nebraska – one near Shelton and the other near

Page. The Shelton Base Line was established on April 26, 1899, north of the Union Pacific Railroad between the towns of Shelton and Gibbon. This location would serve as one of the most important locations in the 98th Meridian Survey; it would become the location where a testing line known as a comparator would also be established to determine the true lengths of the measuring devices that would be used on the other base lines.

The comparator was approximately 100 meters in length and was built adjacent to the Shelton Base Line. A device known as the Ice Bar was shipped in from Washington D.C. and used to measure the comparator line. This bar was the world's finest field-measuring device and consisted of a steel bar 5 meters in length that was suspended in a trough of melting ice that moved along on rails while readings were taken with powerful microscopes. The ice kept the bar at a consistent temperature throughout the measurement, so the effects of contraction or expansion of the bar were not a factor. Its true length was previously determined by comparison to a standard bar that defined the true length of the meter as known to mankind at that time. Once the comparator line was measured with the Ice Bar ten different times and its length known, the steel tapes and another device known as the Duplex Bar were used on the comparator line to see how they measured the line compared to its true length as determined by the Ice Bar. Two 100-meter steel tapes from the Japanese Government, used as standardized measuring devices for Japan, were also brought to Shelton and compared to the comparator line. The Shelton Base Line was measured with the steel tapes and the Duplex Bar between May 8 - 22, 1899.

During this same period, the sea-level elevations of the transcontinental line following the 39th Parallel were being prepared to come north into Nebraska. The connection point for the Nebraska leveling was at Abilene, Kansas, where the leveling left that location on March 30, 1899, under the direction of A. L. Baldwin. This leveling route going north into Nebraska was intended to follow as closely as possible the triangulation of the 98th Meridian Survey so that elevations could be established on several triangulation monuments and especially those at the base lines located at Shelton and Page. The route taken by the precise sea-level leveling depended upon the locations of the railroads, since the gradual grade of the railroads was ideal for both running the lines and also for establishing permanent monuments known as bench marks. The route into Nebraska entered at Superior, then went west for about 25 miles where it then turned and went north. A connection off the main leveling route was made to triangulation station Blue Hill since it was in proximity to the railroad. The route then went through Hastings and to Grand Island. At Grand Island a precise line was run westward a distance of about 22 miles to the Shelton East Base station. Then the line was run northeastward from Grand Island to Columbus. By June 17, 1899, the operations of the precise leveling was turned over to Benjamin E. Tilton who carried it on northward to Norfolk. Although this leveling route established to Norfolk was still about 70 miles east of the intended location for the Page Base Line, it did serve as a location to also connect with a line of precise levels established at Sioux City, Iowa, by the Missouri River Commission in 1890.

By April of 1900 the 98th Meridian Survey had reached the area of Greeley, Nebraska. Frank D. Granger was working ahead of the main surveying crew, searching out the best areas for new monument locations that could be observed between successive stations. In May of 1900 Granger reached the Elkhorn River Valley and took note of the level terrain north of the town of Page that would fit the requirements for the next base line location north of the one located at Shelton. Permanent marks were established for the ends of the Page Base Line, and the measurement of this line preceded the triangulation network that was advancing from the south. The triangulation crew reached the vicinity of Page and stored their equipment there on October 17, 1900, to end their work season. The monuments being placed for triangulation stations, except at the base line points, were generally 8" square marble posts approximately 3' long. Below these posts was a second monument consisting of an upside-down stone crock with a drill hole in the center, or sometimes a stone jug with a tack in the cork. These lower monuments would serve as a backup if the surface monument was removed or disturbed. The top of the marble posts were divided into four quadrants by deep grooves. In each of the quadrants was one individual letter that together formed the letters "U S C S" (United States Coast Survey).

The two Page base stations, Page SW Base and Page NE Base, formed the end points of a line in a northeast-southwest direction. This line stretched across both open prairie and cultivated land, crossing twelve barbed wire fences and five cornfields. The length of the line was 8.25 km (5.13 miles) and was divided into eight separate sections for measuring purposes with different devices. The end points, or base stations, consisted of limestone blocks measuring 6" square and 8" tall for the lower monuments, and limestone blocks 24" square and 14" tall for the surface monuments. The surface monuments were also lettered for the United States Coast & Geodetic Survey and had a copper bolt in the center for the precise mark. The end points of the interior sections of the base line were marked with wooden posts 4"x6" with copper rivets in the center. The exception was section 6 where the end points were marked with limestone blocks 6" square and 54" long with copper bolts in the center. This section was measured with all devices for comparison.

