HISTORY OF WEATHER OBSERVATIONS
SALT LAKE CITY, UTAH
1857 — 1948

November 2005

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This report was prepared for the Midwestern Regional Climate Center under the auspices of the Climate Database Modernization Program, NOAA's National Climatic Data Center, Asheville, North Carolina.

ACKNOWLEDGEMENTS

The climate of Salt Lake City was recorded by scores of people for almost one hundred fifty years. Along the way, scores of people who cleaned out their files chose not to throw away the records of those observations, notes, photographs, and other materials we now find valuable. There are now scores of people who seek to preserve those documents and to identify their stations' histories. All of these people made this study possible and, to them, thank you.

A special thanks to Christopher Young and Steve Summy of the National Weather Service in Salt Lake City who shared several old documents that were good sources for this study.

Perhaps someone will read this study when a hundred years from now. If so, to you, thanks for continuing the thread of interest in climate history.

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HISTORY OF WEATHER OBSERVATIONS
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INTRODUCTION

The first people who lived or visited the area that now comprises Utah did not record weather—not the Native Americans, not the Spanish explorers, and not the mountain men. Change was coming quickly. There was a failed application for statehood in 1849 followed by the creation of the Utah Territory on 9 September 1850. In 1850, the population of Utah had reached 11,380 and was growing. On 11 January 1851, Great Salt Lake City was incorporated and the following month, Brigham Young was sworn in as the first governor of the Utah Territory.

The summer of 1855 brought insects and a severe drought. The following year brought continuing deprivations caused by the previous drought. It ended with a winter that arrived early. Those events were certainly sufficient to spur interest in monitoring weather and climate. Whether or not that became motivation for legislative action is unknown.

Whatever the motivation, weather observations began in December 1858 and there was pride expressed in that milestone. Salt Lake City's newspaper, The Deseret News, described the event in its 7 January 1857 issue.

> By the Meteorological Observations for December as furnished by brother Henry E. Phelps and printed on the last page of this number, it will be seen that an unusual amount of snow has fallen.
>
> It wil1 doubtless be gratifying to Professor Henry,[1] Secretary of the Smithsonian Institution, and to all lovers of meteorological science, that the Honorable W. W. Phelps,[2] at the request of His Excellency Governor Young,[3] has consented, with the assistance of his son, Henry,[4] to keep a regular set of meteorological readings.

The agreement between Phelps and the Governor was formalized when a resolution by the Legislature of the Utah Territory authorized the position of Superintendent of Meteorological

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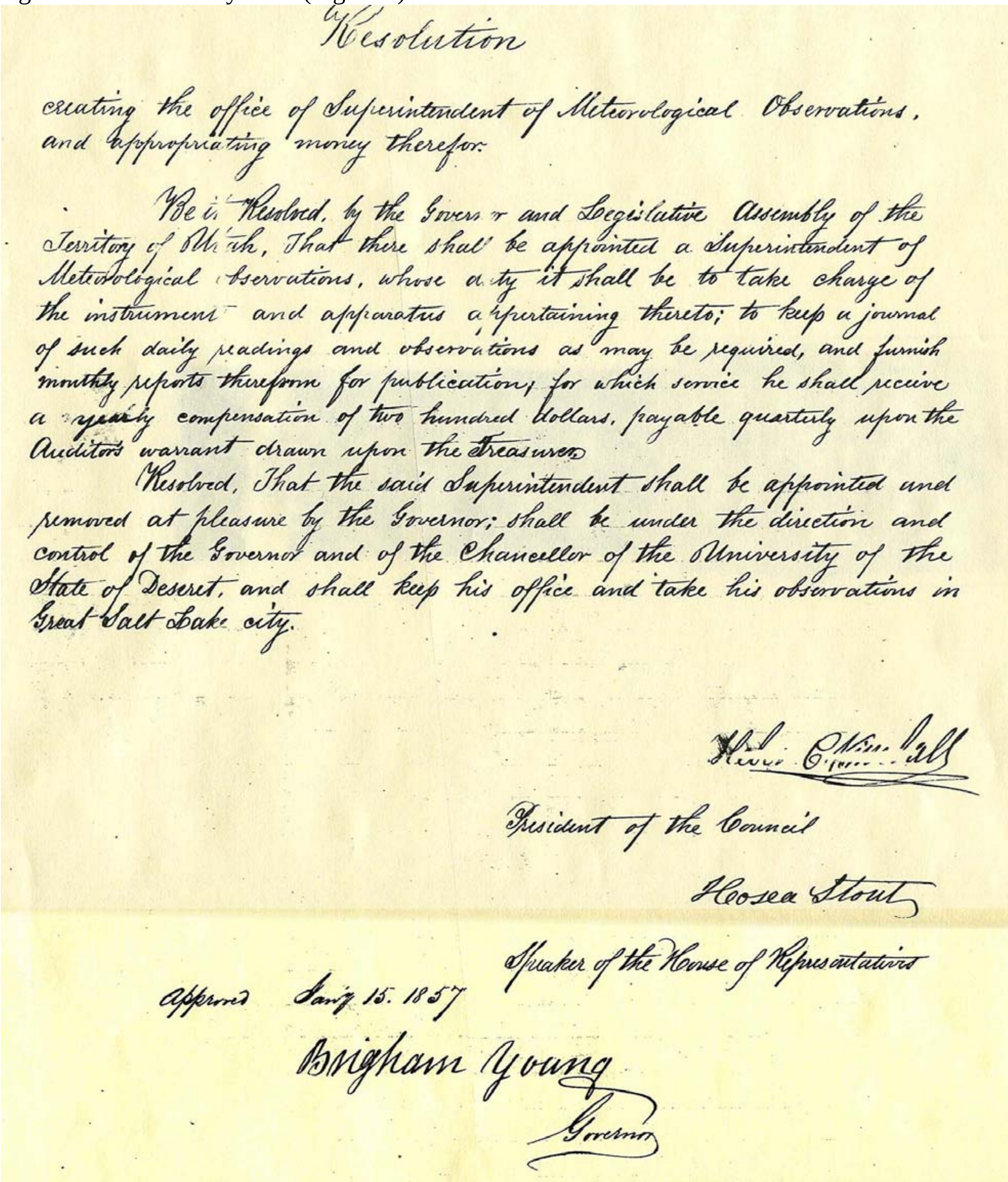
[1] Joseph Henry was the first Secretary of the Smithsonian Institution that was formed in 1847 in Washington D.C. and which would receive the weather reports

[2] William W. Phelps was Utah's second weather observer

[3] Brigham Young was the first Governor of the Utah Territory

[4] Henry E. Phelps was Utah's first weather observer

Observations and appropriated $200 per year compensation to that individual. Governor Young signed it on 15 January 1857 (Figure 1).



A Resolution

creating the office of Superintendent of Meteorological Observations, and appropriating money therefor.

Be it Resolved, by the Governor and Legislative Assembly of the Territory of Utah, That there shall be appointed a Superintendent of Meteorological Observations, whose duty it shall be to take charge of the instruments and apparatus appertaining thereto; to keep a journal of such daily readings and observations as may be required, and furnish monthly reports therefrom for publication; for which service he shall receive a yearly compensation of two hundred dollars, payable quarterly upon the Auditor's warrant drawn upon the Treasurer.

Resolved, That the said Superintendent shall be appointed and removed at pleasure by the Governor; shall be under the direction and control of the Governor and of the Chancellor of the University of the State of Deseret, and shall keep his office and take his observations in Great Salt Lake city.

Heber C. Kimball

President of the Council

Hosea Stout

Speaker of the House of Representatives

Approved Jany 15. 1857

Brigham Young

Governor

Figure 1. Resolution by the Utah Territory's Legislature 15 January 1857
Source: Territorial Legislative Records 1851—1894, Utah Historical Society

Just two weeks later, Henry Phelps entered the first observations from Salt Lake City and, at the end of February, submitted the completed form to the Smithsonian Institution. He signed as Superintendent of Meteorological Observations (Figure 2). Thus began the long record of weather observations in the City.

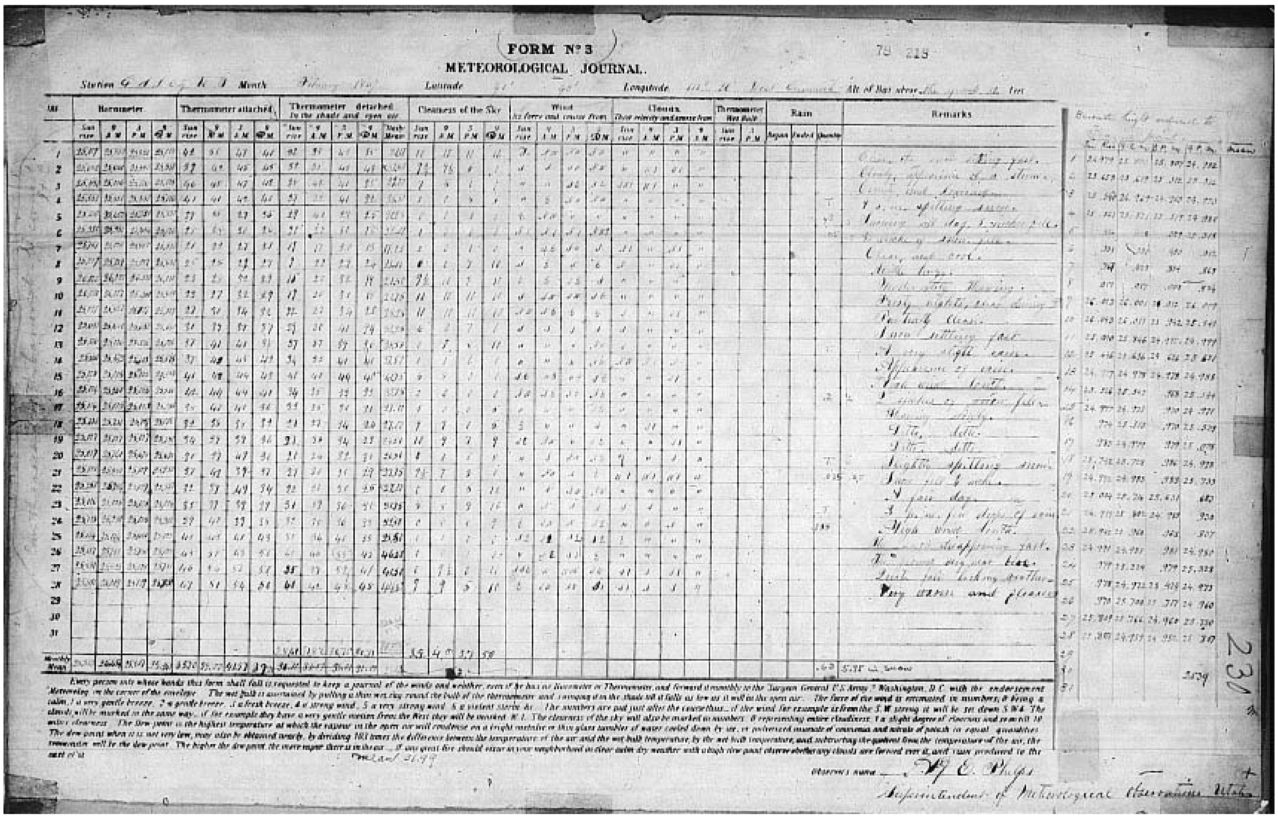


Figure 2. First Salt Lake City Observations February 1857
Source: National Climatic Data Center

The Location

The observations began in what was then a relatively small city. When one stands amid the current city that fills the valley for as far as the eye can see and whose population now exceeds 800,000, the small town nature of the 1857 city is difficult to imagine. That town had not yet been significantly affected by the warming that accompanies increased population and modern city structures. The sources of that warming such as pavement, sidewalks, masonry buildings, and canyon-like streets were yet to come (Figure 3).

Figure 3. Salt Lake City 1857
Source: Illustrated London News 2 January 1858

The Record

One hundred forty eight years of climate observations by well-qualified and dedicated observers are available to researchers who wish to study Utah's climate. Members of the National Weather Service continue recording and preserving Salt Lake City's climate.

Goal of the Study

The goal of this study was to document the weather observational history of Salt Lake City, Utah. The climatic data, and information from the observations made there, are readily available for the entire period of record. They may be accessed through the National Climatic Data Center, the Western Regional Climate Center, and the State Climatologist of Utah. The challenge of this study was to identify Salt Lake City's role in the development of a federal weather observational program and where it fit in the route that followed from the Utah observers' first efforts as Smithsonian Institution volunteers, through the Signal Service Observer Sergeants and the Weather Bureau meteorologists, to the current National Weather Service Forecasters and their extensive observational and forecast network of today.

LOCATION OF OBSERVATIONS

Latitude, Longitude, and Elevation

Smithsonian Observation Sites

The location of the first observations in 1859 was given as 40˚ 45' N and 111˚ 56' W of Greenwich.

In May 1872, it was listed at 40˚ 46' N and 111˚ 53˚ W at 4,000 feet.

Signal Service Observation Sites

In July 1872, the location was 40˚ 42' 44" N and 111˚ 56' 24" W at an elevation of 4,200 feet above mean sea level (MSL).

In January 1873, the location was 40˚ 42' 44" N and 111˚ 26' 36" W at an elevation of 4,200 feet above mean sea level (MSL).

In February 1873, the location was 40˚ 46' N and 111˚ 53' W at an elevation of 4,000 feet MSL.

In May 1873, the location was 40˚ 42' 44" N and 111˚ 26' 34" W at an elevation of 4,200 feet above mean sea level (MSL).

19 Mar 1874, the position was 40˚ 46' N and 111˚ 54' W at an elevation of 4,310 feet MSL. According to the Weather Bureau's Form 530-1 dated 27 December 1855, the latitude and longitude did not change throughout the remainder of the downtown observations[5]. Those ended on 1 November 1973 when the station was closed.

Street Addresses

The first four observers made observations in the downtown area. The first two observers were a father-son team who lived and worked at the same address. That was at the corner of 1st South and West Temple Streets. The son, Henry Phelps, was the first observer from February 1857 to August 1858. The father, W. W. Phelps then submitted the reports until June 1872.

The third observation site was the home of Thomas Bullock who lived diagonally across West Temple Street from the Phelps home. He substituted for W. W. Phelps in June 1872 and for E. L. T. Harrison in January, May, and June 1873. Bullock noted in his January 1873 report that the observation location was "Block SW of Railroad Depot."

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[5] In November 1884, the location was 40˚ 46' 08" N and 112˚ 06' 08" W at an elevation of 4,200 feet above mean sea level (MSL) on other records.

The fourth location was the home of E. L. T. Harrison who lived on East Temple between 1st South and South Temple Streets. His approximate location is shown on the map below (Figure 4). In 1890, he lived at 79 West First South Street.

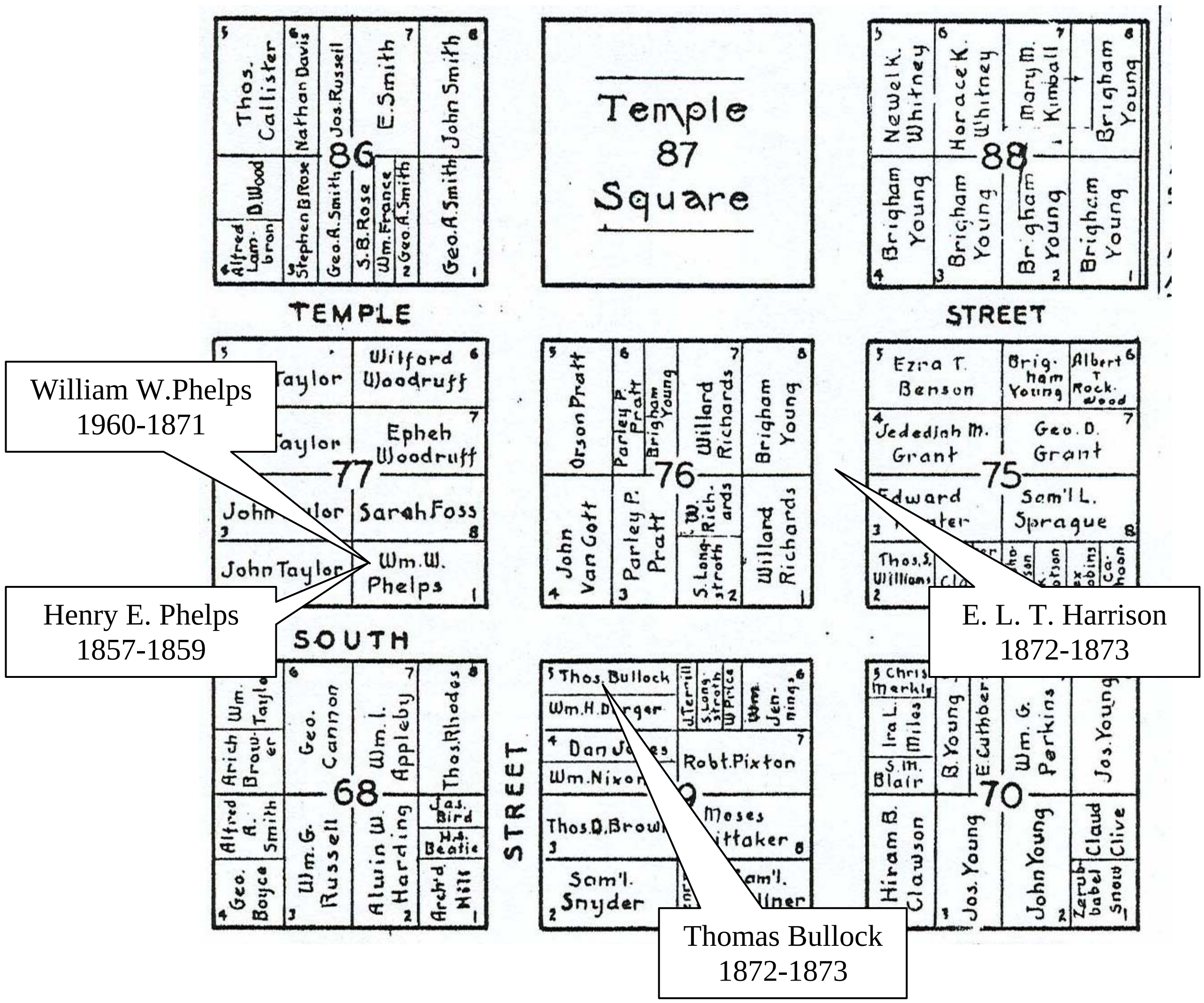

Figure 4. Downtown Location of Smithsonian Institution Observers
Source: Base Map from Utah State Historical Society

Observation Sites

The location of the observation sites in the downtown area changed over the years when the Signal Service began observations in Salt Lake City. Their first office opened on 19 March 1874. There were two important criteria for selecting a location. First and foremost, there had to be convenient access to the telegraph. That dictated that the site be in a railroad city because of the collocation of the rail and telegraph lines. Salt Lake City was such a city. Second, the preferred site for observations was the top of a tall building where wind data could be collected, reasonably unperturbed by other buildings. Salt Lake City had several such buildings. Figure 5 shows the post-Smithsonian locations of the Signal Service and the Weather Bureau.

