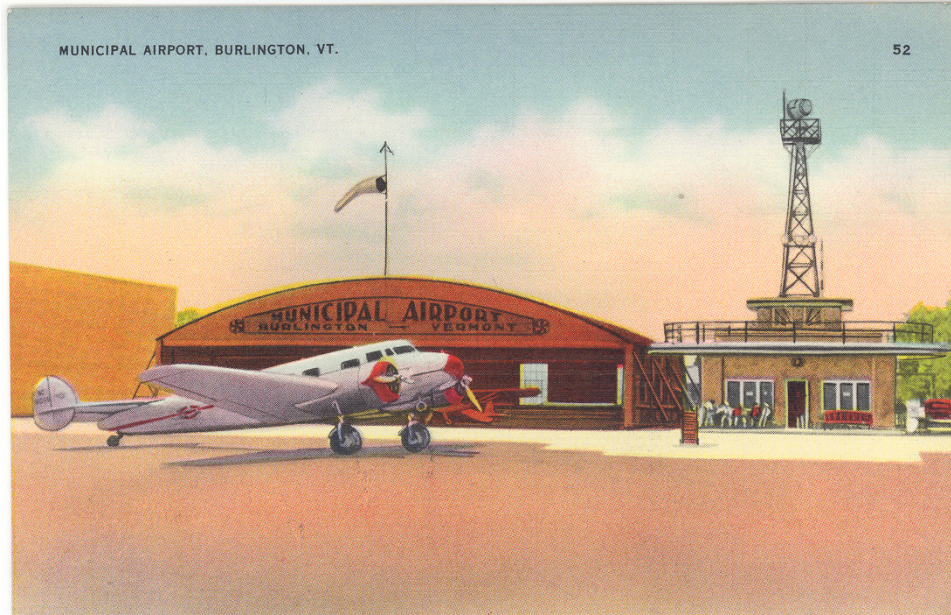


THE HISTORY OF SURFACE WEATHER OBSERVING IN BURLINGTON, VERMONT, 1832-1973



The Burlington, Vermont Municipal Airport circa 1935. From author's personal collection of post cards.

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Executive Summary

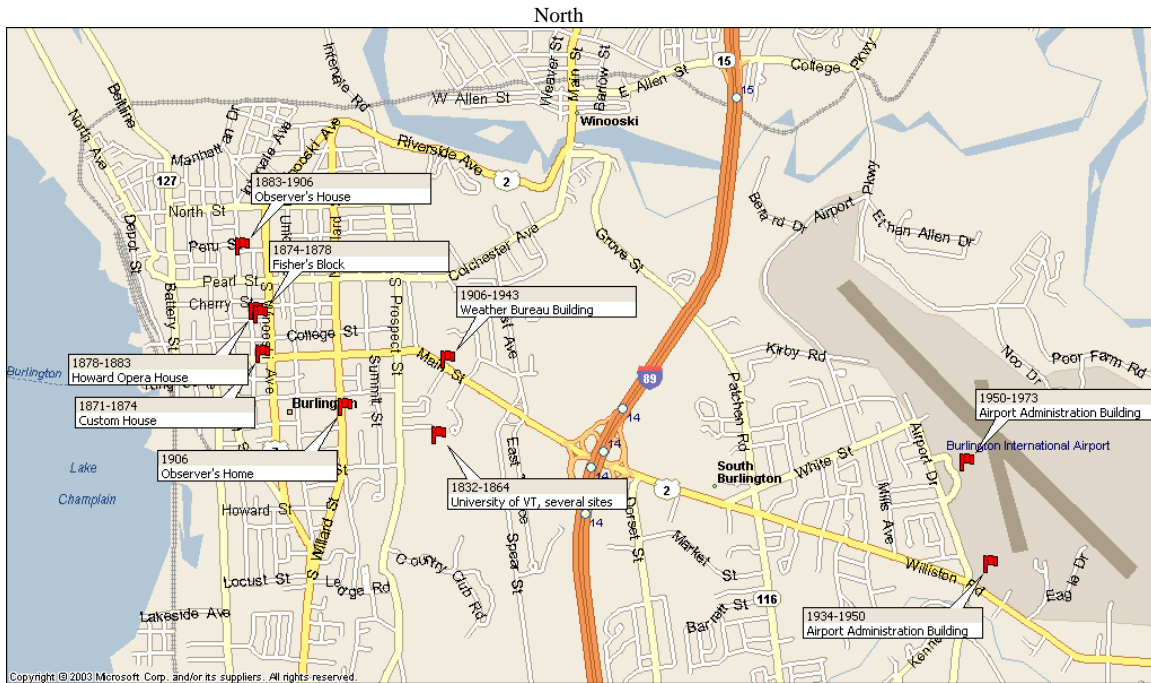
Weather observing in the Burlington, Vermont area was begun in January 1832 by Zadock Thompson. Thompson took observations in the area until his death in December 1855 but his widow, Mrs. Phebe Thompson, continued observations until December 1856. At this time, N. K. Petty assumed the role as observer on the campus of the University of Vermont, a location begun by Mr. Thompson. Petty's observations end in 1864 and it wasn't until May 1871 that the U.S. Army's Signal Service established an observing program in Burlington being located at several sites in the downtown area. Walter Benton Gates served as a volunteer Signal Service observer from October 1883 until March 1906 when the U.S. Department of Agriculture's Weather Bureau established a city office. The move to the municipal airport was made in March 1934. In February 1950, the Weather Bureau office moved to a new Administration Building at the airport.

Goal of Study

The goal of this study is to document the primary weather observational path at Burlington, Vermont leading to the current and on-going National Weather Service observing program. Though other weather observers have been in the Burlington area those not considered part of the original path have been excluded from this study. This does not minimize the importance of these collateral observations, but does allow for the focusing on the formal weather observing program that continues to this day.

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

Location Map



Map 1. The locations of weather observing sites in the Burlington, Vermont area from 1832 until 1973.