The precise sea-level elevations that had been established to Norfolk were resumed on June 22, 1900, by Benjamin E. Tilton using leveling instrument No. 6. This route followed the railroads northwest from Norfolk to Plainview, then west to Page where three permanent bench mark monuments were established in the Page area and completed on July 28, 1900. The bench mark monuments being established in Nebraska consisted of limestone posts squared to 6" on each side and were about 4½' in length. On the top surface a sunken square hole to fit the bottom of a leveling rod was in the center surrounded by the letters "U S B M" (United States Bench Mark). The three bench marks established at Page were K_2 located near the railroad depot, L_2 located one mile north of town, and M_2 which was on the farmstead near the Page SW Base station. A precise level connection was made to Page SW Base from bench mark M_2, giving it a first-order elevation status. A connection between SW Base and NE Base was then made by O. M. Leland by running elevations both ways between the two points for an accuracy check.

The Page Base Line was measured between August 24 - 31, 1900, with A. L. Granger in charge. Five separate measuring devices were used consisting of two 50-meter steel tapes (No. 247 & 248), two 100-meter steel tapes (No. 85 & 88), and two Duplex Bars (No. 15 & 16). The Duplex Bars when used together constituted one measuring device. Sections 1, 2, 4, 5, 6, and 7 were each 1000 meters in length. Section 3 was 1050 meters, and section 8, that ended at the Page NE Base station, was 1201 meters in length.

The first three base line sections were measured in one direction with one 50-meter steel tape and then run in the reverse direction with the other 50-meter steel tape. Sections 4 and 5 were measured with the two 100-meter steel tapes in the same fashion. The last two sections, 7 and 8, were measured with the Duplex Bars forward and backward. Section 6 was measured with all five devices so that the accuracy of each type of measuring device could be checked.

The Duplex Bar, developed by William Eimbeck, consisted of two rods, one of brass and one of steel, that each operated independently and were enclosed inside a metal housing. The units were placed upon tripods end to end with precision. Connection points made of polished agate that when brought together served as the measuring point. The rear bar was then brought forward and connected to the former front bar as they were carried along on the tripods. The brass and steel rods served as an independent check of each other due to the thermal expansion or contraction caused by temperature change.

Occupation of the Page base stations for angle measurements was completed before the close of the 1900 season. Observations from Page SW Base was performed atop a wooden tower 21' high on September 13, 15, 17, 19, and 20, 1900, and observations from Page NE Base were performed from a 15' high tower on September 22, 25, 26, and 27, 1900. Sixteen sets of measured angles to other points were observed at each station location.

At the time the monuments were placed at the Page base stations, descriptions were made to later aid in finding their locations. Page SW Base was described as being in the SW¼ of Section 1, T28N, R10W, located two miles north and 0.7 mile west of Page on land owned by William Lord, and about 100 meters northwest of his house. Page NE Base was described as being in the SE¼ of Section 16, T29N, R9W, in

open prairie on State property designated as school land being rented at that time by T. S. Roche of Page. There were no close objects by which to reference the mark except for a large sand blowout located to the northeast and approximately 600 meters away.

On April 15, 1901, Frank D. Granger returned to Page, Nebraska, and resumed the network of the 98th Meridian Survey north to the Missouri River. At that location it was connected to the triangulation previously done by the Missouri River Commission in 1889-1890, and then continued north into South Dakota. The 98th Meridian Survey was deemed completed in 1907 between Corpus Christi, Texas, at the Gulf on the south end, and the border with Canada on the north end. The north location was along the border common to North Dakota and Minnesota. Geodetic positions and azimuths for the triangulation stations were computed upon the Clarke Spheroid of 1866 and referenced to the United States Standard Datum. The precise sea-level leveling that arrived at Page was extended westward to Wyoming in 1901-02 and connected with another line coming up from the transcontinental leveling line at Denver.

A telegraph line was established between the railroad depot at Page and the Page SW Base station during 1907 so that a precise longitude position could be fixed upon the monument. The telegraph line provided a means of getting a precise clock time that was needed to establish longitude. From Page, longitude connections were made to Howard, South Dakota, and to Omaha, Nebraska. Latitude positions were established by astronomical observations based upon the known positions of the celestial bodies. Page SW Base became one of only a few points in Nebraska at that time to have a known precise latitude and longitude position.