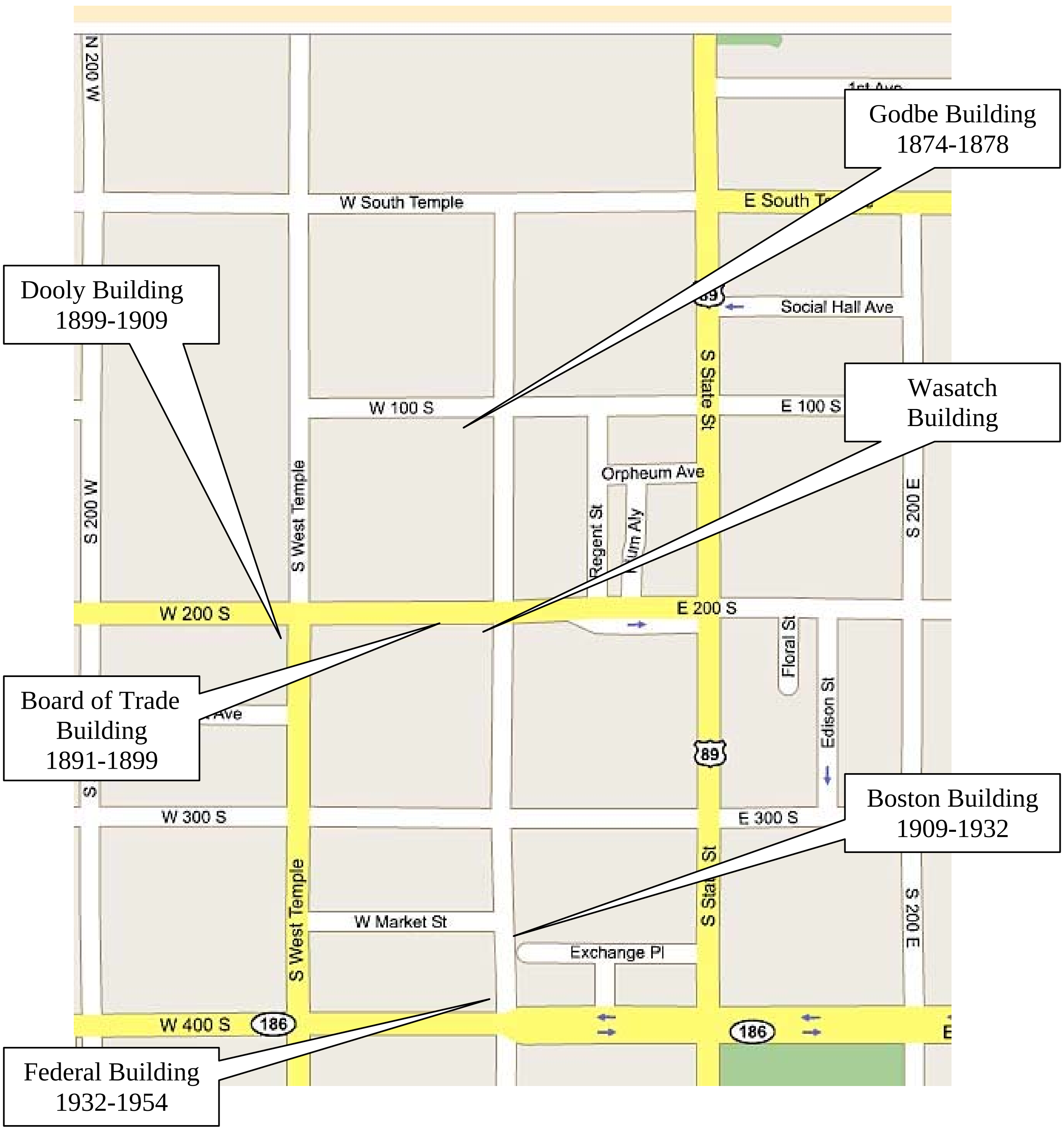

Figure 5. Post Smithsonian Observation Locations
Source: Author Plots Over Google Map

The first Signal Service site was on the roof of the Godbe-Pitts Building (Figure 6) at the southeast corner of Main and 1st South Street beginning on 19 March 1874. Note the weather vane on the roof. The office (Figure 7) was on the 3rd Floor. Both the Post Office and the Telegraph Office were within one block.

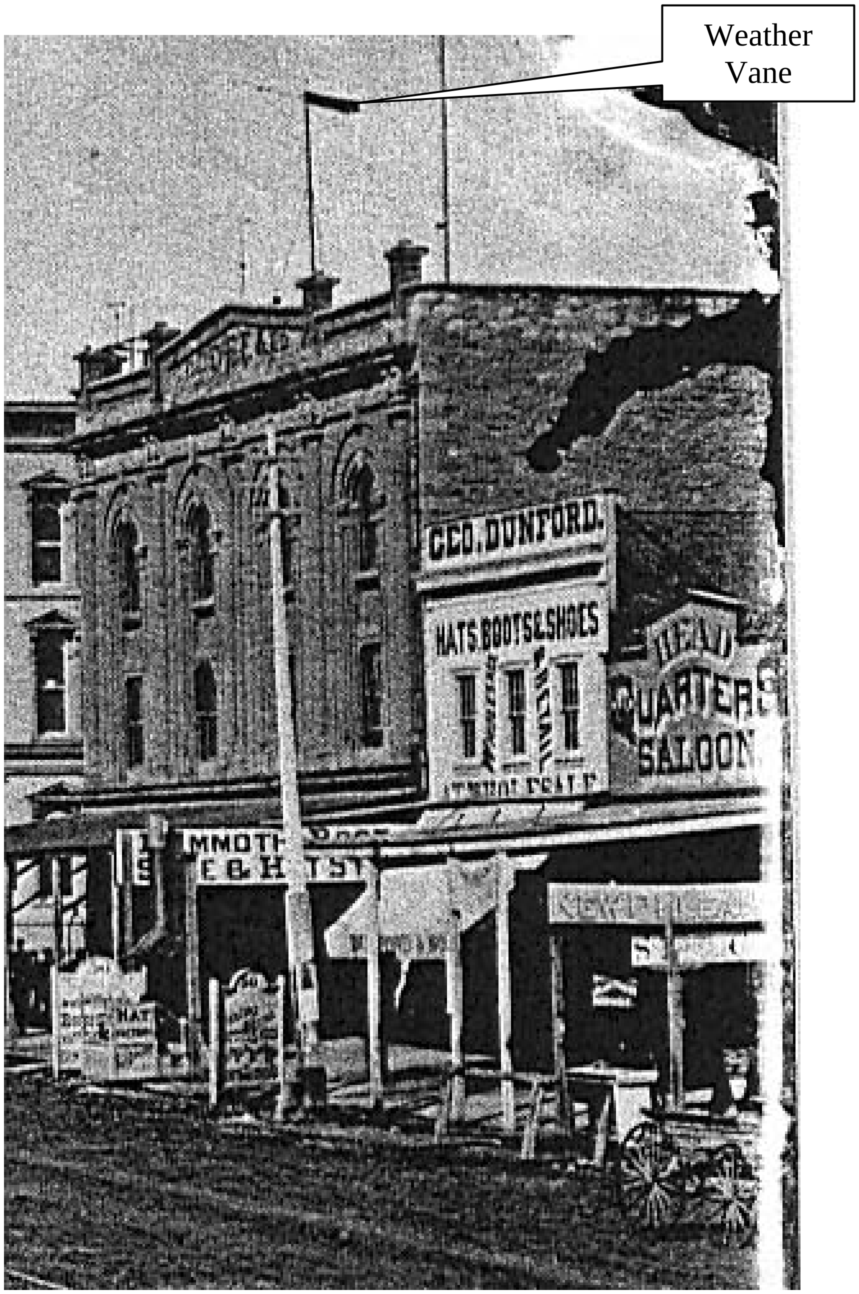

Figure 6. Godbe Building, Observation Site 1874-1876
Source: Utah Historical Society, J. Cecil Alter Collection

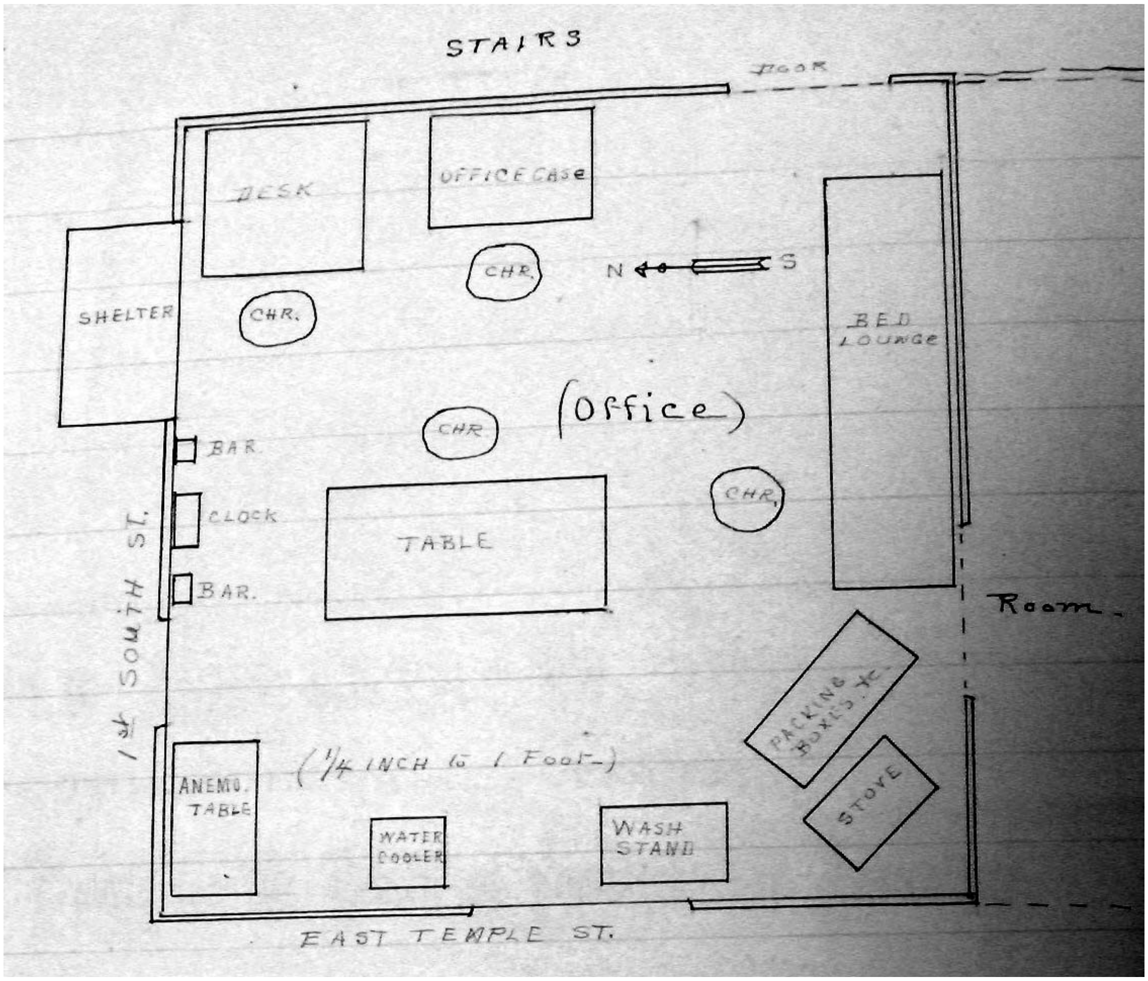

Figure 7. Office Layout 1874
Source: National Archives and Records Administration

The office was typical for the era. There was a bed and a washstand for the observer who probably lived there as well as worked there. The window shelter was in a north-facing window overlooking 1st South Street.

The roof area above the office (Figure 8) was used as the location of the rain gauge and the anemometer.

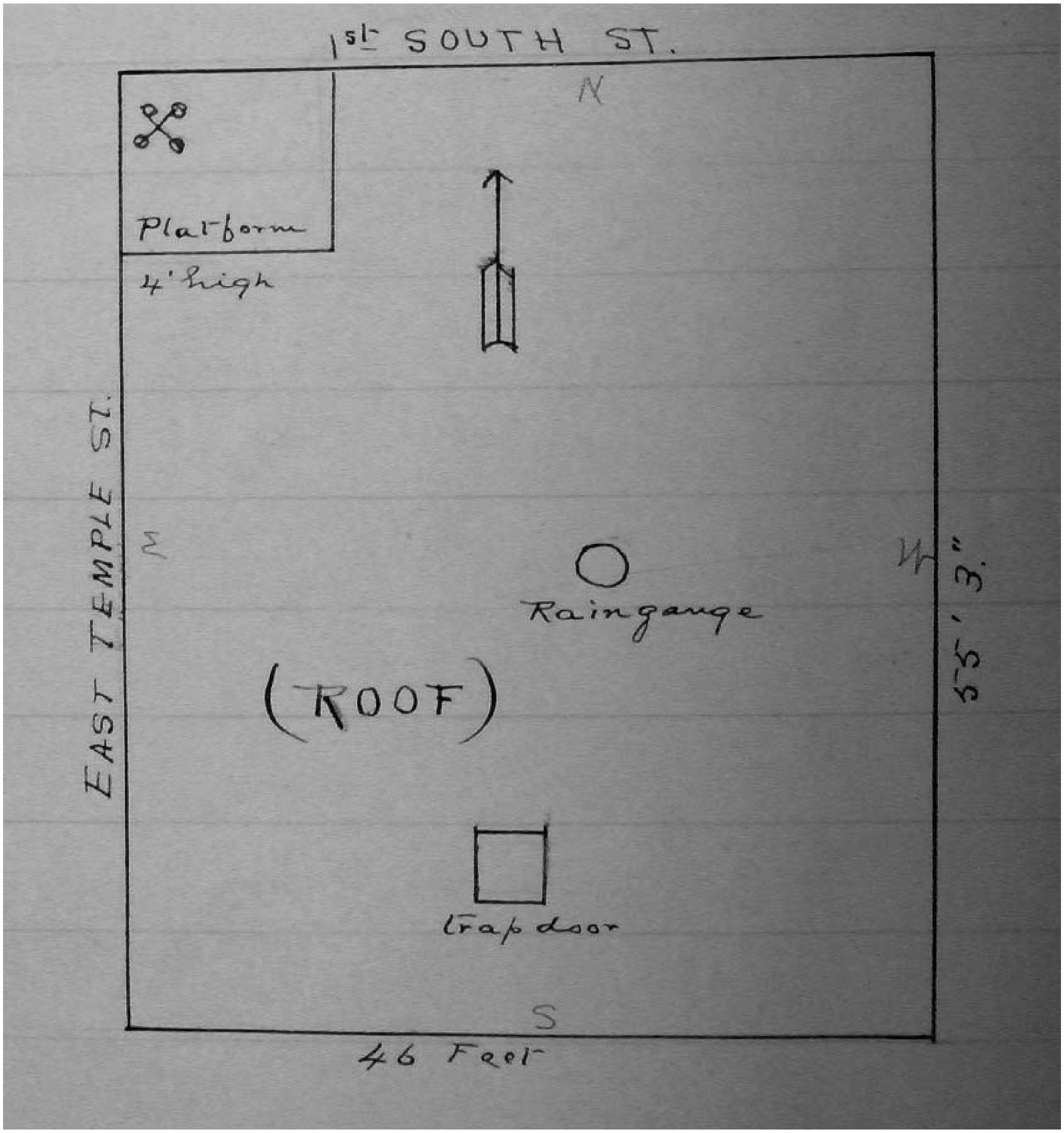

Figure 8. Roof Layout 1874
Source: National Archives and Records Administration

On 29 June 1876, the site was moved to the Wasatch Hotel (Figure 9) on the Southeast corner of Main and 2nd South Street. The Wasatch Hotel Building was a four-story brick building with an attic. It was described as the best location in the city and was within a block of the Western Union Telegraph office, an important criterion.

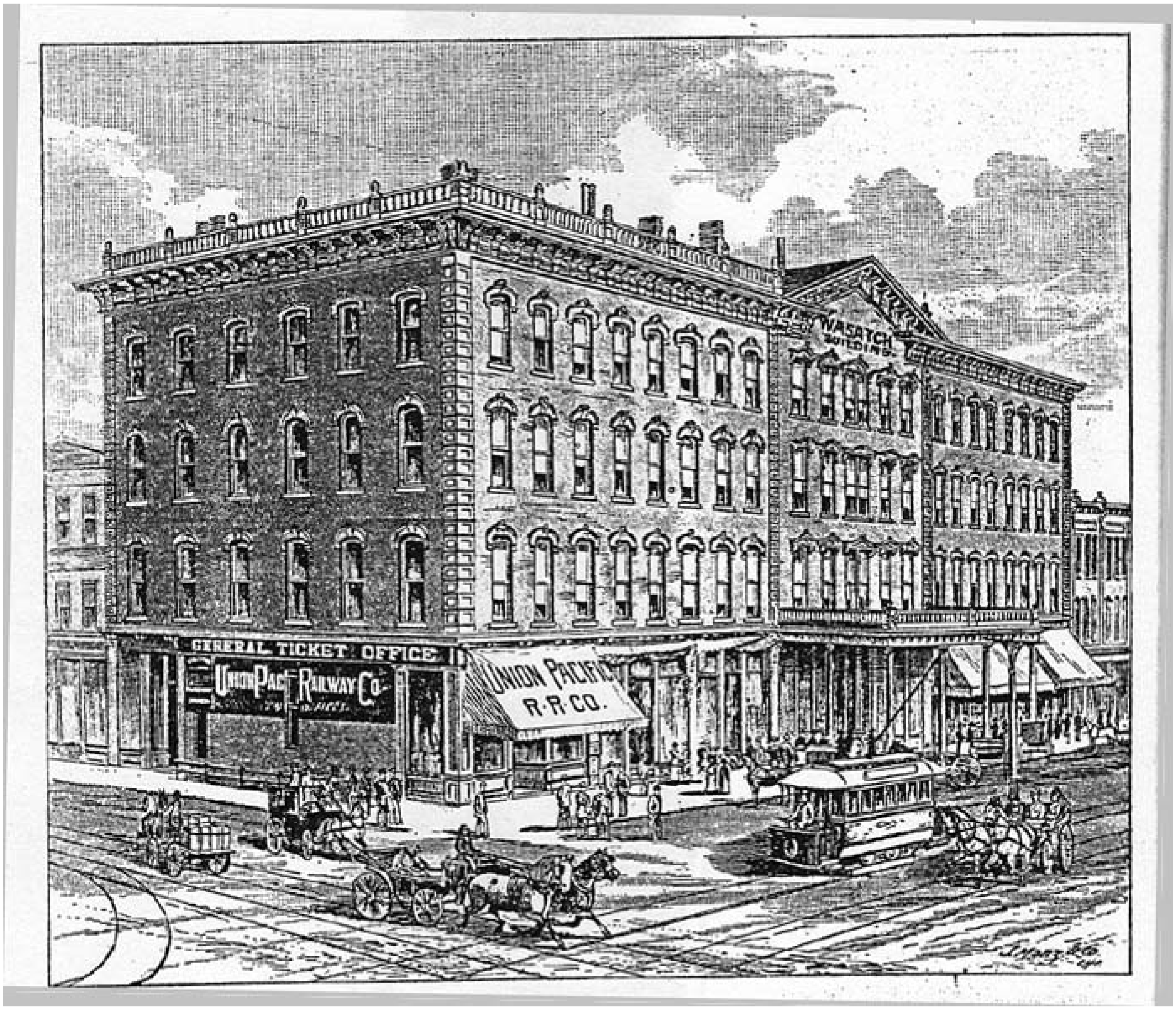

Figure 9. Wasatch Building, Observation Site 1876-1891
Source: Utah, Her Cities, Towns, and Resources

The fourth floor (top floor) office occupied rooms 114, 115, and 117 providing more space as shown in an inspector's drawing from 1878 (Figure 10). The office was still furnished as living quarters for the observer.