The following lists the chronology of weather station locations in the Burlington, Vermont, area from 1832 until 1973:

January 1832 – December 1856 – volunteer observers - 44° 29' N 73° 11' W, Elevation 346 feet (256 feet above Lake Champlain)

- 1832 – 1856, Mr. Zadock Thompson, Smithsonian Institution beginning in August 1853, University of Vermont campus,
- 1856, Mrs Phebe Thompson, Smithsonian Institution Observer, University of Vermont campus

January 1858 – November 1864 – volunteer observer - 44° 27' N 73° 14' W, Elevation 367 feet

- Mr. N. K. Petty, Smithsonian Institution Observer, High Street, University of Vermont campus [Name might be M.K. Petty as his hand written entries are difficult to read]

May 1871 – August 1874 – U.S. Army Signal Service – 44° 29' N 73° 12' W, Elevation 190 feet

- U.S. Custom House at the SE corner of Church Street and Main Street

August 1874 – November 1878 – U.S. Army Signal Service – 44° 29' N 73° 12' W, Elevation 215 feet

- Fisher's Block at the SE corner of Bank Street and Church Street

December 1878 – June 1883 – U.S. Army Signal Service – 44° 29' N 73° 12' W, Elevation 213 feet

- Howard Opera House at the SW corner of Bank Street and Church Street

October 1883 – March 1906 – U.S. Army Signal Service and Weather Bureau volunteer observer –

- William Benton Gates
55 Elmwood Avenue -1883-1891, 44° 29' N 73° 12' W, Elevation unknown
57 Elmwood Avenue - 1891-1906, 44° 29' N 73° 12' W, Elevation unknown
301 South Willard Street -1906, 44° 29' N 73° 12' W, Elevation unknown

March 1906 – June 1943 – Weather Bureau –44° 29' N 73° 11' W, Elevation 398 feet

- Weather Bureau Building at 601 Main Street

March 1939 – February 1950 – Weather Bureau – 44° 29' N 73° 09' W, Elevation 331 feet

- Burlington Municipal Airport, Administration Building

February 1950 – July 1973 – Weather Bureau – 44° 29' N 73° 09' W, Elevation 331 feet

- Burlington Municipal Airport, New Administration Building

Location and Instrument Descriptions

1832 – 1856: Mr. Zadock Thompson, a Professor of Chemistry and Natural History, began his observing in the Burlington, Vermont, area in 1829 on the campus of the University of Vermont. The exact address on the campus has not yet been determined. However, records of his observations from 1829 were lost and the years 1830 and 1831 were summarized in a paragraph each. His detailed observations, beginning in January 1832, have survived to this day. Mr. Thompson moved to Hartley, Quebec on January 1, 1834 and to Sherbrooke, Quebec in June 1836, returning to Burlington and the University of Vermont in January 1837. His observation site was 250 feet above sea level one mile east of Lake Champlain. Zadock Thompson became affiliated with the Smithsonian Institution's volunteer observer program in August 1853. Mrs. Phebe Thompson assumed

the observers role in January 1856 at the death of Zadock Thompson continuing as a Smithsonian volunteer. She continued observing on the campus through December 1856.

Thermometer – No information was found.

Barometer – No information was found.

Wind instruments – No information was found.

Rain gage – No information was found.

1858 – 1864: No records have been found for 1857. Beginning in January 1858 the observations resumed on the University of Vermont campus as N. K. Petty [or M.K. Petty] became the observer. Mr. Petty, a professor at the University, lived on High Street according to the 1864 Burlington City Directory. It is assumed that his observations were taken at this location since recordings were made at 7AM, 2PM and 9PM. He listed his elevation as being 367 feet above sea level. Mr. Petty was affiliated with the Smithsonian Intuition’s observing program. He continued observing through November 1864 when he entered this note on his observational form, “By reason of absences, the Register kept by the undersigned will be discontinued from this date.”

Thermometer – No information was found.

Barometer – No information was found.

Wind instruments – No information was found.

Rain gage – No information was found.

1871 – 1874: No observational program has been found for the period December 1864 through May 24, 1871, when the U.S. Army Signal Service established an office in the U.S. Custom House at the southeast corner of Church Street and Main Street. The office was located on the third floor of the Custom House (Figure 1.)

The 1871 Report of the Chief Signal Officer contains the first set of explicit details on the instruments in downtown Burlington. The report stated that the office was located in a third floor office with the wind instruments (wind-vane, anemometer and wind-gauge) located on a raised platform on the roof. The exposure was good and the circulation of air unobstructed. The instruments on station were listed as one barometer, one thermometer, one hygrometer, one anemometer, one rain-gauge, and one wind-vane; all of which were in good condition.

Thermometer – The instrument shelter projected from a north window in the office and was built after the Smithsonian plan with the instruments placed so that they

could be read without opening the window. The instruments were 35 feet above the ground. On April 1, 1873 the height changed to 33 feet.

Barometer – The barometer was located at a height of 223 feet above mean sea level.

Wind instruments – The wind instruments were 46 feet above the ground until June 1871 when they were moved to the center of the building roof and the height changed to 49 feet. On April 1, 1873 the height changed to 60 feet.

Rain gage – The eight-inch rain gage was located at 46 feet above the ground until June 1871 when it was moved to the center of the building roof and the height changed to 49 feet. On April 1, 1873 the height changed to 45 feet.



Figure 1. The Custom House and Post Office building in Burlington, Vermont. Date of photograph is unknown. From Bailey/Howe Library, University of Vermont.

1874 – 1878: The Signal Service moved to a new location on Fisher’s Block on August 4, 1874 remaining at this location through November 1878. This location was on the southeast corner of Bank Street and Church Street, and 0.2 mile north of the previous location.

Thermometer – The instruments were at 29 feet above the ground.

Barometer – The barometer was located at a height of 241 feet above mean sea level.

Wind instruments – The wind instruments were at 49 feet above the ground.

Rain gage – The eight-inch rain gage was 44 feet above the ground.

1878 – 1883: The final location for the Signal Service observations in Burlington was at the Howard Opera House at the southwest corner of Bank Street and Church Street from December 1878 through June 15, 1883 (Figure 2.) This location was 50 west of the previous site.



Figure 2. The Howard Opera House, circa. late 1800's, located in Burlington, Vermont. The site of U.S. Army Signal Service weather observations, 1878-1883. From the Bailey/Howe Library, University of Vermont.

Thermometer – The instruments were at 56 feet above the ground.

Barometer – The barometer was located at an elevation of 268 feet above mean sea level.

Wind instruments – The instruments were at 80 feet above the ground.

Rain gage - The eight-inch rain gage was at 74 feet above the ground.

1883 – 1906: Walter Benton Gates assumed the role as a volunteer observer, first with the Signal Service and later with the Weather Bureau, in October 1883. The first address given was that of City Hall Park. However, other addresses are indicated including 55 Elmwood Avenue (11/1883-11/1891), 57 Elmwood Avenue (1891-1906) and 301 South Willard Street (1906). The relocation to South Willard Street represented a move to a higher elevation and a residential setting that was further removed from the shores of Lake Champlain. Gate’s observations continued through March 1906.