The important Page base stations fell into obscurity in the years following the completion of the 98th Meridian Survey. The base stations were visited by C&GS personnel in 1935 when large work forces were assembled in the years of the Great Depression to create new areas of triangulation that would densify the nation's network. At that time the Page SW Base surface monument was found to be in good condition except the copper bolt in the center was missing. A standard 3½" bronze disk bearing the name of the Coast & Geodetic Survey was set into the limestone to replace the missing bolt. The stamping on the disk was described as being "Page Southwest Base 1900 1906". The 1906 designation is likely an error inadvertently placed by the 1935 surveyors. In 1906 six of the base lines of the 98th Meridian Survey were remeasured with Invar steel tapes to compare to the distances previously obtained with the regular steel tapes. Neither the Page nor the Shelton base lines were remeasured during the 1906 use of Invar steel tapes. The ground was owned by Peter Nissen in 1935 and the monument resided in a hog lot near an orchard. Bench mark M2 located near the Nissen farm house was also still in place.

At the time of the 1935 recovery, the Page NE Base station was under cultivation, having been so since around 1927. During the years 1933-35 the soil in the area was said to have drifted considerably and covered the mark. A statement made to C&GS personnel by R. D. Stevens who had been previously farming the land indicated that he was aware of the monument and had tried unsuccessfully to locate it several times. The land in 1935 was being leased by A. E. Ebminstein, who was not familiar with the location of the monument and had allowed the land to revert back to pasture. Prodding was done in an attempt to locate the monument, but this effort was unsuccessful. No record has been made of anyone attempting to find this mark since the 1935 search.

In 1949 the Page SW Base monument was again visited when the area west of Page was surveyed into a large network of triangulation stations that extended west to Newport, south to Burwell, and north to the South Dakota border. This was secondary triangulation that was used mainly for mapping purposes. The SW Base station location was still on land owned by Peter Nissen, but was being rented by Charles Sorenson. Both the triangulation station and the bench mark on the Nissen property were recovered in good condition. At this time C&GS personnel also set two reference marks that consisted of bronze disks in concrete pads that would aid in finding the location or properly resetting the Page SW Base monument in the event that it had been moved. In 1977 the land was purchased by Larry Mudloff who bulldozed in the entire farm site to be used for cultivation. At this time it is suspected that the monuments were likely also removed although Mr. Mudloff does not remember seeing them. Presumably destroyed were the

surface mark for Page SW Base, the two reference marks, and bench mark M_2. It is presumed that the original 1900 lower monument at the Page SW Base location is still in its original location beneath the cultivated field. Also presumed to be gone are the 1900 established bench marks designated K_2 that was located by the former Page railroad depot and L_2 that was located approximately 1½ miles north of Page.

Currently the land where the Page SW Base station is located is owned by Larry Mudloff and is used for agricultural farming purposes. The land where the Page NE Base station is located is still school land and is currently being leased by Robert Belik as pasture.

Recovery:
On April 14, 2007, Nebraska surveyors Erik Hubl, Seth Kauffman, Gene Thomsen, Steve Rasmussen, Lyle Davis, and Jerry Penry recovered the Page Base monuments. Two GPS points had previously been set near both sites. Using these points, an angle and distance was determined to the base stations and the position located using a total station. Both calculated positions were exactly right on the center of the monuments.

The lower monument found at the Page SW Base location was a 6" square limestone post set in concrete. (The surface monument was removed during the 1970's). The original surface monument was found at the Page NE Base location. It is a 24" limestone monument set in concrete.

Sign Dedication:
Sometime between discovery of the monuments on April 14, 2007, and the spring of 2009, the pasture where the Page NE Base monument was located was cleared and turned into a cultivated field. (Google Earth imagery of August 2009 shows it under cultivation). The Page NE Base monument was removed from the field and stored at the home of Holt County Surveyor Steve Rasmussen for several years. In early 2015, the monument was brought to Page and placed on public display. Local resident Lyle Harvey and a former resident of Page, George Casey, began a fund raising campaign to have a historical sign placed next to the monument to explain what it represents and to give a historical explanation of the Page Base Line. Local residents and the Professional Surveyors Association of Nebraska provided the funds to purchase the sign. On May 24, 2015, the sign was officially dedicated with a crowd of approximately 50 people attending. After the dedication, Jerry Penry gave a slide show presentation explaining the details of the 98th Meridian Survey and the importance of the Page Base Line.

The Monuments:
The lower monuments for both Page SW Base and Page NE Base should still remain intact and buried in the cultivated fields. The surface monument at Page SW Base was removed during the removal of the trees at buildings at the old farm site and is presumed to have been buried in a debris pit. The surface monument for Page NE Base is currently on display in the town of Page, Nebraska next to the historical sign.