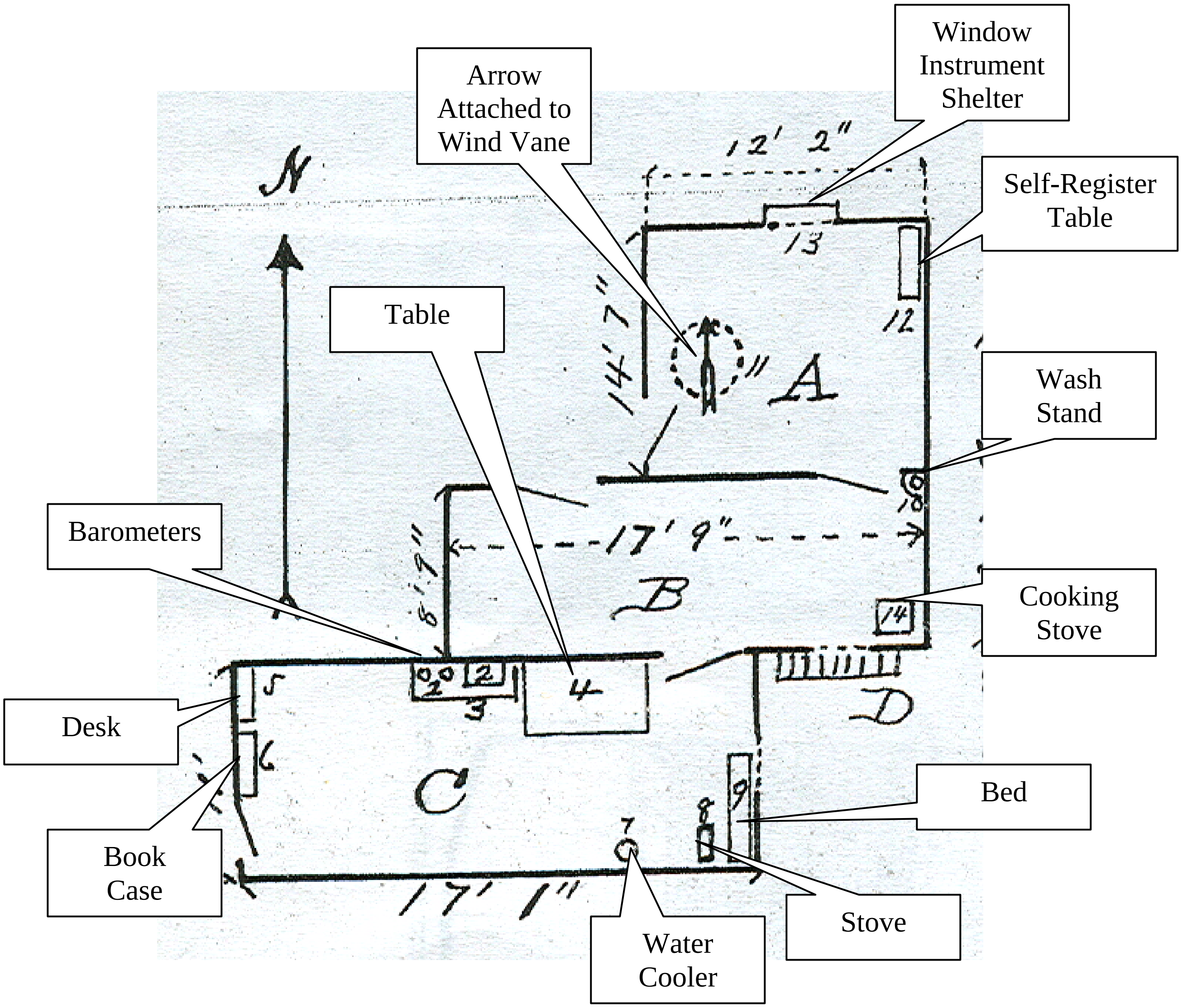

Figure 10. Office Layout 1878, Wasatch Hotel Building
Source: National Archives and Records Administration

There was a problem on the roof of the Wasatch Building. There was a ridge (Figure 11) that was a cause for concern to the Inspector who visited in 1887. He noted that the rain gauges were on a platform that was located on the west side of the roof ridge in an area that was “surrounded by high chimneys.” The tops of the gauges were at least five feet lower than the level of the ridge and ten feet away horizontally. The gauges were sheltered by the ridge when the wind was from the east.

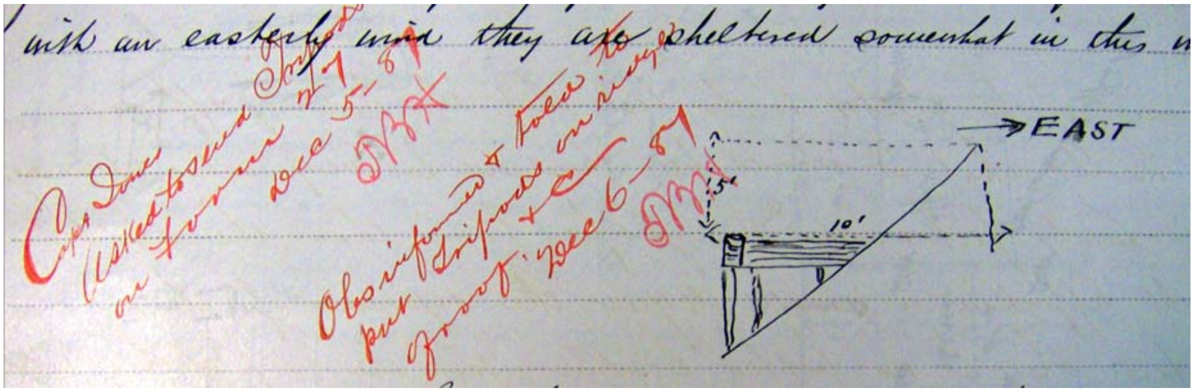

Figure 11. The Ridge Problem
Source: National Archives and Records Administration

The Inspector recommended a solution. He suggested that a platform be built to straddle the ridge at a point directly east of the anemometer (Figure 12). That suggestion was implemented on 2 April 1878.

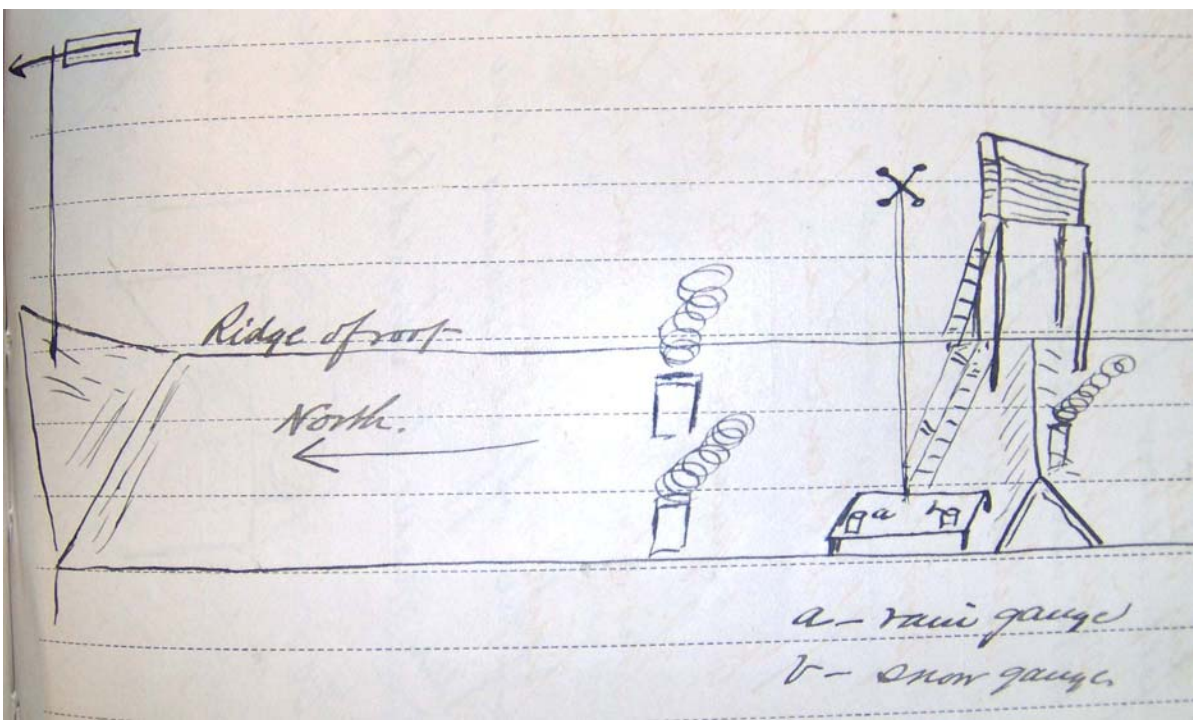

Figure 12. The Ridge Solution
Source: National Archives and Records Administration

Subsequently, other Inspectors had other opinions. In November 1887, one Inspector reported that the gauges were not properly exposed. He described the shelter in the center of the roof, the wind vane on the northeast corner of roof, and the rain and snow gauges mounted on the ridge of the roof midway between the shelter and the west edge of the roof. They had been moved since the last inspection and raised by three feet. But now, the instrument shelter was interrupting winds from the southeast and affecting the anemometer. They recommended raising the vane by six feet.

The observation site was moved to the Board of Trade Building at 154 West 2nd South Street on 31 July 1891. The office was on the 5th Floor of that building (Figure 13) in rooms 50, 51 and 52.

Figure 13. Board of Trade Building, Observation Site 1891-1899
Source: Utah Historical Society

On 15 March 1899, The Weather Bureau Office was moved to the Dooly Block, at the Southwest corner of West Temple and 2nd South Street. The Office was on the 6th Floor of the building (Figure 14) and occupied three rooms, rooms 601, 628, and 629. The Post Office was in the same building and the Telegraph Office was one and a half blocks away. Weather flags were flown from the staff on the roof. In 1902, the office was described as having walls and ceilings discolored by smoke. That was probably a common problem from heating with coal burning stoves.

Figure 14. Dooly Block, Observation Site 1899-1909
Source: Utah Historical Society

The Boston Building (Figure 15) was the next home for the Weather Bureau. It was situated on the Northeast corner of Main Street and Exchange Place. They occupied rooms 1103, 1104, 1105, 1106, and 1107 on the 11^{th} Floor on 1 July 1909. This building was directly opposite the Post Office and two blocks from the Telegraph Office. Weather flags were displayed on a staff on the roof. From that lofty spot they probably could be seen over most of the downtown area.

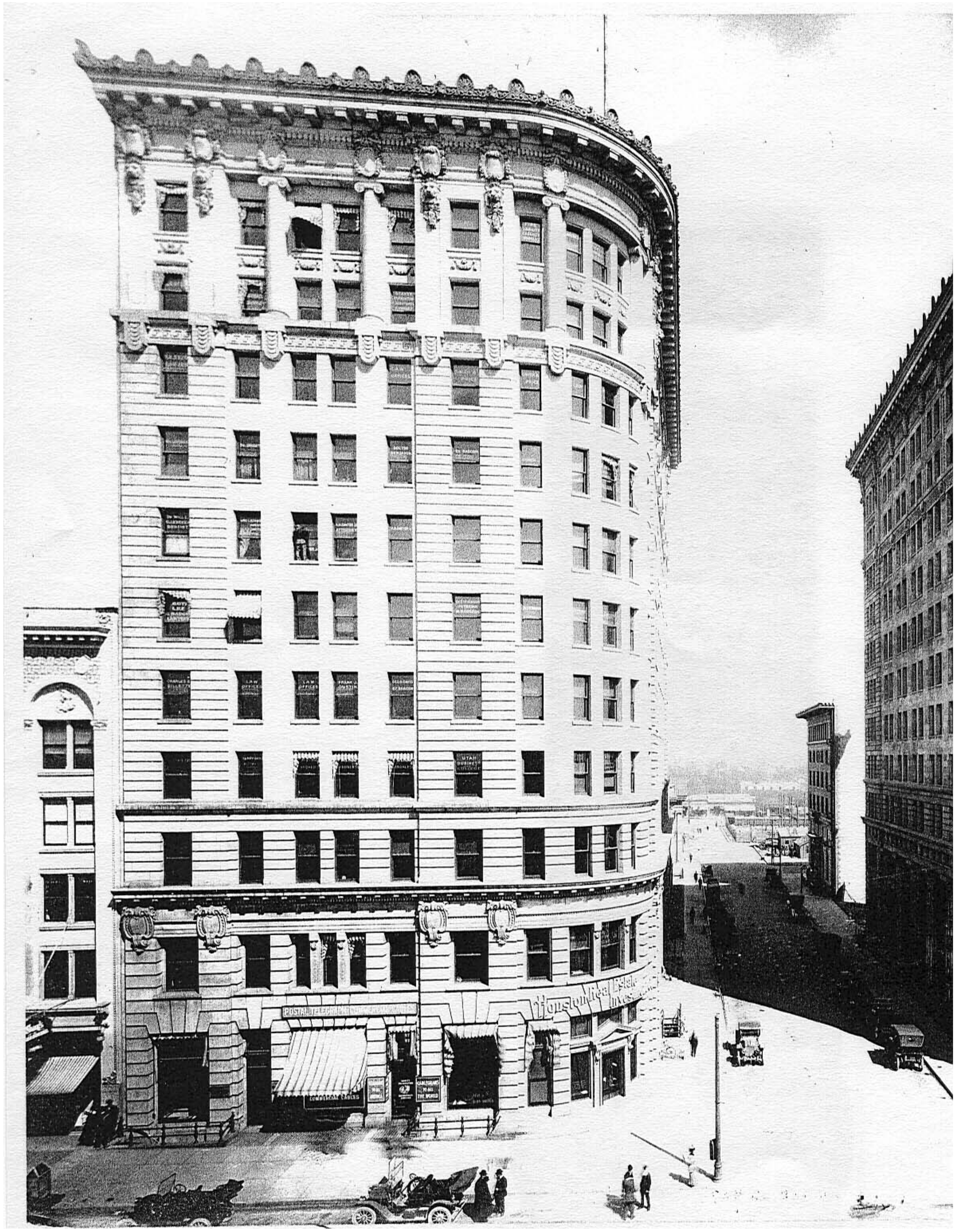

Figure 15. Boston Building, Observation Site 1909-1932
Source: Utah Historical Society

The 501 Federal Building (Figure 16) located at the Northwest corner of Main and 4th South Street was the next location of the Weather Bureau offices. The move was completed on 1 December 1932. They occupied four rooms and also had a storeroom. Note the instrument shelter visible on the roof.

Figure 16. Federal Building (Post Office), Observation Site 1932-1973
Source: Utah Historical Society

The climate office at Salt Lake City employed several people who worked to collect and analyze the data being received and to compile it for future use. Most current offices compartmentalize their rooms into cubicles with six-foot dividers to prevent intercommunication among employees. The photograph in Figure 17 shows the Salt Lake City Climatological Office from an era before cubicles.

Figure 17. The Climatological Office, Salt Lake City
Source; J. Cecil Alter Album, National Archives and Records Administration

One important aspect of the Weather Bureau offices was the printing of weather maps. Those daily maps were a popular product of the office. Figure 18 shows the printer and his printing press from the Salt Lake City Office.

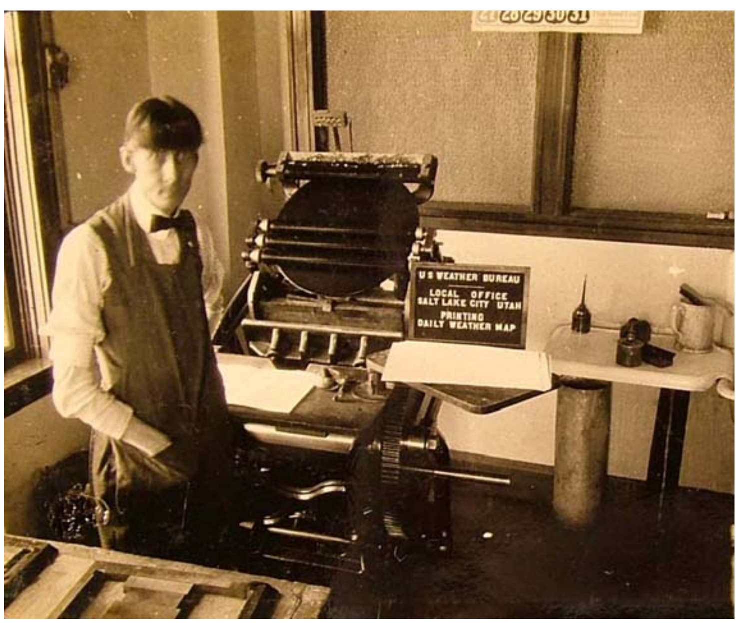

Figure 18. The Printer at Salt Lake City
Source; J. Cecil Alter Album, National Archives and Records Administration

The office remained at this location until it was closed on 1 November 1973 and the building torn down. However, all instruments except the rain gauge had been removed and the Weather Bureau office closed on 15 August 1954.

Environment

One of the Signal Service Inspectors drew a map of the physical environment around the Salt Lake City weather station in 1886 (Figure 19). Although a simple drawing, it gives the feel for the major features and size of the Salt Lake Valley.