Thermometer – In 1897, at 57 Elmwood Avenue, Walter Gates listed his thermometer as a “Green’s max and min, and ordinary” mounted in a double blind (Weather Bureau pattern) shelter located on the west side of the house, 12 feet from the ground. In February 1906, located at 301 South Willard Street, the shelter was listed as “attached to north window of house about 1 foot above sod (basement window of house.)”

Rain gage – In 1897, the rain gage was a standard Weather Bureau gage on a post, 3 feet above ground. In 1906, the rain gage was “in a box attached to west veranda of house; top of gage about 7 feet above ground”.

Note: The Weather Bureau station history form of January 1961 just simply lists the extreme thermometers at 5 feet and the rain gage at 4 feet for the entire period October 1883 to March 1906.

1906 – 1943: In 1905, the University of Vermont donated a block of land to the U.S. Government for the purpose of establishing a Weather Bureau office. The building was completed in 1906 and observations began on March 29, 1906. The address for this building was 601 Main Street (Figure 3.) This location was 1 mile east southeast from the previous location. It was recorded by Weather Bureau personnel that “The location is excellent for meteorological purposes but rather far out from the business portion of the city.”

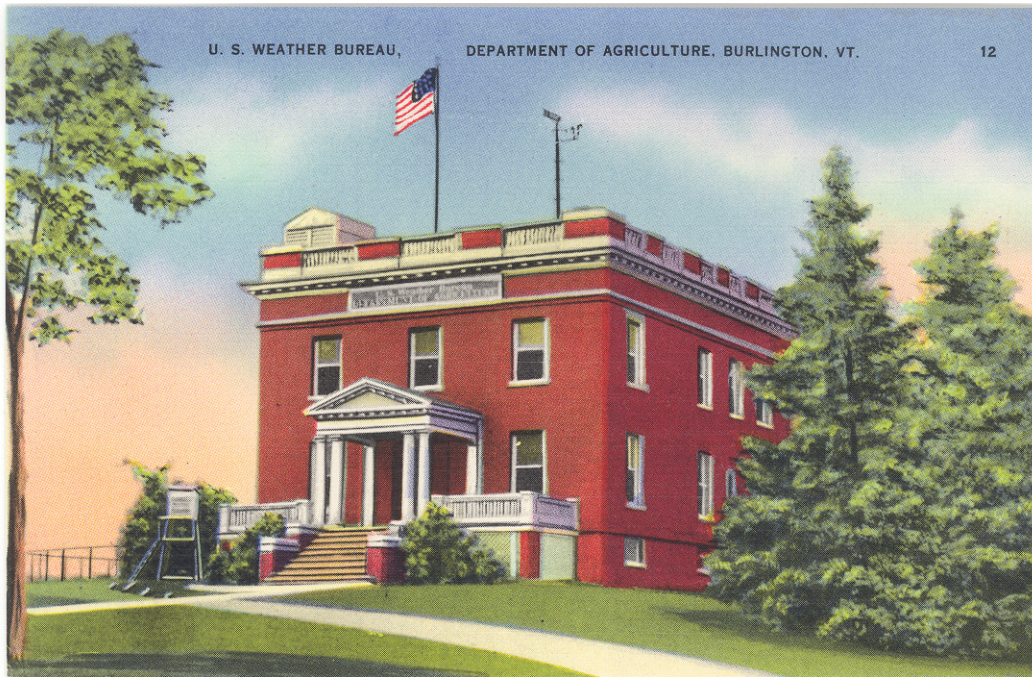


Figure 3. The U.S. Weather Bureau Building located on the campus of the University of Vermont, Burlington, Vermont, circa. 1910. From author's personal collection of post cards.

The location of the instrument shelter and the wind equipment can be clearly seen in the early 1900's picture (see Figure 3.) Observations were taken at this location until June 4, 1943, overlapping with the new observational site at the Burlington Municipal Airport.

Thermometer – The instruments were at 12 feet above the ground.

Barometer – The barometer was located at an elevation of 403.22 feet above mean sea level.

Wind instruments – The wind instruments were at 48 above the ground.

Rain gage – The eight-inch gage was 3 feet above the ground.

1934 – 1950: Observations began at the Burlington Municipal Airport on February 4, 1934. The airport location was 2.5 miles east southeast from the previous site on Main Street. Initially National Airways, Inc., personnel took weather observations as required for their own use. All regular airway reports originated at the City Office.

On March 1, 1939, the first telegraph reports were sent from the airport location. The station was now operated by the U.S. Civil Aeronautics Authority (CAA) who had an office in the northwest corner of the Administration Building. On June 4, 1943, the U.S.

Weather Bureau consolidated the two observing sites in Burlington at the airport location closing the City Office. The Weather Bureau occupied the same office as the CAA had been using.

See Figures 6 and 7 for the location of the Weather Bureau office at the airport in November 1940 and September 1943.