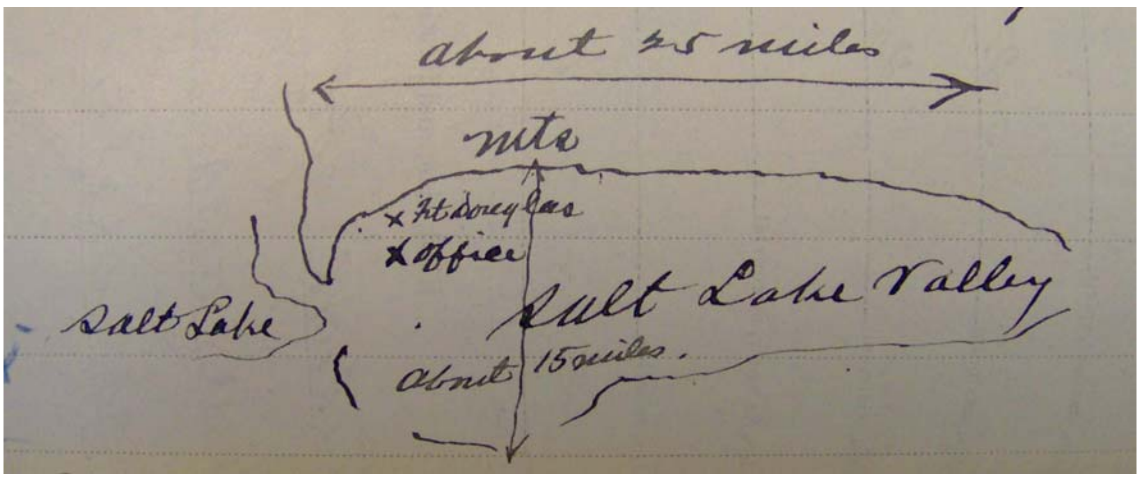

Figure 19. The Salt Lake City Environs 1886
Source: National Archives and Records Administration

The inspector who made the drawing also described the station’s environment.

> On the east from N to S is a range of mountains 3 or 4000 feet high one mile distant north 3 miles east & thence extending south 25 miles making a circle around the great salt lake valley and back on the west side 12 miles distant leaving the NW quadrant only one or too high buttes. Thus it can be seen that good wind observations here are impossible. No higher building in the city. Instrument shelter gives a good exposure.

The location of the observations in the downtown area of Salt Lake City presented at least two potential impacts on the observations. First, there is the well-documented urban heat island that develops as a city grows. As the size of the city increases, the temperature increases measurably. Second, because the observations were made on top of tall buildings, the wind speed increases compared to non-urban areas. The Inspector mentioned that the wind measurements were further complicated by the disruptions caused by the surrounding mountains,

Airport Observation Sites

As the importance of aviation increased, there was action to open observation sites at the major airports. This was done at Salt Lake City but the location downtown remained as a station as well. For several years, the two stations operated independently but simultaneously.

Those airport observational sites posed a different problem compared to the downtown location. The move from the warmer inner city to the expansive airport area and would likely show a reduction in temperature and wind speed.

INSTRUMENTATION

The instruments used throughout the Signal Service observation period have a good record. The Climate Record Book from the National Weather Service Office in Salt Lake City was used to document instrument numbers.

Thermometer

The thermometers on 19 March 1874 were in a window shelter and were 31 feet AGL. The Green maximum registering thermometer (Figure 20) was in standard use in the early years of the Signal Service.

Green's Maximum Registering Thermometer.

In this thermometer the maximum temperature is indicated by the mercury itself, requiring no separate index. It is mounted as follows:

Fasten the gimlet screw piece in a board or other proper support, on its extremity suspend the thermometer by its attached socket, and secure by screwing up the nut tight; at six or eight inches left of this insert in the board the plain brass pin, to serve as a second support on which the edge of the scale rests; this pin is placed a little lower than the screw piece so that the thermometer may not rest exactly horizontal, but with the bulb end about an inch lower than the other.

To set for observation, take out the pin and spin round the thermometer on its main support and replace the pin; the bulb will now be full of mercury and the column in the tube unbroken, except at a spot near the bulb, where a contraction of the bore will be seen; this stricture will not prevent the mercury passing forward on heating, but will prevent its return on cooling; in this way it will indicate the highest temperature reached since it was set. To re-set, take out the pin, spin thermometer on its support and replace the pin; in putting in pin raise the thermometer no higher than is needed to get in the pin.

Figure 20. Instructions for Green's Maximum Thermometer
Source: Thermometer Record, Cincinnati Observatory Sep 1 1882-June 30 1884

The Salt Lake City Climate Record Books record the instrument numbers and their dates of use. The record for the maximum thermometers (Table 1) is peculiar because of the frequent exchange of them, often for only a few days or a few weeks. It appears to be a procedural cause rather than one that arises from an instrument error. Note the asterisks that indicate broken thermometers, few when compared to the total number of changes made.

Table 1. Maximum Thermometers Used at Salt Lake City

	In Use	
Number	**From**	**To**
120	19 Mar 1874	17 Jan 1885
643	27 Jan 1885	24 Apr 1886
788	24 Apr 1886	14 Oct 1886
1205	15 Oct 1886	1 Nov 1893
2052A	1 Nov 1893	30 Jun 1894
3703	30 Jun 1894	1899
5362	1899	12 Nov 1903
3703	12 Nov 1903	25 Nov 1907
12135	25 Nov 1907	18 Dec 1907
12607	18 Dec 1907	2 Nov 1912
12135	28 Dec 1912	
16705		28 Apr 1913
16493	28 Apr 1913	16 May 1917
15080	16 May 1917	28 May 1917
20192	28 May 1917	1919
20194	1919	5 Dec 1920
21489	5 Dec 1920	13 Dec 1920
15080	13 Dec 1920	5 Jan 1921
22939	5 Jan 1921	4 Mar 1923
19573	4 Mar 1923	5 Jul 1924
22947	5 Jul 1924	8 Sep 1924
*25645	8 Sep 1924	1 Jan 1927
22947	1 Jan 1927	18 Jan 1927
*29164	18 Jan 1927	22 Apr 1927
22947	22 Apr 1927	24 May 1927
22487	24 May 1927	21 Oct 1927
22947	21 Oct 1927	7 Dec 1927
30346	7 Dec 1927	9 May 1929
22947	9 May 1929	7 Dec1927
*30346	7 Dec1927	9 May 1929
22947	9 May 1929	23 May 1929
32026	23 May 1929	23 Dec 1933
22947	23 Dec 1933	2 Jan 1934
32974	2 Jan 1934	9 Feb 1935
22947	9 Feb 1935	20 Feb 1935
15080	20 Feb 1935	25 Feb 1935
27913	25 Feb 1935	4 Feb 1936
28177	4 Feb 1936	13 Feb 1936
27913	13 Feb 1936	31 Mar 1936
28177	31 Mar 1936	28 Apr 1936
27613	28 Apr 1936	25 Oct 1936
38177	25 Oct 1936	4 Nov 1936
*32162	4 Nov 1936	12 Mar 1937
28177	12 Mar 1937	22 Mar 1937
*32407	22 Mar 1937	1 Jun 1937
28177	1 Jun 1937	16 Jun 1937
32413	16 Jun 1937	
*15080		19 Jun 1941
47076	7 Jul 1941	

The Green minimum thermometer (Figures 21 and 22) was in general use by the Signal Service.

Minimum Registering Thermometer.

This is an alcohol thermometer, and is supported by a brass spring piece, having at one end a screw pin to pass through a hole at the side of the scales on which it can turn, at the other end is a notch in which the lower part of the scale rests. The brass piece is screwed on a board so that the thermometer is nearly horizontal, the bulb end about an inch lower than the other. In the bore of the tube is a small black glass float for an index; this is set by lifting the bulb end of scale on its pin support, so that the index runs to the top of the spirit column, the scale then rested in the notch. On a fall of temperature the index is carried back with the spirit; on a rise, the index remains in place, the spirit only going forward; in this way the end of index farthest from the bulb indicates the lowest temperature since the last setting of thermometer.

Spirit thermometers are liable to derangement by the condensation of vapor of alcohol in the upper part of the tube, and from division of column in transportation; to rectify this, put through the hole at top of the scale a strong string, two or three feet long, and spin the thermometer round swiftly many times; keep clear of striking against anything, and all will come right. It may also be done by tapping the end of scale on a table. The thermometer being upright, the spinning is the better way.

Figure 21. Instructions for Green's Minimum Thermometer
Source: Thermometer Record Cincinnati Observatory Sep 1 1882-June 30 1884

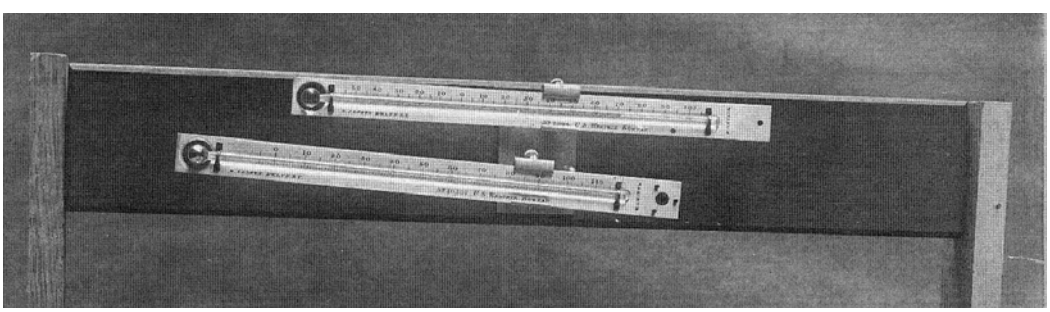

Figure 22. Green Maximum and Minimum Thermometers on a Townsend Mount
Source: National Archives and Records Administration

Table 2. Minimum Thermometers Used at Salt Lake City

	In Use	
Number	**From**	**To**
87	19 Mar 1874	17 Jan 1885
937	27 Jan1885	Mar 1885
640	Mar 1885	15 Oct 1886
937	15 Oct 1886	27 Dec 1887
1498	27 Dec 1887	9 Sep 1889
1863	9 Sep 1889	7 Oct 1889
1498	7 Oct 1889	30 Jun 1894
3076	30 Jun 1894	1898
4672	1898	18 Oct 1901
3076	18 Oct 1901	23 Apr 1902
6032	23 Apr 1902	27 Jul 1907
3076	27 Jul 1907	25 Nov 1907
8862	25 Nov 1907	16 Jul 1908
1299	16 Jul 1908	26 Nov1910
9275	26 Nov1910	13 Dec 1910
10393	13 Dec 1910	29 May 1926
9275	29 May 1926	9 June 1926
17795	9 Jun 1926	
11286	31 Jul 1933	

Table 3. Dry Thermometers Used at Salt Lake City

	In Use	
Number	**From**	**To**
3030	19 Mar 1874	Jun 1875
151	Jun 1875	27 Jan1855
1411	27 Jan1855	1 Jul 1885
2958	1 Jul 1885	14 Oct 1886
1411	14 Oct 1886	14 Jul 1887
2122	14 Jul 18871	1 Nov 1893
2217	1 Nov 1893	17 Nov 1894
3443	17 Nov 1894	30 Oct 1903
4318	30 Oct 1903	
5898		24 Mar 1916
4066	24 Mar 1916	16 Feb 1923
6010	16 Feb 1923	4 Mar 1923
6768	5 May 1926	29 May1927
6010	29 May1927	13 Jun 1927
8758	13 Jun 1927	27 Feb 1930
6810	27 Feb 1930	10 Mar 1930
9889	10 Mar 1930	

The wet bulb thermometers used at Salt Lake City are shown in Table 4. The asterisks indicate instruments known to have been broken.

Table 4. Wet Thermometers Used at Salt Lake City

	In Use	
Number	**From**	**To**
62	19 Mar 1874	26 Nov 1881
1067	26 Nov 1881	27 Jan 1885
1414	27 Jan 1885	Jul 1885
146	Jul 1885	10 Oct 1876
1414	10 Oct 1876	14 Jul 1887
2127	14 Jul 1887	10 Nov 1890
942	10 Nov 1890	1 Nov 1893
2221	1 Nov 1893	30 Jun 1894
3379	30 Jun 1894	17 Oct 1894
3566	17 Oct 1894	1 Jan 1900
3946	1 Jan 1900	30 Oct 1903
3448	30 Oct 1903	
5748		17 Nov 1911
5969	17 Nov 1911	Feb 1913
3379	Feb 1913	24 Jul 1914
5878	24 Jul 1914	14 Jun 1917
7303	14 Jun 1917	17 Apr 1918
5697	17 Apr 1918	13 Nov 1822
7714	13 Nov 1822	4 Dec 1922
8429	4 Dec 1922	13 Nov 1924
7714	13 Nov 1924	25 Nov 1924
12379	25 Nov 1924	2 Jan 1928
7714	2 Jan 1928	31 Mar 1928
8868	31 Mar 1928	18 Dec 1928
7714	18 Dec 1928	12 Nov 1929
8868	12 Nov 1929	26 Nov 1929
9855	26 Nov 1929	16 Jan 1930
8868	16 Jan 1930	4 Feb 1930
9829	4 Feb 1930	29 Dec 1930
8868	29 Dec 1930	9 Jan 1931
*11092	9 Jan 1931	29 Nov 1931
8868	29 Nov 1931	14 Dec 1931
*11443	14 Dec 1931	11 Feb 1933
8868	11 Feb 1933	24 Feb 1933
*11423	24 Feb 1933	1 Jan 1934
8868	1 Jan 1934	29 Jan 1934
*11587	29 Jan 1934	22 Oct 1935
8868	22 Oct 1935	5 Nov 1935
*15337	5 Nov 1935	25 Jan1938
*7682	25 Jan1938	17 Feb 1938
8868	17 Feb 1938	9 Mar 1938
18081	9 Mar 1938	

Barometer

Barometer # 1704 was placed into use on 19 March 1874 (Table 5). It was at 4,030 feet MSL and 29 feet 4 inches AGL. The Green Barometer (Figure 23) was in widespread use at that time.

Table 5. Barometers Used at Salt Lake City

Number	In Use From	In Use To
1704	19 Mar 1874	27 Oct 1874
1888	27 Oct 1874	1 Jan 1875
1861	1 Jan 1875	1 Jun 1875
262	1 Jun 1875	31 Jan 1882
1861	31 Jan 1882	1 Jan 1887
480	1 Jan 1887	1 Jul 1887
546	1 Jul 1887	1 Jan 1889
2000	1 Jan 1889	1 Jul 1893
546	1 Jul 1893	1 Aug 1896
2000	1 Aug 1896	25 Nov 1896
546	25 Nov 1896	1 Jan 1897
499	1 Jan 1897	

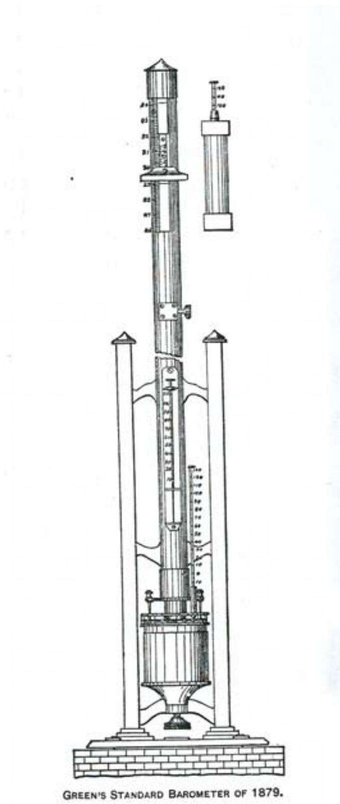

Figure 23. Green Standard Barometer 1879
Source: National Archives and Records Administration

Triple Register

The Triple Register (Figure 24) was an electrical device that recorded three elements of the weather: the direction and velocity of the wind each minute, the amount of rainfall as it fell, and the accumulated hours and minutes of sunshine. The information was recorded by pens on graph paper wrapped around a drum that rotated once per week. The working parts of the Triple Register were made of brass and the unit was covered by a glass case to protect the device from dust. It was quite an impressive part of the meteorologist's equipment.

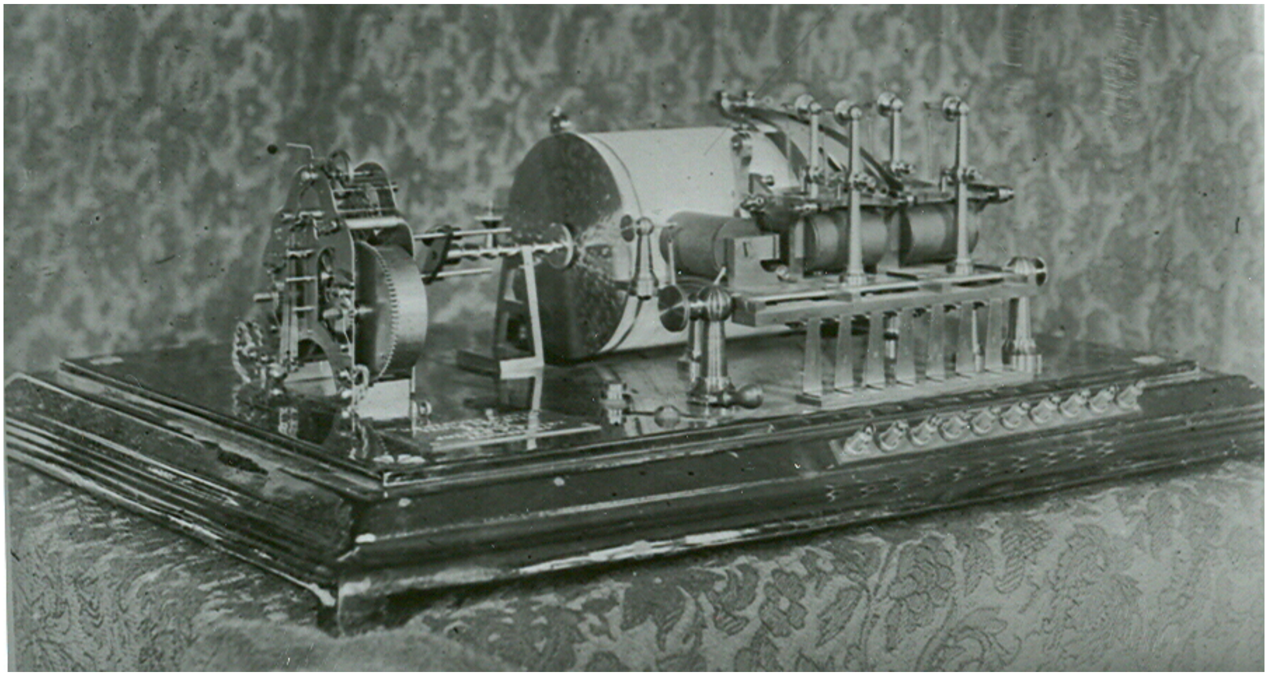

Figure 24. Triple Register, Salt Lake City
Source: Utah Historical Society, J. Cecil Alter Collection, C-1602, Box 1

Wind was measured in two ways. A wind vane that was mounted on the roof determined the wind direction. It swiveled toward the direction from which the wind came. Also mounted on the roof were the anemometer cups. The wind rotated those cups that in turn rotated the shaft to which they were attached. Each time the shaft rotated 500 times, one mile was added to the "total miles run." That total was displayed on a dial like the one shown in Figure 25. That is to say, the dial displayed the total number of miles of air that had passed since the anemometer dial was reset. Both the wind direction and the wind speed were electrically connected to the triple register were they were registered on the Triple Register's graph. The difference between the miles run dial and its earlier reading could be divided by the elapsed hours to determine the average wind speed for the period.

Figure 25. Total Miles Run Dial
Source: Author

The triple register also recorded sunshine. The sensor was a glass tube with a large bulb at either end (Figure 26). It was normally located on the roof. One end was clear, the other coated with lampblack. The tube was partially filled with mercury. In the middle of the tube were two wires. When exposed to sunshine, the lampblack would absorb solar radiation causing the mercury to expand and cover the ends of the two wires. The electrical circuit between the two wires would be completed. That connection would be recorded on the triple register until cooling (as the sunshine ended) caused the mercury to contract and uncover the two wire ends thus breaking the connection.

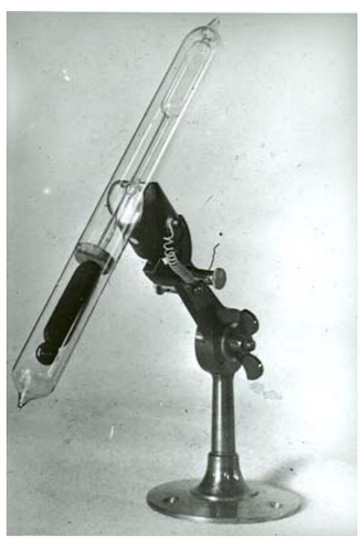

Figure 26. Sunshine Recorder, Salt Lake City
Source: Utah Historical Society, J. Cecil Alter Collection, C-102 Box 1

Rain Gauge

From 19 March 1874 to 1 July 1899, an ordinary brass gauge 20 inches in length and 2.53 inches in diameter with an 8 inch diameter funnel, was used. From 1892 to 1 July 1899, a Marvin Float gauge #27 was used at least part of the time. There is no record of whether or not it was used as an official gauge. After 1 July 1899, a self-registering tipping bucket rain gauge (Figure 27) with a 12 inch diameter was used.

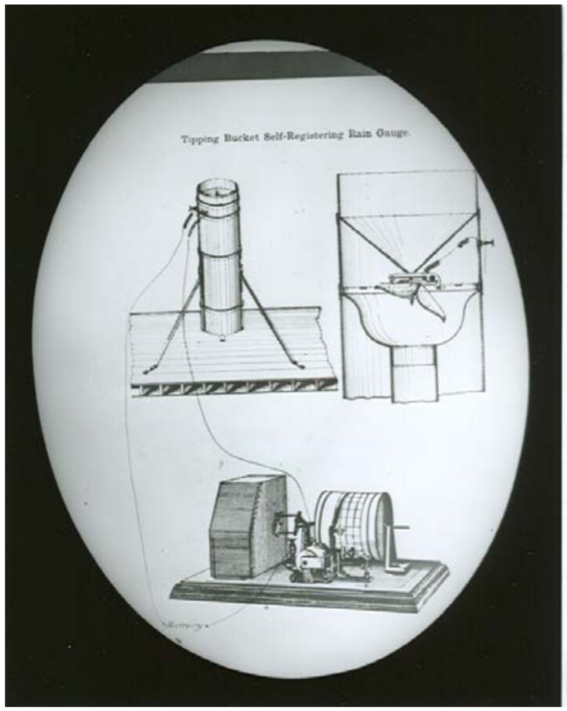

Figure 27. Self-Registering Tipping Bucket Rain Gauge
Source: Utah Historical Society, J. Cecil Alter Collection, C-102 Box 1

From 19 March 1874 to 28 June 1876, gauge was on the roof of the Godbe building at an elevation of 65.4 feet AGL. On the Wasatch Hotel roof, the gauge was at 78.7 feet AGL. Various Inspectors gave that elevation as 77.0 and 77.5 but there was no actual change in location. On the Board of Trade Building, the gauge was at 75.5 feet AGL. The gauge on the roof of the Dooly Building was at 96.8 feet AGL.

A tipping bucket rain gauge (Figure 28) was mounted on the roof. A funnel directed rainfall into a small “bucket” on one end of a seesaw like device. The seesaw tipped when the bucket filled with one hundredths of an inch of rain. The tipping emptied that bucket and placed the bucket at the other end of the seesaw under the funnel to be filled next. Each time the buckets tipped, an electrical signal marked another 0.01” of rain on the triple register.

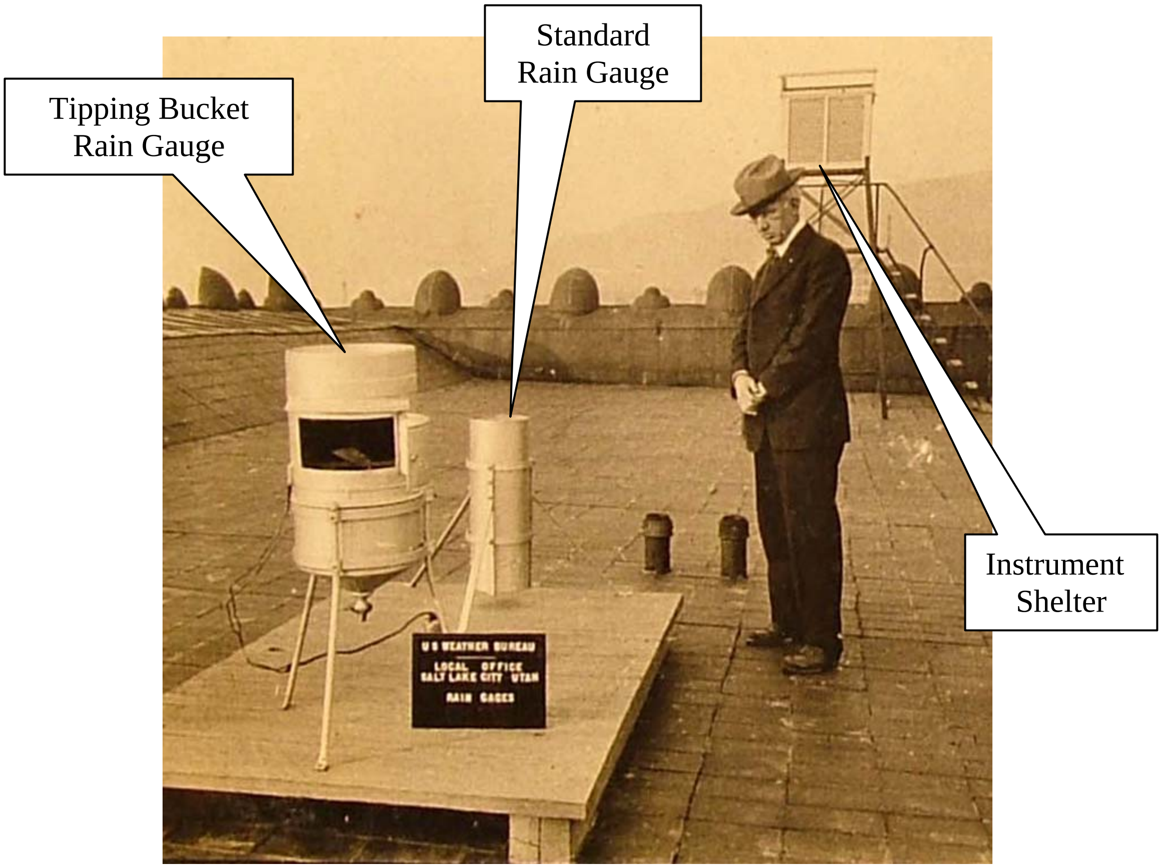

Figure 28. Weather Bureau Rain Gauges, Salt Lake City
Source: J. Cecil Alter Album, National Archives and Records Administration

The rain gauge site was changed 1 April 1935 from the rain gauge platform, top of gauge 84 feet AGL.

A new tipping bucket gauge was installed at 3:22 p.m. 11 September 1940. The tipping bucket was discontinued on 1 December 1941. A Friez automatic recording weighing rain and was installed on the roof of the Federal Building at 84 feet AGL on 16 November 1940.

Anemometer

The vane was located on the roof in 1874. The rod from the vane extended down through the ceiling into office allowing wind direction to be read without going outside.

The Weather Bureau's anemometer was mounted on a tower (Figure 29) on the roof of the Federal Building.

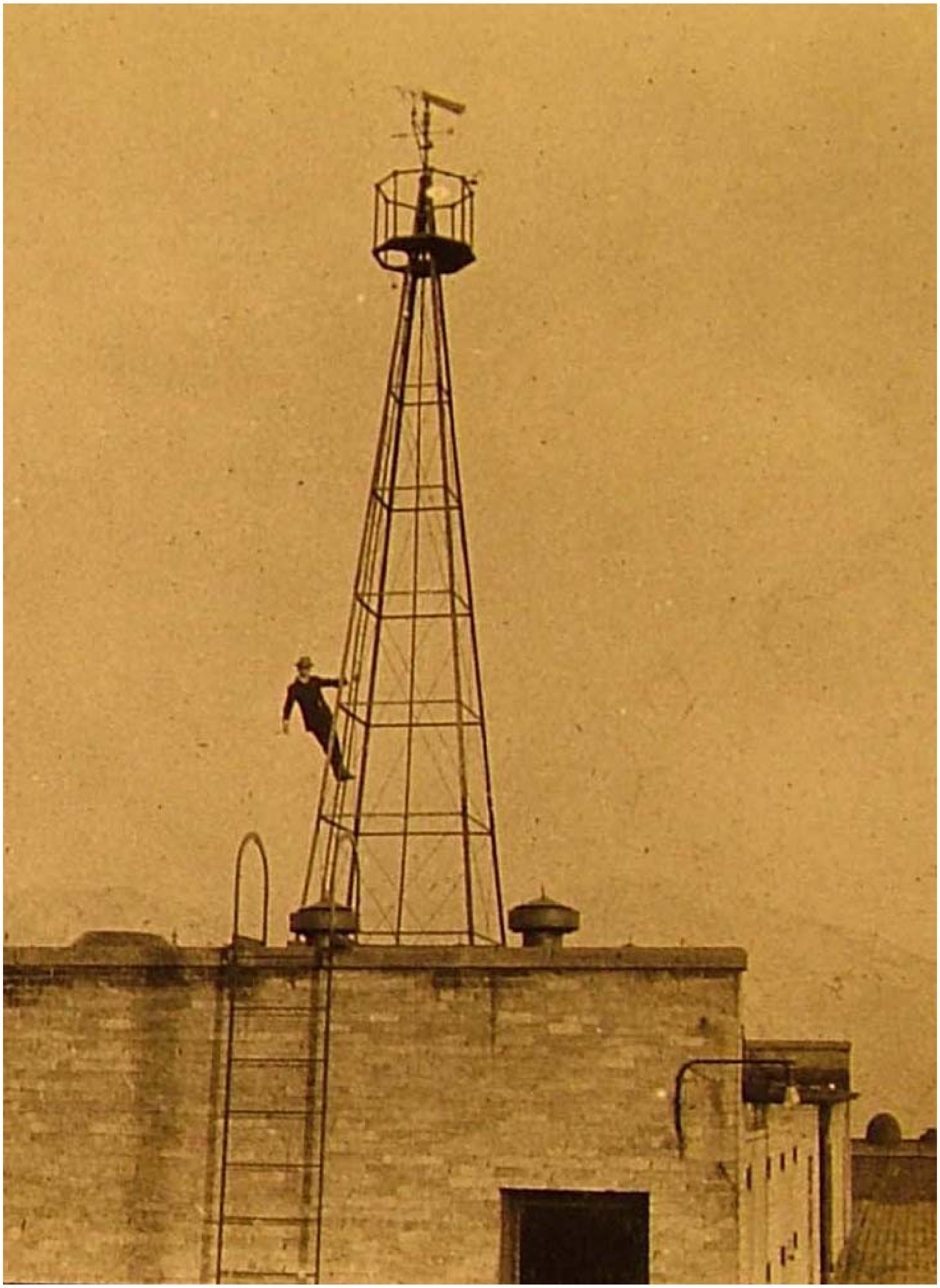

Figure 29. Wind Tower with Anemometer and Vane at Salt Lake City
Source: J. Cecil Alter Album, National Archives and Records Administration

Table 6. Anemometers Used at Salt Lake City

	In Use	
Number	**From**	**To**
76	19 Mar 1874	18 Dec 1876
188	18 Dec 1876	1 Oct 1883
444	1 Oct 1883	11 Jun 1885
234	11 Jun 1885	20 Nov 1887
414	20 Nov 1887	31 Jan 1888
368	31 Jan 1888	22 Jun 1888
414	22 Jun 1888	1 Nov 1891
634	1 Nov 1891	19 Mar 1900
592	19 Mar 1900	16 Mar 1901
661	16 Mar 1901	2 May 1901
842	2 May 1901	1 Sep 1906
322	1 Sep 1906	18 Feb 1909
569	18 Feb 1909	15 Mar 1915
661	15 Mar 1915	2 May 1918
1156	2 May 1918	16 Sep 1918
1136	16 Sep 1918	9 Jun 19199
1208	9 Jun 19199	18 Jun 1919
1233	18 Jun 1919	24 Feb 1923
1208	24 Feb 1923	17 Apr 1923
1157	17 Apr 1923	1 Jan 1928
1390	1 Jan 1898	

Shelters

The Deseret News of 7 January 1857 provided a description of the first shelter and instruments used.

> To facilitate this object,[6] Governor Young has caused a window to be fitted up, in accordance with the Smithsonian instructions, a standard rain gauge to be properly located, and the Smithsonian wind vane to be repaired and mounted. Owing to accidents occurring in the transportation of instruments, the readings will have to commence with a barometer, thermometer, ombrometer[7], and wind vane, and will be extended as fast as the balance of the instruments can be provided.

A window shelter (Figure 30) was used when the Signal Service began making the observations. The first inspection described it as latticed with a slatted floor. That type shelter continued until 1 May 1885.

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[6] The reference is to the objective of recording meteorological observations

[7] Rain gauge

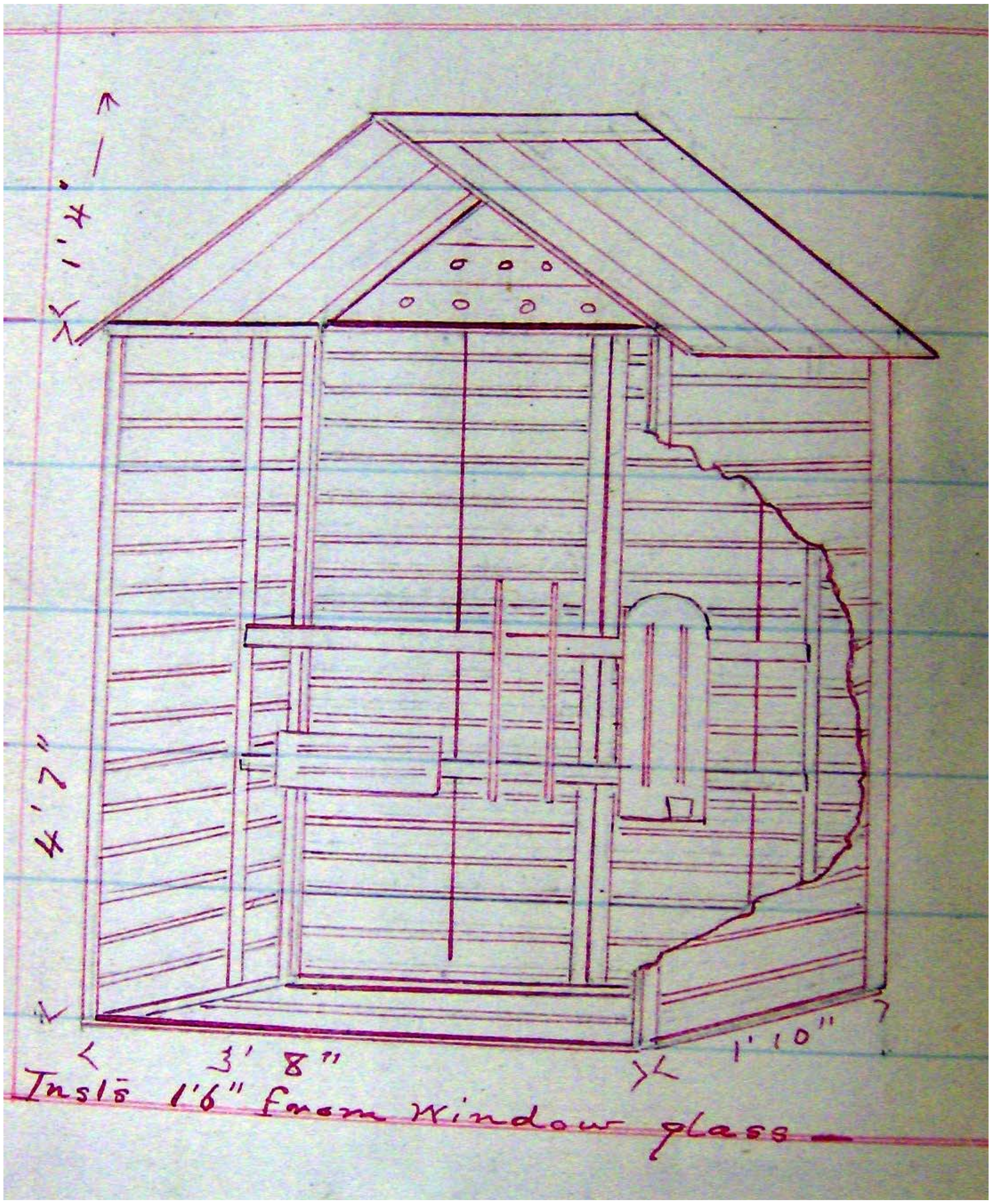

Figure 30. Window Shelter in March 1874
Source: National Archives and Records Administration

The Weather Bureau instrument shelter (Figure 31) at Salt Lake City was standard for those days. Note that the observer had to mount the ladder to the platform to read the instruments inside. Note also the anemometer tower is visible beyond the shelter.

Figure 31. Weather Bureau Instrument Shelter at Salt Lake City
Source: J. Cecil Alter Album, National Archives and Records Administration

The shelter housed the maximum and minimum thermometers on a Townsend Mount. A view of the interior of the shelter can be seen in Figure 32. The shelter and the 8 inch rain gauge visible behind it were posed for this photograph.