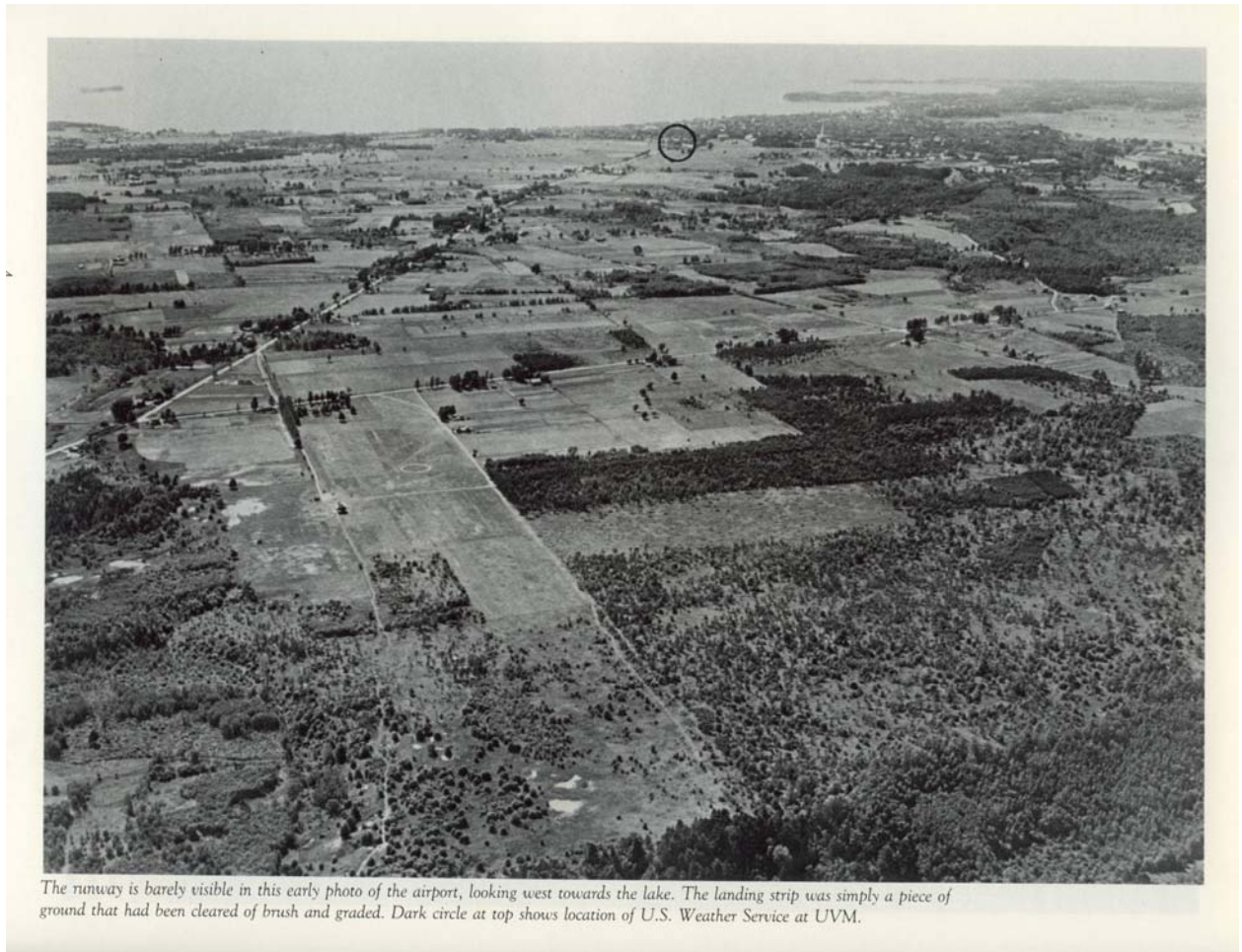


Figure 4 The Burlington, Vermont airport in the 1920's. The caption reads "The runway is barely visible in this early photo of the airport, looking west towards the lake. The landing strip was simply a piece of ground that had been cleared of brush and graded. Dark circle at top shows location of U.S. Weather Service at UVM." Photograph courtesy the Board of Airport Commissioners, Burlington International Airport.

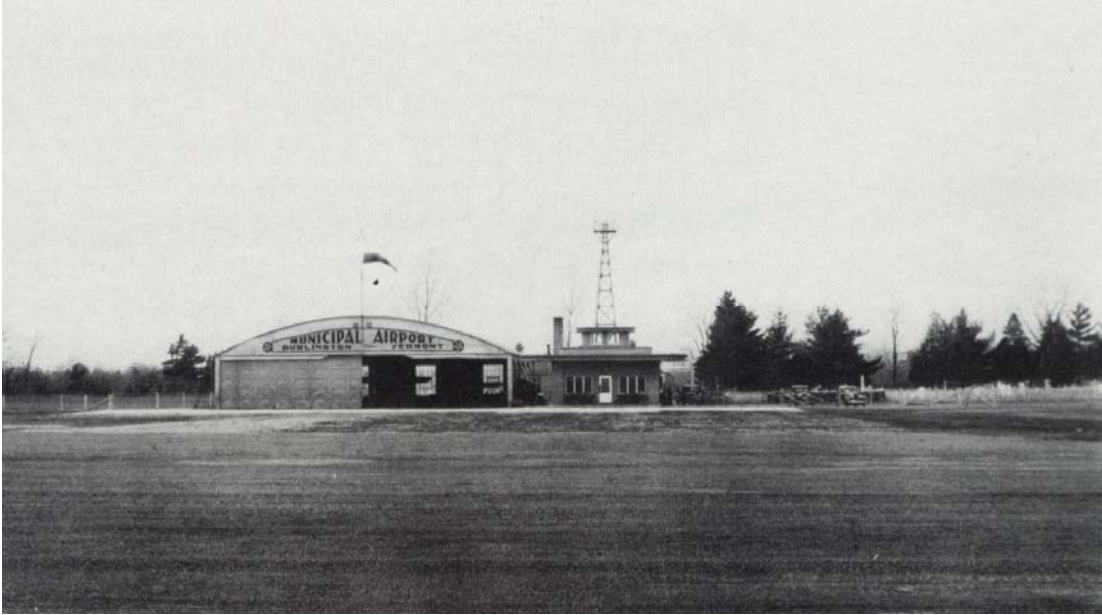


Figure 5. The Burlington, Vermont Municipal Airport in 1934 at the time of the completion of the Administration Building. Photograph courtesy the Board of Airport Commissioners, Burlington International Airport.

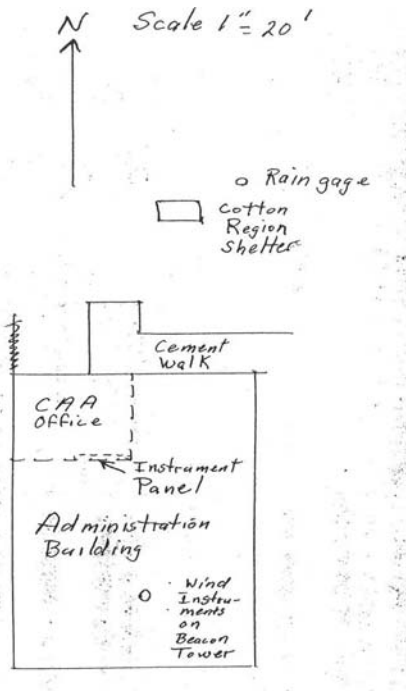


Figure 6. General description of the instrumentation placement at the Burlington, Vermont Municipal Airport in November 1940. From the official station history files, National Climatic Data Center