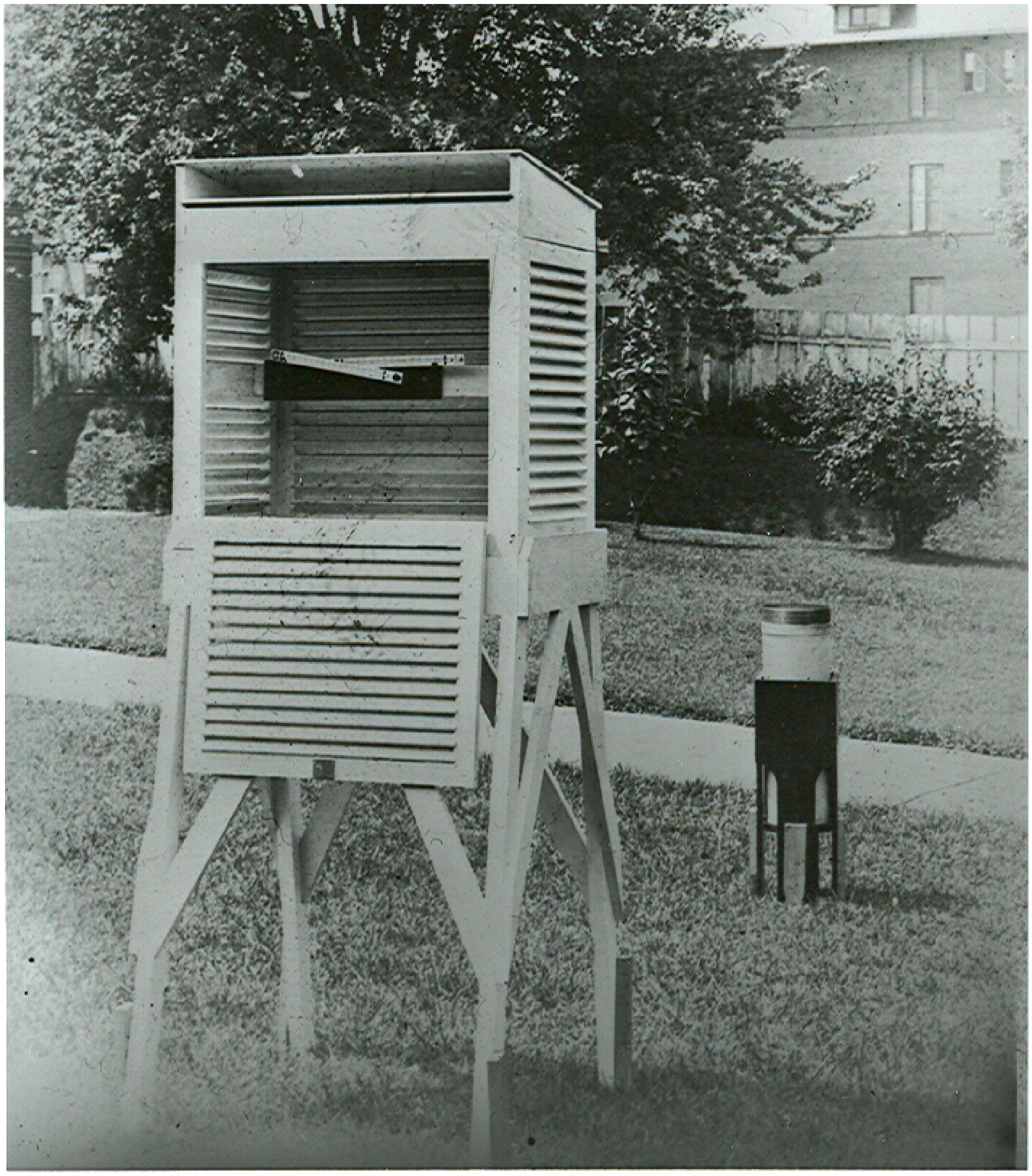

Figure 32. Maximum and Minimum Thermometers In the Instrument Shelter
Source: Utah Historical Society, J. Cecil Alter Collection, C-102 Box 1

THE OBSERVERS

The Smithsonian Institution Observers 1857—1874

The Smithsonian Institution's Climate Network grew rapidly under the leadership of Joseph Henry. In just two years, it had over 150 observers providing monthly report containing daily data. By 1860, there were over 500 stations reporting. The network grew rapidly because Henry obtained a list of people who were already observing weather. That list came from Professor James H. Coffin at Lafayette College in Pennsylvania who had been collecting weather reports from a large number of observers. The Smithsonian prepared circulars and sent them to those on Professor Coffin's list to solicit them to become members for their new network. It is unknown whether or not Henry Phelps received one of those invitations. Perhaps his father, William W. Phelps, received it. In any case, the first report was sent to the Smithsonian and that association would continue for several years. The Smithsonian Institution ledger (Figure 33) contains a record of those first observations received by the Smithsonian from their observers in Salt Lake City.

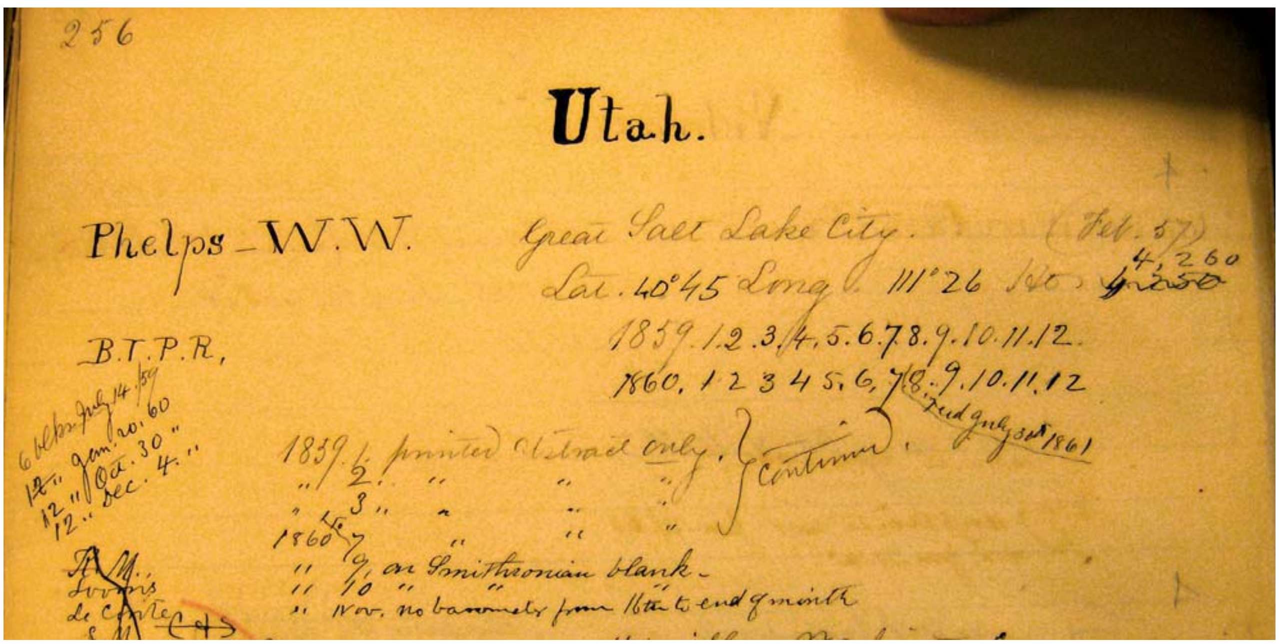

Figure 33. Smithsonian Institution Record of Receipt of First Observations from Salt Lake City
Source: Smithsonian Institution Archives

Figure 33 shows an entry of "B. T. P R" that indicated that barometer, thermometer, psychrometer, and rain gauge data were being reported. Note also in that figure that there was a parenthetical "(Feb. 57)." That was the date of the first record submitted by Henry E. Phelps from Great Salt Lake City.[8]

[8] The first name of the city included the word "Great"

Henry E. Phelps

The first Smithsonian Observer in Salt Lake City was Henry E. Phelps. He signed the first record submitted to the Smithsonian in February 1857 as the "Superintendent of Meteorological Observations Utah." He began his observations the month following enactment of the resolution (Figure 1) that authorized that position.

The 1860 census listed Henry Phelps as a twenty-eight year old son living in his father's house. In the 1880 census, he was listed as a retail dry goods man living on West Temple Street.

William W. Phelps

In September 1858, William W. Phelps began submitting the weather data to the Smithsonian replacing his son Henry. Figure 31 shows the receipt of what were W. W. Phelps' data from the 1st through the 12th months of 1859 and 1860.

W. W. Phelps was a prominent man in the early history of Utah aside from his work as the Superintendent of Meteorological Observations in Utah. His prominence came from a variety of activities. He preached the funeral sermon for Joseph and Hyrum Smith in 1844; was the Mormon Church printer in Missouri; wrote the words to twenty-nine hymns in the Church's first hymnal; assisted in the draft of the constitution of the "State of Deseret;" was the first Speaker of the House of Representatives of the Utah Territory in 1852; was the secretary of the Universal Scientific Society in 1855; and was excommunicated from the Church in 1838 and 1847.[9] He had many interests and talents. He was the translator of some Indian hieroglyphics that were found south of Salt Lake City. His translation said that the inscriber had left Jerusalem 1,200 years before coming to Utah. He published monthly climatological summaries (Figure 34) in the newspaper, The Deseret News.

In the 1860 census, he was listed as 68 years old printer. He died in 1872.

[9] He was reinstated each time

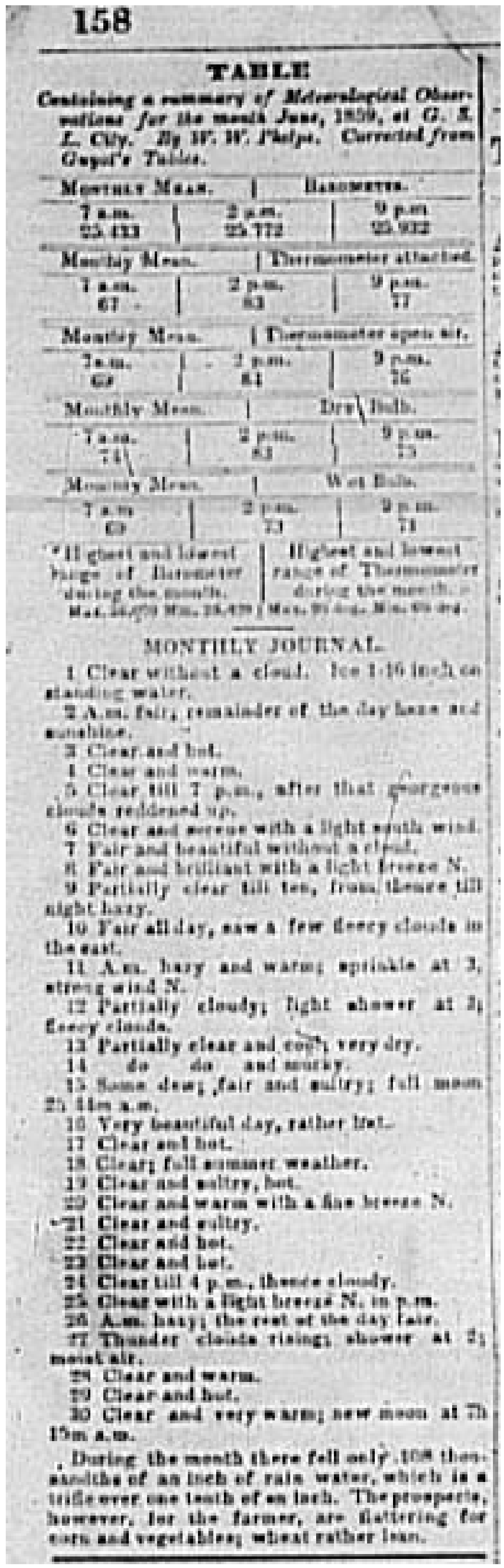

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TABLE

Containing a summary of Meteorological Observations for the month June, 1859, at G. S. L. City. By W. W. Phelps. Corrected from Guyot's Tables.

Monthly Mean.	Barometer.	
7 a.m.	2 p.m.	9 p.m.
25.433	25.772	25.932

Monthly Mean.	Thermometer attached.	
7 a.m.	2 p.m.	9 p.m.
67	83	77

Monthly Mean.	Thermometer open air.	
7 a.m.	2 p.m.	9 p.m.
69	84	76

Monthly Mean.	Dry Bulb.	
7 a.m.	2 p.m.	9 p.m.
74	83	75

Monthly Mean.	Wet Bulb.	
7 a.m.	2 p.m.	9 p.m.
69	73	71

*Highest and lowest range of Barometer during the month.	Highest and lowest range of Thermometer during the month.
Max. 25.970 Min. 25.439	Max. 93 deg. Min. [illegible] deg.

MONTHLY JOURNAL.

1 Clear without a cloud. Ice 1-16 inch on standing water.

2 A.m. fair; remainder of the day hazy and sunshine.

3 Clear and hot.

4 Clear and warm.

5 Clear till 7 p.m., after that gorgeous clouds reddened up.

6 Clear and serene with a light south wind.

7 Fair and beautiful without a cloud.

8 Fair and brilliant with a light breeze N.

9 Partially clear till ten, from thence till night hazy.

10 Fair all day, saw a few fleecy clouds in the east.

11 A.m. hazy and warm; sprinkle at 3, strong wind N.

12 Partially cloudy; light shower at 3; fleecy clouds.

13 Partially clear and cool; very dry.

14 do do and smoky.

15 Some dew; fair and sultry; full moon 2h 11m a.m.

16 Very beautiful day, rather hot.

17 Clear and hot.

18 Clear; full summer weather.

19 Clear and sultry, hot.

20 Clear and warm with a fine breeze N.

21 Clear and sultry.

22 Clear and hot.

23 Clear and hot.

24 Clear till 4 p.m., thence cloudy.

25 Clear with a light breeze N. in p.m.

26 A.m. hazy; the rest of the day fair.

27 Thunder clouds rising; shower at 3; moist air.

28 Clear and warm.

29 Clear and hot.

30 Clear and very warm; new moon at 7h 15m a.m.

During the month there fell only .108 thousandths of an inch of rain water, which is a trifle over one tenth of an inch. The prospects, however, for the farmer, are flattering for corn and vegetables; wheat rather lean.

Figure 34. Climate Summary for June 1859 from The Deseret News 20 July 1859
Source: National Archives and Records Administration

January 1871 through April 1872

Observational records for January 1871 through April 1872 were not received by the Smithsonian Institute. No records from that period are extant.

Elias L. T. Harrison

Elias L. T. Harrison's first observations were on 19 May 1972. He wrote on the Smithsonian form, "Commission received on the 8th and time occupied until the 19th in endeavoring to obtain blank forms, instruments etc from predecessor's office." This apparently occurred just after W. W. Phelps's death and indicates that he immediately took over. The first full month's data were from June 1872 (Figure 35).

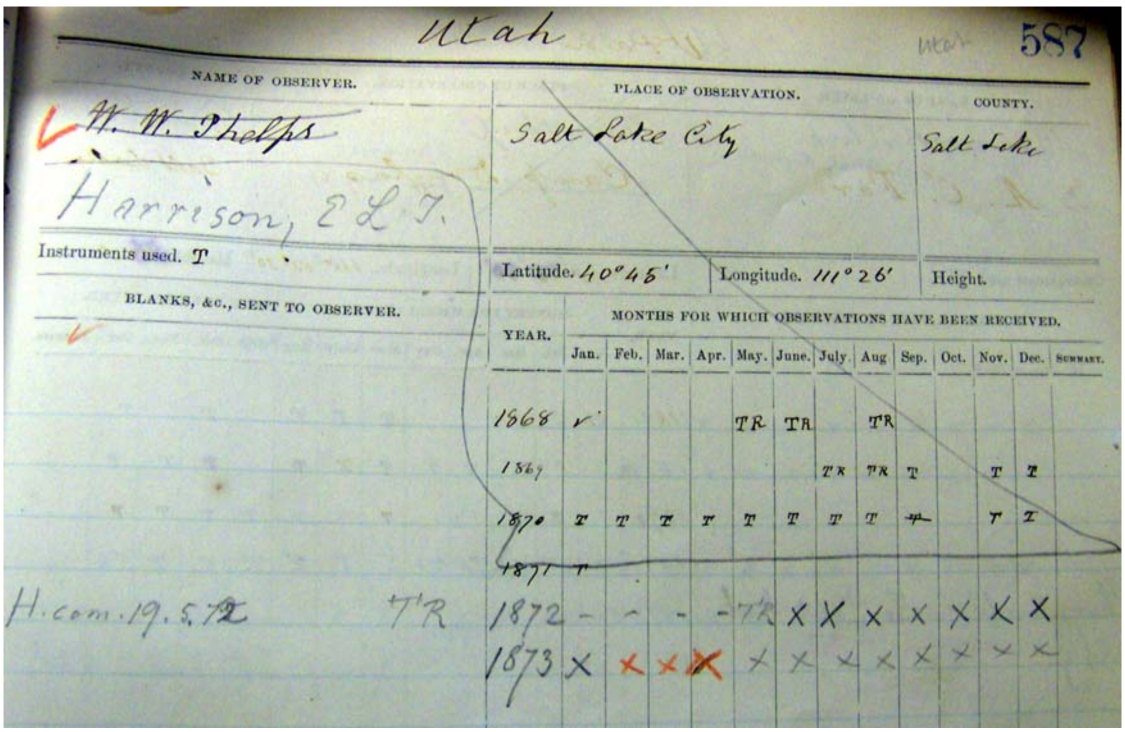


Figure 35. Smithsonian Records of Salt Lake City Observations 1868-1873
Source: Smithsonian Institution Archives

Harrison was born in England according to the 1880 census. He was an architect who was the interior designer of the Salt Lake City Theatre that was built in 1861. He designed the galleries, ceilings, front boxes, and the proscenium of that building.

Like his predecessor, he was excommunicated from the church in 1869 for disagreeing with Brigham Young's policies and leadership in the Utah Magazine that he and William S. Godbe, published. The two of them became charter members of the Unitarian Church.

Thomas Bullock

Thomas Bullock recorded the data for July 1872 and January, May, and June of 1873. He apparently was substituting for E. L. T. Harrison. He was in the 1860 census as a 43 years old farmer and clerk who was born in England. He immigrated to the United States in 1843 and joined the Mormon trek to the Utah Territory. He was secretary of the Deseret Agricultural and Manufacturing Society. He was the County Recorder for Salt Lake County, Clerk of the Utah Territorial Legislature, and directed the Utah census of 1851. He was the Mormon Church historian and wrote most of what was later published as the History of the Church. Brigham Young dismissed him from the historian job in 1865. Subsequently, he moved to Coalville and served as the County Recorder for Summit County. He died there in 1885. Bullock (Figure 36) had fathered 23 children.