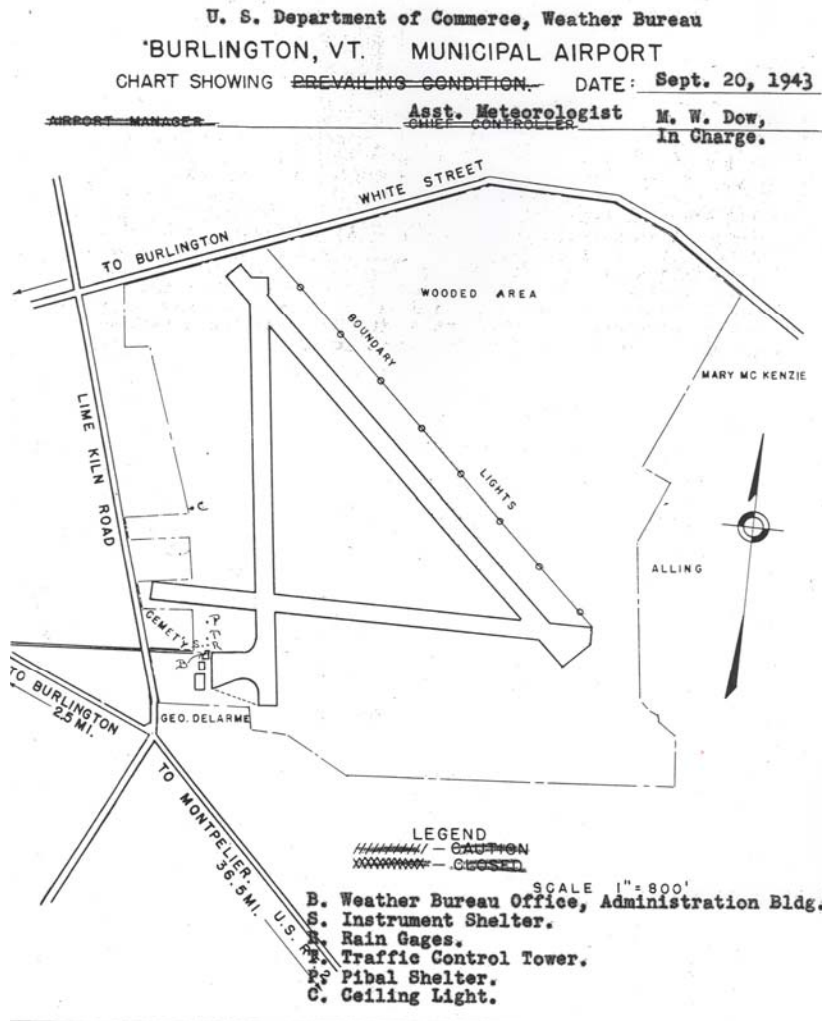


Figure 7. The location of the Weather Bureau office at the Burlington, Vermont Municipal Airport in September 1943. From the official station history files, National Climatic Data Center.

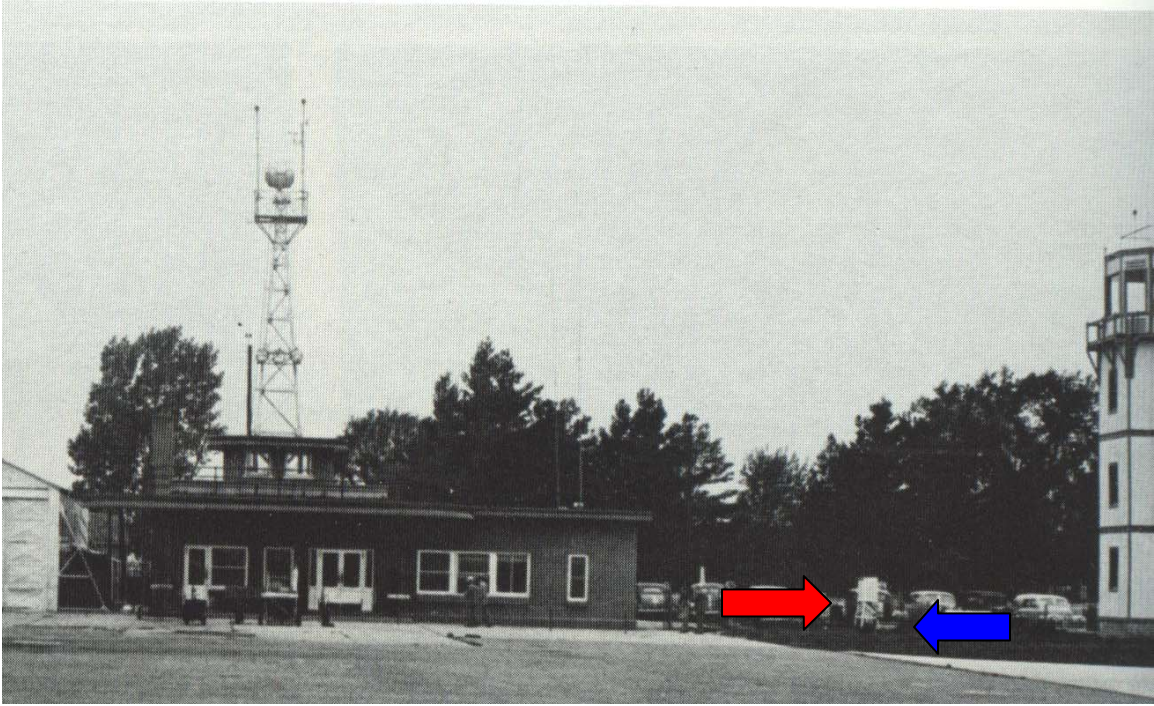


Figure 8. The Burlington, Vermont Municipal Airport circa mid-1940's. The instrument shelter can be clearly seen (red arrow) as well as the rain gage (blue arrow) located between the Administration Building and the Air Traffic Control Tower. Photograph courtesy the Board of Airport Commissioners, Burlington International Airport.



Figure 9. The Air Traffic Control Tower at the Burlington, Vermont Municipal Airport circa mid-1940's. The Tower was 42 feet tall containing 105 steps. Photograph courtesy the Board of Airport Commissioners, Burlington International Airport.

Thermometer – The “Airways Shelter” was located over a grass plot with a good exposure as of February 7, 1934. The mercury-alcohol maximum and minimum thermometers and a psychrometer with a fan were located in the shelter which was 5 feet above the ground. Initially the shelter was “..installed somewhat too high for average person but post will be cut down so that shelter will be about five feet above ground.”

After the 1939 addition to the Administration Building the instrument shelter, still an “airways shelter” was located 20 feet north of the north door of the building. The shelter was at 5.5 feet (station reports beginning in 1941 indicate height of the shelter floor as being 4 feet above the ground with the dry bulb being 6 inches above the floor) and located over sod. On November 9, 1940, a Weather Bureau Cotton Region Shelter was installed 25 feet north of the Administration building. It was mounted on a Townsend support. Maximum and minimum thermometers and a fan were installed. A 2 foot high picket fence around the 10 foot square area housing the shelter and rain gage was

requested in November 1940 to “..prevent molestation of equipment.” It is not clear if this fence was built or not. See Figure 8. The Air Traffic Control Tower was constructed 20 north of the instrument site in 1942.

In September 1943, the station inspector recorded the following, “Exposure only fair. Too close to runways, building, etc., and over sand soil. Maxima several degrees higher than City Office readings on sunny days; minima lower on clear nights, due to radiation.”

Barometer – In 1934, the station only had an aneroid barometer, number 1497. Corrections were supplied by the City Office on a regular basis. An H. J. Greene, Fortin type mercurial barometer, number 1173, at an elevation of 335.74 feet mean sea level was installed on May 22, 1939. The station was also equipped with a 7-day, scale 1 to 1 barograph in March 1939 but this was replaced in November 1940 with an “open-scale” 4-day barograph. The aneroid barometer was removed from the station in November 1940.

At the time of the consolidation of the City Office and the airport offices in June 1943, an aneroid barometer (number 2025A) and an extra mercurial barometer (number 570A) were available at the airport location.

Wind instruments – Initially no wind instruments were available at the airport location. A pressure type wind speed indicator, an Apthorp Windmeter, was installed by the city and was used by the airline personnel as needed. On March 15, 1939, a Weather Bureau anemometer and a wind vane were installed at the top of the Beacon Tower. The 3 foot metal vane and the 3-cup anemometer were mounted on a 12 foot support mounted on the floor of the tower giving a total height of 51 feet above the ground. This location was chosen as it was the “..only exposure possible as administration building roof too low; obstructions near especially large hanger 80 feet to south.” Station reports from 1941 and 1942 indicated that the height above ground was 60 feet although the wind support continued to be listed as 12 feet.

The April 15, 1943 station report indicates that the wind instruments were located on the Beacon Tower which was on the roof of the Administration Building. The instruments were mounted on a 12 feet support, 37 feet above the roof of the building and 51 feet above the ground. The anemometer continued to be of the 3-cup design and the vane a 3 foot metal type. See Figure 8. One station report had a hand written entry that on September 20, 1943 the CAA had wind instruments mounted on the top of the Air Traffic Control Tower but it is unclear if this replaced the Administration Building location or was, in deed, a second set of instruments. The wind vane can be seen on the ATC Tower roof in Figure 9.

Rain gage – An eight-inch copper rain gage was installed on the ground 26 feet north of the Administration Building on November 9, 1940. The top of the gage was 3 feet above the ground. At this same time a snow gage (with box support), a snow board,

and a 3-foot snow-measuring stick were made available. The ATC Tower was constructed 20 feet north of the gages in 1942. See Figure 8.

In June 1943 a Friez tipping bucket gage was installed at the airport. The top of the gage was 3.5 feet above the ground. The station report of September 1943 states that “Location of rain gages only fair; located midway between Administration Bldg. and Traffic Control Tower, about 30 ft. from each. Probably not badly effect by former, which is only about 15 ft. high, and not too badly by latter, which tho 45 ft. high is only 12 ft. square.”

Other instruments – By 1938 the station was equipped with a ceiling light projector and a clinometer. In June 1943, a sunshine recorder was located at the airport.

1950 – 1973: The Weather Bureau moved to the new Administration Building on February 15, 1950 a move of some 0.3 miles north from the previous location. The Weather Bureau occupied three rooms on the second floor of the building including an operations room, balloon inflation and storage room, and an office for the Official in Charge. See Figure 10 for a sketch of the station layout. The offices and instruments remained in this location until July 19, 1973.

A note on the Exposure and Installation of Instruments form dated May 16, 1955, reveals that the “Shelter is located between parking lot and ramp, both of which are blacktop.”