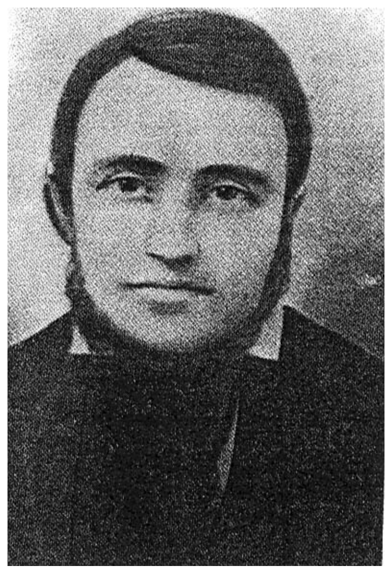


Figure 36. Thomas Bullock
Source: The Pioneer Camp of the Saints

The Signal Service Observers 1874—1890

The Signal Service was established in 1870 and soon opened their Meteorology School at Fort Whipple (now Ft. Myer) in Virginia to train Army Privates to become Observer Sergeants Those carefully chosen Privates could be promoted to Sergeant if they were considered to be capable of fulfilling the responsibilities of that rank. Those responsibilities were significant. The Meteorologist in Charge is the position now that the Observer Sergeants filled back then. The job then and now requires good public relations because the Observer Sergeants became well known members of their community.

The new Signal Service weather stations were located in major cities around the Country, cities that had railroads running through them. Salt Lake City was such a city. They needed access to the telegraph lines along the railroads so that they could send weather reports and receive weather maps.

As the Signal Service grew, their responsibilities grew. They became highly visible and respected members of their community. Their published weather maps spurred a public interest in weather that has not waned since.

His duties were not over because his public relations job had not yet begun. Those duties were prescribed in detail in the Instructions to Observers.

> An observer, upon opening a new station, will, as soon as practicable, put himself in communication with the board of trade, chamber of commerce, or board of underwriters, and such other bodies as may desire to co-operate with this office in its efforts to make the service locally, as well as generally useful. If meteorological committees have not been appointed by any or all of these bodies, their appointment should be urged as a matter of special importance, and the committees requested to place themselves in communication with the Chief Signal Officer. He will also communicate with such colleges, scientific associations and other institutions of learning as may be located at or near his station, and will explain to their officers and members the nature and object of his duties, and invite their co-operation. He must constantly bear in mind that he is expected to use every effort in his power to render his office of the greatest public utility.

Those instructions were fulfilled in Salt Lake City by a series of Observer Sergeants.

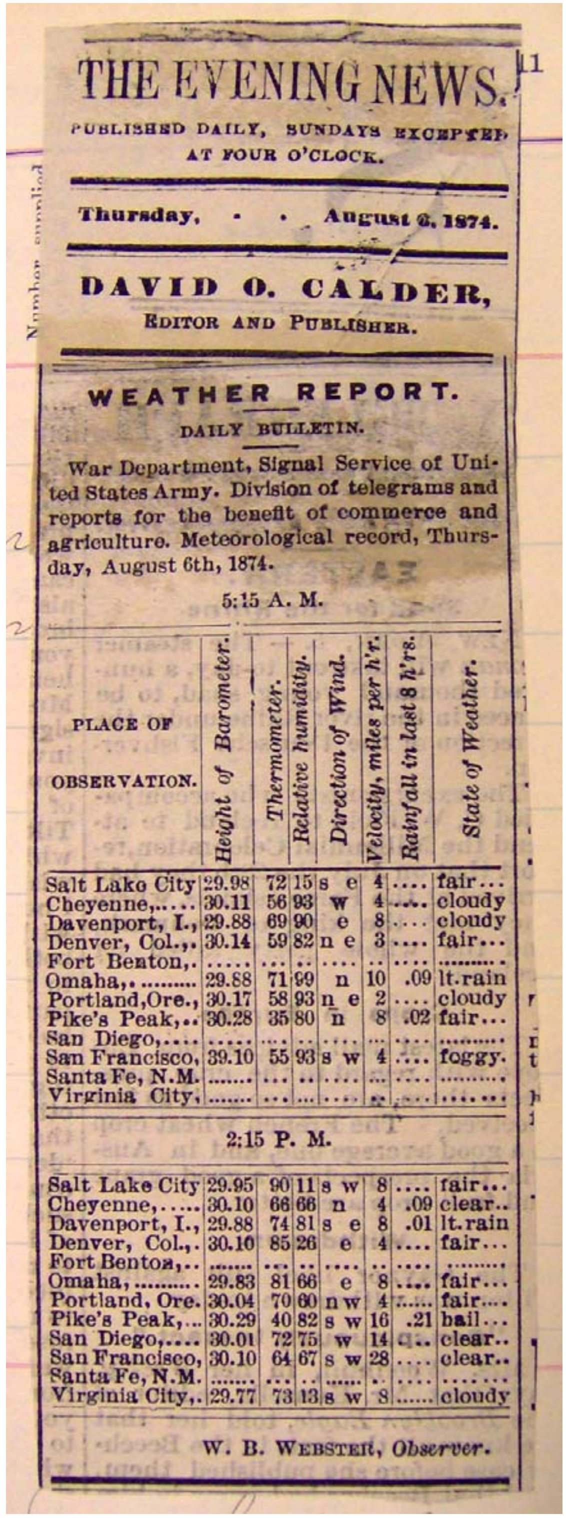
Sgt. Samuel W. Beall

Sgt. Samuel W. Beall was the first Signal Service observer in Salt Lake City. He was born in Maryland and enlisted in the Signal Corps on 25 September 1871. He was assigned to Salt Lake City and began observations on 18 March 1874.

Sgt. W. B. Webster

Sgt. W. B. Webster replaced Sgt. Beall on 18 July 1874. An Inspector who visited in August 1874 commented that "There is quite an interest taken by the citizens here in the service, although they do not receive the probabilities,[10] the visits to the office are quite numerous." Sgt. Webster regularly submitted weather information to the newspapers (Figure 37).

[10] Forecasts produced in Washington, D. C. were called probabilities in those days



THE EVENING NEWS.

PUBLISHED DAILY, SUNDAYS EXCEPTED AT FOUR O'CLOCK.

Thursday, . . August 6, 1874.

DAVID O. CALDER,

EDITOR AND PUBLISHER.

WEATHER REPORT.

DAILY BULLETIN.

War Department, Signal Service of United States Army. Division of telegrams and reports for the benefit of commerce and agriculture. Meteorological record, Thursday, August 6th, 1874.

5:15 A. M.

PLACE OF OBSERVATION.	Height of Barometer.	Thermometer.	Relative humidity.	Direction of Wind.	Velocity, miles per h'r.	Rainfall in last 8 h'rs.	State of Weather.
Salt Lake City	29.98	72	15	s e	4	....	fair...
Cheyenne,.....	30.11	56	93	w	4	....	cloudy
Davenport, I.,	29.88	69	90	e	8	....	cloudy
Denver, Col.,.	30.14	59	82	n e	3	....	fair...
Fort Benton,.	.....	...	..	....	..	....	....
Omaha,.........	29.88	71	99	n	10	.09	lt.rain
Portland,Ore.,	30.17	58	93	n e	2	....	cloudy
Pike's Peak,..	30.28	35	80	n	8	.02	fair...
San Diego,....	.....	...	..	....	...	....	....
San Francisco,	39.10	55	93	s w	4	....	foggy.
Santa Fe, N.M.	....	...	..	....	...	....	....
Virginia City,	....	...	...	....	..	....	....

2:15 P. M.

PLACE OF OBSERVATION.	Height of Barometer.	Thermometer.	Relative humidity.	Direction of Wind.	Velocity, miles per h'r.	Rainfall in last 8 h'rs.	State of Weather.
Salt Lake City	29.95	90	11	s w	8	....	fair...
Cheyenne,.....	30.10	66	66	n	4	.09	clear..
Davenport, I.,	29.88	74	81	s e	8	.01	lt.rain
Denver, Col.,.	30.10	85	26	e	4	....	fair...
Fort Benton,..	....	...	..	....	..	....	....
Omaha,..........	29.83	81	66	e	8	....	fair...
Portland, Ore.	30.04	70	60	n w	4	.....	fair....
Pike's Peak,...	30.29	40	82	s w	16	.21	hail...
San Diego,....	30.01	72	75	w	14	...	clear..
San Francisco,	30.10	64	67	s w	28	....	clear..
Santa Fe, N.M.	....	...	..	......	..	....	....
Virginia City,.	29.77	73	13	s w	8	......	cloudy

W. B. WEBSTER, *Observer.*

Figure 37. Weather Summary 6 August 1874
Source: The Evening News, Salt Lake City

Sgt. J. F. Tenney

Sgt. J. F. Tenney replaced Sgt. Webster on 24 January 1875. When he departed, the observations were made by Sgt Henry Fenton in November 1875 and by Sgt. William M. Gillieray in December 1875.

Sgt. John Craig

Sgt. John Craig became the Observer Sergeant in January 1876. He served in that position for nine years[11]. Craig was publishing weather information in the Salt Lake City Daily Tribune, Daily Herald, and Deseret Evening News.

He eventually transferred to the Weather Bureau and retired after 54 years of service in 1928.

After Sgt. Craig's departure on 3 February 1885, Cpl. Neil Blake did the observations in March 1885 and Mr. William M. Gillieray in April. Gillieray apparently was a civilian during that month.

Pvt. Edwin C. Thompson

Pvt. Edwin C. Thompson became temporary Official in Charge in May 1885. He had enlisted and went to the Army's meteorology school in Fort Myer in August 1884. His short stint in charge in Salt Lake City began a long career that ended with retirement in 1932.

Sgt. John B. Marbury

Sgt. John B. Marbury was the Observer Sergeant beginning in October 1885 for one year.

Pvt. W. D. Fuller

Pvt. W. D. Fuller made the observations after Sgt. Marbury departed in March 1886 .

Cpl. William A. Korts

William A. Korts was a Private when he became the Official in Charge on 1 September 1886. He was promoted to Corporal in November and by 1888 was a Sergeant. For much of his period at Salt Lake City, he worked alone. That required a very demanding schedule to say the least.

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[11] In November and December 1884, observations also were made by a Dr. Horace R. Mirtz from Salt Lake City who used hand drawn forms. He signed as Assistant Surgeon, a title used by US Army physicians. That makes it appear that he was from an Army Post. His observations are in addition to those two months of Sgt Craig's observations.

Sgt. P. R. Fitzmaurier

Sgt. P. R. Fitzmaurier began observations in August 1888 and, except for January and February 1891 when William M. Gillieray filled in, continued through March 1892.

Sgt. George N. Salisbury

Sgt. George N. Salisbury became Official in Charge in April 1891. Later that year, he joined the newly created Weather Bureau as a civilian employee.

The Weather Bureau Observers 1891-1947

On 1 October 1890, Congress passed an act that transferred the weather service from the Signal Service to the Department of Agriculture. This was the result of the success of the "probabilities" and the desire to focus those forecasting skills to a practical application rather than a generic and regionally oriented one. The decision had some immediate impacts. The Signal Service sites, located on the roofs of tall buildings in downtowns and collecting data from other tall buildings in other downtowns, would now become responsible for forecasts focused on agricultural operations. Almost immediately, voluntary observers from the countryside were recruited to provide observations of weather data that would make those forecasts possible. Times were changing!

The transition in purpose would take a while. To facilitate the transition, Congress allowed those individuals, who wished to do so, to transfer from the Army to the new Weather Bureau as civilian employees. Those who could retire, like Sgt. Salisbury, did. They then returned to work as civilians in the Weather Bureau in the same facility performing the same job as when they had been doing in the Signal Service.

George N. Salisbury

George N. Salisbury joined the Weather Bureau and signed as Mr. Salisbury in December 1891 when the Weather Bureau took over the office in Salt Lake City. He was born in Minnesota and was a graduate of the University of Minnesota. He also graduated from the Fort Myer meteorology school after his enlistment in 1883. He spoke French and German and had three years of experience in state weather office work before arriving in Salt Lake City. He later served as the Meteorologist in Charge in Seattle from 1894 to 1923.

James Henry Smith

James H. Smith became the Official in Charge in November 1898. He had William D. Maxwell as his assistant.

He entered the Regular Army on 14 October 1867 after having served in the Illinois Volunteers during the Civil War. He joined the Signal Service on 21 October 1870. His tour at Salt Lake City continued until his resignation in 1916.

Lester H. Murdock

Lester H. Murdock assumed the role of Official in Charge in January 1899. He was a native of Illinois and was thirty years old when he took charge.

Robert J. Hyatt

Robert J. Hyatt took over as Official in Charge in April 1903 and served in that capacity through December 1909. He earned a medical degree from the Medical and Dental College of Washington, D. C. In 1906, he was assisted by J. Cecil Alter who would later become the Meteorologist in Charge. He also had Harley B. Goodin, who had a degree from Valparaiso, and a messenger Harvey L. Selley. Vern H. Church substituted for Hyatt in February 1909.

Hyatt was active in the community and gave ten senior level lectures on meteorology at the State Agricultural College at Logan in 1909.

1910 through 1912

The 1910 through 1912 period is one during which the Official in Charge could not be reconstructed from the available records.

Alfred H. Thiessen

Alfred H. Thiessen was the Official in Charge on 1 January 1913. He may have been in that job prior to that time. He was a native of New York. He taught meteorology courses at the University but that course was transferred to the Department of Physics in 1914. He resigned from the Weather Bureau in 1920 to become a Captain in the Regular Army.

J. Cecil Alter

J. Cecil Alter replaced Thiessen in May 1917. He had arrived in Salt Lake City in September 1902 and he stayed there until 1941. He was born in Rensselear, Indiana and attended Valparaiso University, Northern Indiana Teachers Institute, and Purdue University.

His assistants in August 1917 were Thomas A. Blair (whose degree was from Stanford), Perry R. Hill, and Eckley S. Ellison. There were also the printer Synder and the messenger Eldredge.

Alter was a prolific writer on a wide variety of topics. He often provided essays to the local newspapers. He also published widely on meteorological topics. He developed the Mountain Snow Survey in Utah that allowed a prediction of irrigation water supply and designed a snow gauge that was adopted by the Weather Bureau. He was a historian and wrote four books about Utah history. He was editor of the Utah Historical Quarterly until 1928. He was a member of the American Meteorological Society, the American Geophysical Union, and was a life member of the Utah Academy of Science and the Utah Historical Society.

Alter (Figure 38) maintained a scrapbook[12] of the newspaper clippings of articles by, about, or relating to him. Only some of the 200 pages were about weather.

Figure 38. J. Cecil Alter
Source: Salt Lake Tribune, 21 May 1964

Harry M. Hightman

Harry M. Hightman replaced Alter in August 1941. He was born in Maryland and entered the Weather Bureau on 29 August 1912. He had served at Grand Junction, CO and Columbia, SC before going to Salt Lake City.

G. K. Greening

G. K. Greening assumed the duties in Salt Lake City in September 1941.

Archer B. Carpenter

Archer B. Carpenter was the Acting Director beginning in August 1948.

[12] Now preserved by the Utah Historical Society

THE OBSERVATIONS

The observations in Salt Lake City began on 1 February 1857. The first data form to be submitted was the Meteorological Journal, the Form 3 designed and used by the Army in their climate network. The effort to collect climate data was the work of Joseph Lovell, M.D. in 1818. He ordered each Army surgeon to ".... keep a diary of the weather...." and to note ".... everything of importance relating to the medical topography of his station, the climate, diseases prevalent in the vicinity...."

The medical doctors in the Army were a logical choice to perform those early observations. If there was a connection between climate and disease, they were most likely to find it. They were trained scientists, schooled in the importance of careful observations and reasoned analysis. They were responsible people who could be trusted in this task just as they were in other medical tasks. They fulfilled their obligations as evidenced by the fact that the entries of the observations and the signature of the surgeons were in the same handwriting.

The Army was a logical choice of an organization to assume the climatic data collection. It had the ability to direct action and assure compliance. It had the capacity to collect data in a single standardized format so that geographical differences would be assessed. It had the advantage of having a presence even in the most remote areas of the frontier especially in areas that had few or no cities. That was important because some knowledge could be obtained before large numbers of people migrated into the frontier areas.

There were no Army Posts in the Utah Territory in 1857. Yet, Henry E. Phelps for February of that year submitted his observations on of their forms. The instructions at the bottom of the form (Figure 2) may explain why Phelps was using an Army form.

> Every person into whose hands this form shall fall is requested to keep a journal of the winds and weather events, even if he has no Barometer or Thermometer, and forward it monthly to the "Surgeon General U.S. Army," Washington, D. C. with the endorsement "Meteorology" on the corner of the envelope.

It was not noted where Phelps obtained the blank forms. There would be an Army post, Camp Floyd, opened late in November 1858—but that was almost two years later. There were no Army posts in the Territory at the time of the first observation. One must conclude that someone, Phelps perhaps, had brought the forms with him from Missouri.

The observations included barometric pressure, temperature, clearness of the sky, wind direction and force, clouds, precipitation, and remarks. The data were entered onto the form four times each day for each of the twenty-eight days of that February. The observation times were sunrise, 9 a.m., 3 p.m. and 9 p.m. Only the column for wet bulb temperature was empty caused, no doubt, by the lack of the thermometer required to measure it. There were additional columns, hand drawn by the observer, attached to the form that recorded the barometric pressure "reduced to freezing point" also at the same four times per day internal. Clearly, this was the work of a well-qualified and dedicated observer.

Henry Phelps submitted the Army forms to the Smithsonian Institution rather than to the Army.

The Smithsonian Years

The first use of a Smithsonian Institution form was in January 1860. In that waste not, want not era, it was common to continue using old forms so long as they lasted. That may have been the case here.

The Smithsonian institution, headed by Joseph Henry, was created in 1846 and immediately began establishing a climate observation network. Henry envisioned three types of observers; those without instruments who would observe the sky, extent of clouds, wind, and beginning and ending time precipitation. A second group would do that too but would also be equipped with thermometers. The third group would be equipped with a complete set of instruments to observe temperature, precipitation, pressure, humidity, clouds, wind direction and wind speed. The Smithsonian observations at Salt Lake City fit into the latter category. Their first report on a form titled “Register of Meteorological Observations” contained entries in all columns except winds. At 7 a.m., 2 p.m., and 9 p.m., he reported the barometric pressure in inches, the temperature from the thermometer attached to the barometer, the barometer reading reduced to the freezing point, the open air temperature, the dry and wet bulb temperatures, the precipitation amounts with starting and ending times, amount of sky coverage and type and velocity of clouds, the force of the pressure of vapor in inches, and the relative humidity in percent. In March 1858, wind data were added to the report

The Smithsonian became the weather data collection agency for the U.S. Department of Agriculture in 1847. By 1860, the Smithsonian had observers reporting from thirty-one states and was receiving real time observations by telegraph from some of them. The Smithsonian received as many as half-a-million separate weather observations each year. It required up to fifteen people to make the necessary arithmetic calculations — human computers so to speak. In 1861, the Smithsonian published the first of a two-volume compilation of climatic data and storm observations for the years 1854 through 1859.

William W. Phelps regularly provided the Deseret News with climatological summaries at the end of each month. Its readers must have been interested in such discussions just as people in other areas of the nation were developing a similar interest.

The last Smithsonian form was submitted from Salt Lake City in December 1873. The Smithsonian’s extensive climate observation network had been supplanted by the Signal Service.

The Signal Service Years

On 9 February 1870, Congress directed the War Department to form a weather network and to make meteorological observations at the Army Posts in the United States. The Signal Service was formed for that effort because of their capability using their telegraph network. At 7:35 a.m.

on November 1, 1870, its observers reported from twenty-four stations. Those observations were transmitted by telegraph to the central office in Washington, D.C. just eleven months after Congress authorized the network. The data were used to produce national weather maps.

The Signal Service soon took over all of the weather observation roles from the Smithsonian Institution. On 10 February 1874, the Chief Signal Officer, General Myer, sent a letter to all the ex-Smithsonian observers announcing that the Smithsonian observation network was no more. He invited them to become voluntary observers in the Signal Service network and told them that he would provide stamped envelopes in which to submit their monthly reports. Some did.

A new Form 22 was used in March 1874 for the first time in Salt Lake City. It had columns for barometer and temperature entries at “a.m., p.m., and midnight;” the mean daily humidity, the total daily precipitation amount, and the daily prevailing wind direction. Use of the new and old form alternated until May 1873 when yet another Form 22 appeared. This one was like the previous revision except that there were three times daily “telegraphic observations” and columns for the “local observations.” The local one only recorded the daily means of the barometer, thermometer, and humidity and the total rainfall.

In July 1877, yet another version of the Form 22 was submitted. It added columns for the rainfall amounts read at a.m., p.m. and midnight, maximum temperature, minimum temperature, maximum wind velocity, and the number of times the wind was from each of eight cardinal directions at seven times per day.

An inspector wrote in November 1878 about the demands being made on the observer due to the Signal Service Rules.

> The early observations make the duty here especially hard, as the observer has to go to the Telegraph Office at 5 a.m. then come back and take the 5:15 a.m. observation, and then go to the Telegraph Office again for the Bulletin, translate it and publish. Unless the Bulletin is of some especial importance I would recommend that its publication be discontinued or that the observer be authorized to get the Bulletin from the Telegraph Office after 7 a. m. observation.”

The latter suggestion was approved by Signal Service Headquarters. That still did not totally solve the problem because of the required observations six times per day. Three of those were made at about 5 a.m., noon, and 7 p.m. local time to coincide with 7 a.m., 2 p.m. and 9 p.m. observations of Washington‘s local times. The other three observations were made at 7 a.m., 2 p.m., and 9 p.m. local Salt Lake City time. Eventually, all observations were made on local Salt Lake City time. Of course, all times were sun times because Standard times were yet to be adopted.

Sgt John Craig’s observations were published in the Morning Herald, and the Deseret Evening News in 1880. That continued the tradition begun years before.

A new reporting form, Form 113A, was placed into use in November 1881. It required observations at 7 a.m., 3 p.m. and 11 p.m. Washington time. It was an eight page form with an enormous amount of detail including such things as cloud amounts, type, direction and speed of movement for each of three different levels. The objective was to make reports at the same time nationwide to allow a weather map to be constructed based on time consistent observations. At Salt Lake City, Sgt. Craig had no assistants and he alone had to make those reading—seven days per week.

There was a note added to the May, June, and July 1886 forms about temperature errors and the corrective action that the observer had taken.

> The Therm. readings are in error, cause unknown. Comparison of Montrose and Winnemucca shows that the mean difference t-t' for 1885&1887 practically equals the difference for 1886 and the mean of t – t' for Salt Lake City in those years had been applied to the dry therm. for 1886

The stations used for comparison were Montrose, Colorado and Winnemucca, Nevada. The reason for the comparison is not apparent. The two stations are quite unlike Salt Lake City in their environment and they are distant as well. There are no corrections apparent on the forms. Perhaps they were made before entry onto the form. There is also no indication of when the corrections stopped.

In July 1889, a new form was placed in use. The readings were now required to use 8 a.m. 75th meridian time, the central meridian of the Eastern Standard Time Zone.[13]

The Weather Bureau Years

On 1 October 1890, Congress passed an act that transferred the weather service from the Signal Service to the Department of Agriculture. The number of weather stations increased over subsequent months as the Weather Bureau increased the number of Cooperative Weather Observers. By 1891, the network of voluntary weather observers across the country had grown to 2,000 stations.

Forecast flags were displayed on a tall staff on top of the Dooley building. The forecast flags were displayed prominently so that citizens could see what weather conditions were forecast for that location. The use of the flags began shortly after the Weather Bureau took over from the Signal Service. Two versions of the flags were used. One displayed the precipitation forecast, the other temperature.

Square flags (Figure 37) gave the precipitation forecasts; white for fair, blue for rain or snow, and half white—half blue for showers. A pennant gave the temperature forecast by its position on

[13] That was at 5:33 a.m. local time in Salt Lake City

the staff—warmer if above the precipitation flag, colder if below, and no change if it wasn't displayed. A square white flag with a small black square in its center forecast a cold wave.[14]

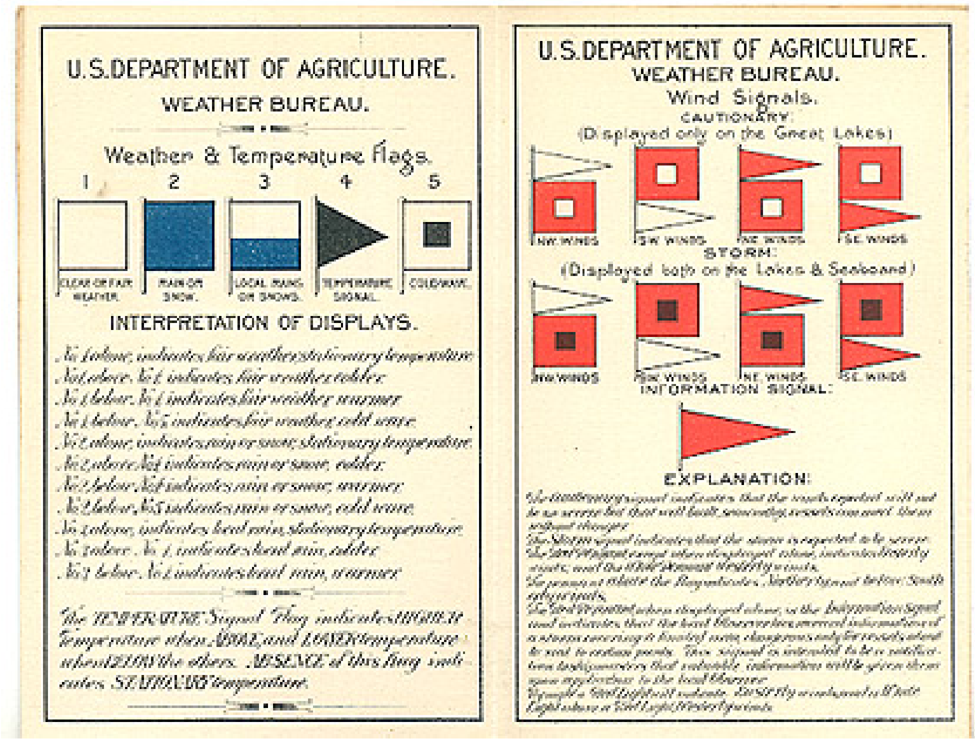

Figure 39. Weather and Temperature Forecast Flags
Source: World's Columbian Exposition Souvenir, 1893

The Inspector's report in 1902 was very complimentary about the new frost warnings being provided by the forecasters. The warnings were being used to protect trees by smudge pots. The Inspector also noted the forecast difficulty imposed by the terrain—small valleys that were close together but with different weather characteristics. He advocated waiving the requirement of not having volunteer observers closer than 25 miles apart as a solution to that problem.

In December 1906, the Salt Lake City Weather Bureau office had grown in the service it was providing. They were distributing about 240 daily weather maps and about 100 forecast cards. It also had 90 cooperative observers reporting weather information

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[14] Salt Lake City did not display the wind signal flags shown that were displayed in the area of the Great Lakes

The Weather Bureau City Office

On 1 July 1940, a major change occurred in Salt Lake City. The official observations for Salt Lake City were assigned to the Salt Lake City Airport location. That change from downtown locations to airports was occurring nationwide as the importance of aviation established new priorities for the Weather Bureau. For example, route forecasts were prepared for the flights originating from Salt Lake City beginning in March 1932.

The downtown location was renamed to become Salt Lake City, Weather Bureau City Office. The City Office continued observations until 15 August 1954 when observations ceased, its equipment removed, and its operation consolidated with those of the airport office. Without much fanfare, a 97 year record in the downtown area ended.

The Digital Record

The National Climatic Data Center has digitized much of the daily weather records produced at Salt Lake City. Those digital data are used by climatological researchers and others interested in the analysis of them. To facilitate access to those data, a number was assigned to each observational location to be used instead of its name.

The Salt Lake City Weather Bureau City Office was assigned the station number 427603 for its digital weather data sets. The Salt Lake City International Airport station was assigned the station number 427598.

AIRPORT STATION

The growth of aviation opened a new need for weather information, a need that sometimes was critical to its success. That need could only be satisfied by weather observations made at the airfield collocated with the flight operations that spawned the need. The need placed new emphasis on some weather elements such as wind velocity and direction. It placed new requirements for some weather elements such as visibility and cloud heights. Salt Lake City's aviation interests developed the Salt Lake City Municipal Airport and with it the inherent need for weather.

The weather station at the airport was opened on 1 May 1928. It moved from that ground location to the roof of the Administration Building on 11 June 1933.

The airport location was designated by the Weather Bureaus as the official observations for Salt Lake City on 1 July 1940 and continues in that role today.

The shelter at the airport was located on ground about 500 feet directly east of station on May 1, 1928.

On 6 June 1933, the instrument shelter was moved to roof of the second floor of Airport Administration Building Approximately at 28 feet AGL

Wind instruments were located at 47 feet AGL on a platform built in a steel radio antenna tower. It remained in that place from 1 May 1928 until 11 Jun 1933.

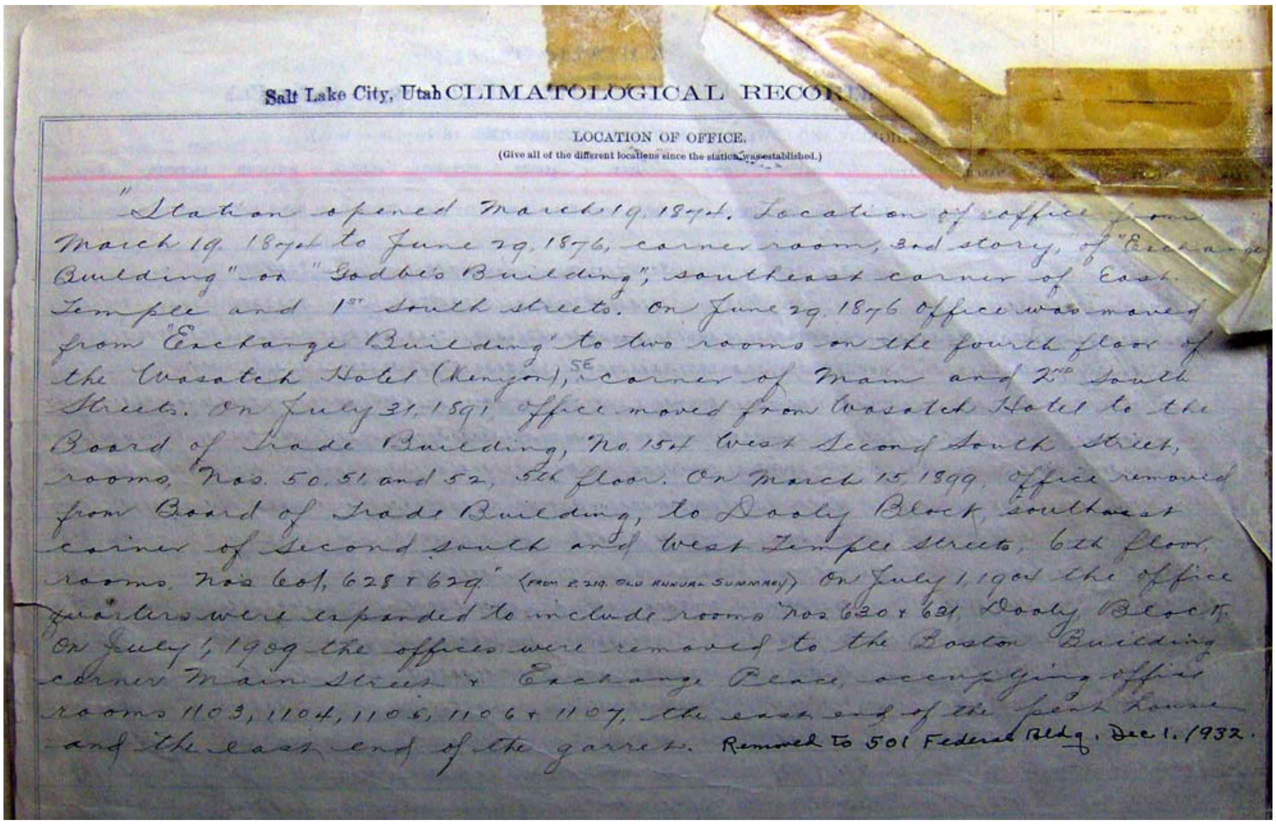
On 11 June 1933, the wind equipment moved to roof of second floor of Airport Administration Building. It was located on top of a 18 foot wind tower on the roof at 46 feet AGL. On 11 March 1944, the wind tower and equipment moved to the roof of the 3rd story of the Administration Building. The new location was 40 feet north of previous one and was 58 feet AGL, 18 feet above the roof. Surrounding structures were reported to have no apparent affect of wind streams.

From 1 May 1925 to 11 June 1933, rain gauges were used on the ground near the instrument shelter. On 11 June 1933, the rain gauges were moved to roof of 2nd floor of Airport Administration Building, 28 feet AGL and 3 feet above roof. There were moved to the roof of newly constructed 3rd floor on 1 April 1944. That placed them 41 feet farther north and 12 feet higher than previous location at 40 feet AGL.

Figure 40. Administration Building, Salt Lake City Airport, in the 1990's
Source: Christopher Young, NWS Forecast Office Salt Lake City

APPENDIX 1

Location of Office
Salt Lake City Climatological Record Book



Salt Lake City, Utah CLIMATOLOGICAL RECOR[illegible]

LOCATION OF OFFICE.

(Give all of the different locations since the station was established.)

"Station opened March 19, 1874. Location of office from March 19, 1874 to June 29, 1876, corner room, 3rd story, of "Exchange Building" or "Godbe's Building", southeast corner of East Temple and 1st South streets. On June 29, 1876 office was moved from "Exchange Building" to two rooms on the fourth floor of the Wasatch Hotel (Kenyon), SE corner of Main and 2nd South Streets. On July 31, 1891 office moved from Wasatch Hotel to the Board of Trade Building, No. 154 West Second South Street, rooms, Nos. 50, 51 and 52, 5th floor. On March 15, 1899, office removed from Board of Trade Building, to Dooly Block, southwest corner of Second South and West Temple streets, 6th floor, rooms Nos 601, 628 & 629." (FROM P. 219, OLD ANNUAL SUMMARY) On July 1, 1904 the office quarters were expanded to include rooms Nos. 630 & 631, Dooly Block. On July 1, 1909 the offices were removed to the Boston Building corner Main Street & Exchange Place, occupying office rooms 1103, 1104, 1105, 1106 & 1107, the east end of the pent house and the east end of the garret. Removed to 501 Federal Bldg. Dec 1, 1932.

APPENDIX 2

Location of Airport Office
Salt Lake City Climatological Record Book

The Airport station is located at the Salt Lake City Municipal Airport, 3¾ miles WNW of the Federal Building in Salt Lake City. This station was established May 1. 1928, on the SE corner of the airport, elevation 4222 feet MSL; the anemometer was 47 feet above the ground. Airway, pibal and evaporation observation program commenced when the station opened, the evaporation program was discontinued May 31. 1933.

On June 11. 1933, the station and all the equipment was moved to the roof (second story) of the Airport Administration Building, 800 ft north of the original location, and 28 feet above the ground. The wind instruments were 18 ft.; the thermometers 5 ft., and the rain gages 3 ft above the second story roof.

March 11. 1944 the anemometer and wind vane were moved to the roof of a newly constructed third floor, and on April 1. 1944 the rain gages were also moved to this new location. The roof of the third floor is 40 ft above the ground, and the wind equipment is 18 ft, and the rain gages 3 ft. above the roof. The instruments (wind and rain) are located 40 ft farther north than there original location on the Administration Building.

March 5. 1946 (4:00 pm) ceilometer equipment was put into service at the Airport. The projector is located 1463 ft. North of the observer's Quarters, and the ceilometer-scanner is located on the roof of the first floor of the Administration Building, and approximately 80 ft. North.

On May 27. 1948 the office was moved from Room 215 of the Administration Building to room 310, directly above, and 12 ft higher.

First observation taken 6:00 am May. 1. 1928. Airport became official Station for Salt Lake City on July 1. 1940, when synoptic observations began. Actual barometer elevation 4239.68?
Lat. 40°46.5'. Long. 111°57.5'. Ground ele. 4222'. Actual barometer ele. 4251.80' in 1948

APPENDIX 3

Methodology

The primary sources of information for this study were the Salt Lake City's observers' daily weather records themselves. Copies of their monthly reports and the data digitized from those reports were available from the Western Regional Climate Center in Reno, Nevada, or the National Climatic Data Center in Asheville, North Carolina. The monthly reports can be considered original sources because they were written by the observers and not altered by subsequent readers.

There were a variety of secondary sources that held information about Salt Lake City, its history, and its people. The author visited and collected information from the holdings of the National Climatic Data Center at Asheville, North Carolina; the National Weather Service Office in Salt Lake City, the Salt Lake City Public Library, the Salt Lake City Historical Society Library, the National Archives and Records Administration in College Park, Maryland, the Smithsonian Institution Archives in Washington D.C., the Western Kentucky University Library, in Bowling Green Kentucky; the LDS Family History Library in Salt Lake City, Utah; the Utah Historical Society Library, and the Utah State Library and Archives in Salt Lake City, Utah.

The tertiary sources were reference materials that are available on-line. Among those were the metadata prepared by the National Weather Service Office in Salt Lake City, the Western Regional Climate Center, and the National Climatic Data Center. In addition, substation histories previously prepared were consulted. Two genealogical research sources, Ancestry.com and Genealogy.com, were used to provide some of the personal information about the observers. For location analysis, the interactive maps available from TopoZone.com were used.

There was an attempt to glean information from all these sources that would allow a glimpse into the lives of the observers, the location of the observation site, and the historical environment that produced the climatic history of the Salt Lake City. Maps, drawings, and photographs were included when appropriate to illustrate the information.

Throughout the research for and preparation of this study, the objective was to produce a document that future studies can use to evaluate the validity of the data that were collected at Salt Lake City, judge the trustworthiness of the observers who collected them, and determine the climatological significance of the whatever variability may be discerned.

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