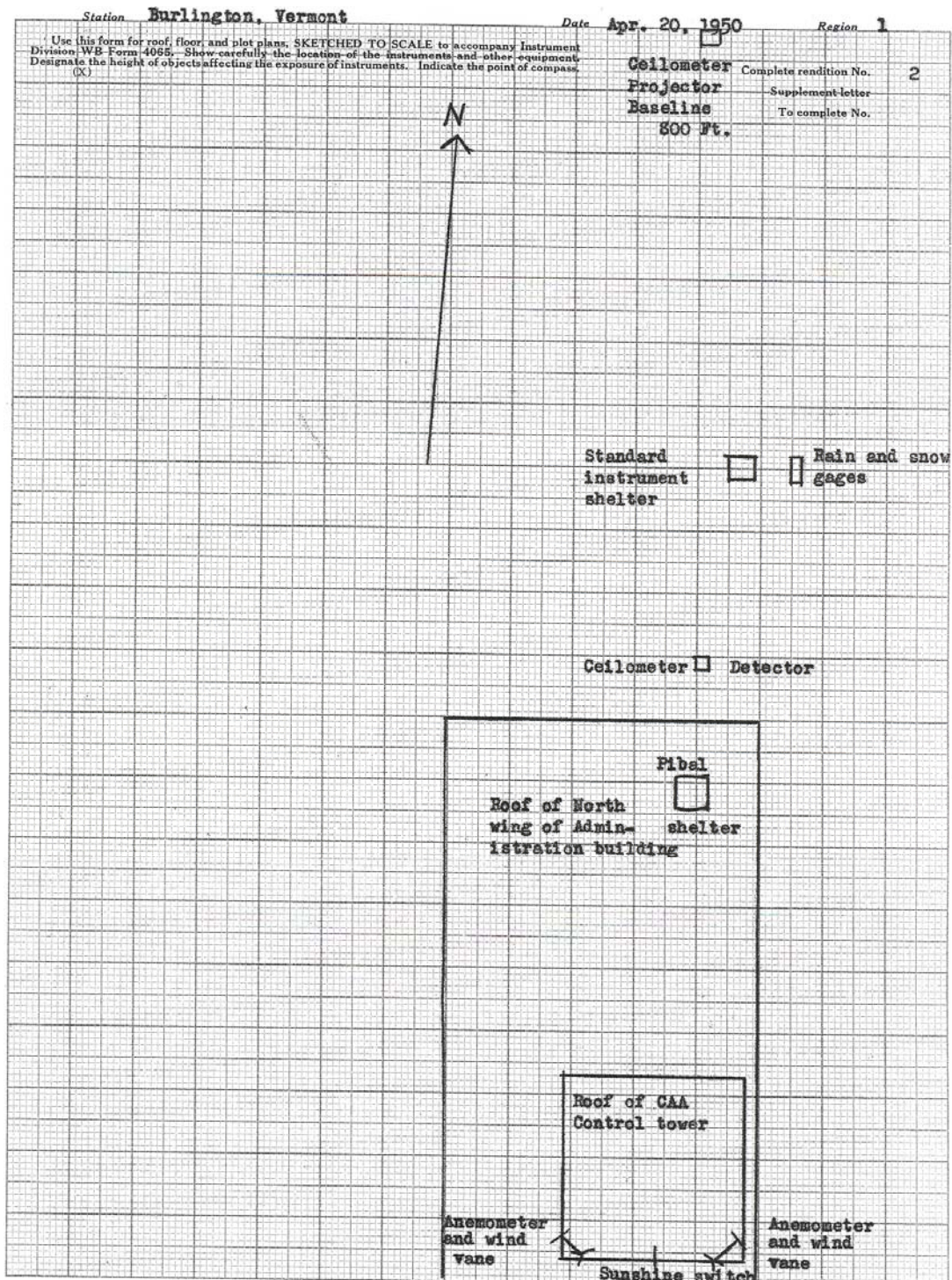


Figure 10. A sketch of the layout of the weather instruments at the Burlington, Vermont Municipal Airport in April 1950. From the official station history files, National Climatic Data Center.



Figure 11. The Burlington, Vermont airport Administration Building in 1950. The weather instruments were located some 30 feet to the north (right) of the building. Photograph courtesy the Board of Airport Commissioners, Burlington International Airport.

Thermometer – The Weather Bureau maximum and minimum thermometers were housed in a “large shelter” 5 feet above the ground. The shelter was located 30 feet north of the Administration Building. The shelter also housed a psychrometer, at 5.5 feet above the ground, and a Friez thermograph at 6 feet. A telepsychrometer, with a height of 5 feet above the ground was available from February 15, 1955 until November 1, 1959. A hygrothmometer, with a height of 4 feet above the ground, was installed 1300 feet NNW of the thermometer site on November 1, 1959. The hygrothmometer was moved 2000 feet of the previous location on November 16, 1964. The height above ground remained at 4 feet.

An interesting note found in the inspection report of January 1951 states, “It was estimated at this station by this Field Aide that to take 8 hourly temperatures an observer must walk a distance of 1 ¼ miles to the shelter and back alone. A roof exposure or steps down the side of the building would eliminate much of the extra steps now necessary.”

Barometer – The station mercurial barometer, number 1173, was located at an elevation of 348.52 feet mean sea level. The station was equipped with a 4-day Micro barograph located 20 feet above the ground, a Kollsman precision aneroid barometer (number 1932) located 19 feet above the ground, and an extra mercurial barometer (number 570-A).

Wind instruments – The anemometer was located 6 feet above the Control Tower roof (which was on the roof of the Administration Building) at 55 feet above the ground. On November 5, 1953, the instruments were raised to 60 feet. On September 6, 1958, were the instruments were “remoted to the field” changing the height to 20 feet. They were moved again on November 16, 1964 to a location 1,200 feet east of terminal building, the height remaining at 20 feet.

Rain gage – The eight-inch Weather Bureau gage was located 30 feet north of the Administration Building. The top of the gage was at a height of 3 feet above the ground. The Friez tipping bucket gage was also in this location with a height above ground of 3 feet.

Other instruments – The station also had the following instruments: a triple register, a ceiling light and a ceilometer. A sunshine switch was installed in June 1951.

Observer Stories

Zadock Thompson

Zadock Thompson, 1796-1856, graduated from the University of Vermont in 1823, where in 1851, he became a Professor of Chemistry and Natural History. He wrote many almanacs and gazetteers, schoolbooks and was the editor of *Iris and Burlington Literary Gazette* and *Green Mountain Repository*. He authored many histories including *History of Vermont, Natural, Civil, and Statistical*. He was the Vermont State Geologist from 1845 until 1848.

Like many of the early observers, Zadock Thompson compiled his observations into a published manuscript entitled “Natural History of Vermont”, in 1853. In the mid-19th century, “very little damage is ever done by hurricanes and hail. The crops oftener suffer from an excess, than from a deficiency of moisture, though seldom from either.” Thompson’s keen eye also noted the key characteristics of the Vermont landscape that make it prone to flash flooding, most notably the steep V-shaped valleys which help to constrain stream flow, producing fast-flowing walls of water. Thompson and his wife, Phebe, took observations in Burlington and southern Quebec from 1829 until December 1856.

Karen Andsager, Midwestern Regional Climate Center, notes that for the period 1849-1854, there are overlapping documents. It looks like the observer, Zadock Thompson, was recording all of his observations in a hand-drawn table in a journal. For the period up through 1850, he copied the observations into another hand-drawn journal. This journal-copy is the available record up through 1850. Also, starting in 1849, he copied the observations into a printed form. This form-copy is the available record starting in 1855. There are some breaks (missing months) in the form-copy during the overlapping period. The observer's original observations in the hand-drawn journal are available for 1850-1854.

Andsager also notes that the interesting thing about these different records is that the observer did not copy all of his observations into either the journal-copy or the form-copy. The original documents (Figure 12) include observations for Sunrise, 9AM, 1PM, 3PM, and 9PM. The journal-copy (Figure 13) includes observations for Sunrise, 1PM and 9PM. The form-copy (Figure 14) includes observations for Sunrise, 9AM, 3PM, and 9PM, through the end of 1852. In 1853, the original changes to the observation times of Sunrise, 7AM, 1PM, 2PM, and 9PM. The form-copy then includes 7AM, 2PM, and 9PM. And just to add to the confusion, there is a third copy, where the observer was copying all (or almost, anyway) of his observations over neatly into a journal exactly the same as the original, but it is available only for 1851, part of 1852, and 1855.

Figure 12. The original journal from January 1851, Burlington, Vermont as recorded by Zadock Thompson. From National Climatic Data Center archives.

Figure 13. A copy of journal from January 1851, Burlington, Vermont as duplicated by Zadock Thompson. From National Climatic Data Center archives.

dependence upon the bureau for weather and climate information, much the same way that State Climatologists function today.

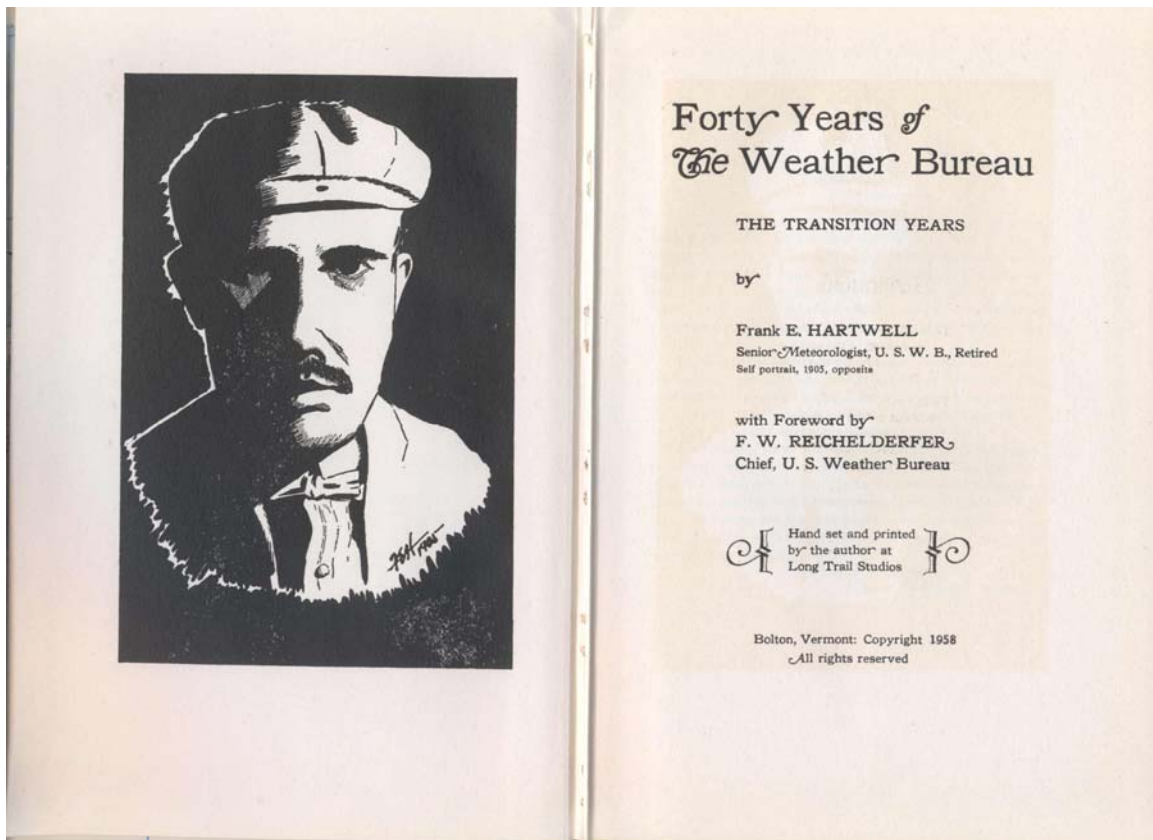


Figure 15. A self portrait of Frank E. Hartwell, meteorologist at Burlington, Vermont from 1919 until 1930 and the cover page for his book “Forty Years of the Weather Bureau, The Transition Years” written in 1958.

The Weather Bureau Building, University of Vermont

The Weather Bureau Building at 601 Main Street in Burlington, Vermont, still stands on the campus of the University of Vermont. The exterior of the building, now known as the Adams Building, remains largely as it was when constructed in 1905. The building was nominated to the National Register of Historic Places in 1997. See the history at http://www.wvm.edu/about_uvm/history/tour.php?tp=true&Page+tour.php&building=45 Figure 16 shows the Adams Building as it stands today, almost exactly as it appeared in 1907 (Figure 3.)



Figure 16. The Weather Bureau Building (presently the Adams Building) at 601 Main Street in Burlington, Vermont as it appears today. From the University of Vermont web site.

This building was one of 25 similarly designed buildings constructed by the Weather Bureau between 1900 and 1910. It has been found that at least 13 of these buildings still exists today housing offices for universities, lawyers, doctors and a seed dealer. Several serve as Bed & Breakfast hotels, one is a private residence, and one is now a museum on a military battlefield.

References and Data Sources

Observational forms as found in the National Climatic Data Center archives

Station history forms as found in the National Climatic Data Center files

Report of the Chief Signal Officer – 1871

Bailey/Howe Library, University of Vermont

Thompson, Zadock, 1853: *Natural History of Vermont with Numerous Engravings and an Appendix*

Meteorology in America, 1800-1870, by James Rodger Fleming

Board of Airport Commissioners, Burlington International Airport, P.O. Box 2302, South Burlington, Vermont, Robert A. McEwing, Director of Planning & Development.

Fletcher Free Library, Burlington, Vermont, reference desk

Andsager, Karen, Midwestern Regional Climate Center, University of Illinois, Champaign, Illinois.

APPENDIX I - METHODOLOGY

The primary sources of information for this study were the Burlington observers' daily weather records themselves. Copies of their monthly reports were available from the National Climatic Data Center's on-line system called WSSRD. The monthly reports can be considered primary sources because they were written by the observers and not altered by subsequent readers. Station history files at the Data Center also provided details as to station and instrument history.

A variety of secondary sources held information about the city and its weather observers including the Baily/Howe Library at the University of Vermont, the public library, and Zadock Thompson's book. Ms. Kelly Quay and Robert A McEwing with the Burlington International Airport helped supply many of the airport historical pictures. Dr. Lesley-Ann Gupigny-Giroux, the State Climatologist for Vermont, and her student, Adam Hillman, assisted greatly in this effort.

All these sources were gleaned to obtain a glimpse into the lives of the observers, the location of the observation site, and the historical environment that produced the climatic history of Burlington, Vermont. Maps, drawings, and photographs were included when appropriate to illustrate the information.

Street maps were generated using Microsoft's Streets and Trips software.