

HISTORY OF WEATHER OBSERVATIONS  
Fort Union, New Mexico  
1851 - 1891

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# HISTORY OF WEATHER OBSERVATIONS

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Gary Grice

## INTRODUCTION

### Historical Overview

Fort Union was located in the Mora Valley in northeastern New Mexico approximately 24 miles northeast of Las Vegas, NM. (Figure 1). The Mora Valley extends northwest to southeast with mountains just to the west. Elevation around the fort was listed at approximately 6,700 feet above sea level, with the climate semi-arid, approximately 18 inches of rain falling annually.



**Figure 1. Location of Fort Union with respect to present day Las Vegas, NM. North is at the top of the page. Locations are plotted on a current map of northeast New Mexico. Distance from left to right side of the map is approximately 50 miles.**

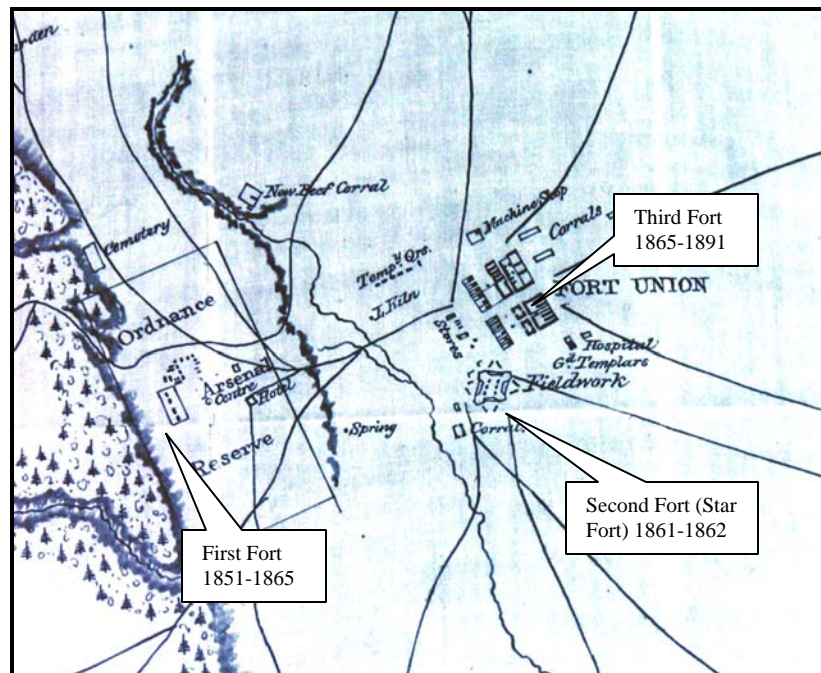
Following Mexico's independence from Spain in 1821, the Mexican Government was eager to trade with the United States, with Santa Fe being the focus of trading activities. As the volume of trade increased between the U.S. and Santa Fe, the need for an established route became apparent, and in 1825 a suitable path from Kansas to New Mexico was surveyed by the U.S. Military. By 1830 the Santa Fe Trail, an international

highway between Mexico and the U.S., was established, with the Mora Valley occupying a strategic and economically important position on the trail.

When war broke out between the United States and Mexico in 1846, the Santa Fe Trail was transformed into a military road. Following the Mexican War, and with the acquisition of New Mexico in 1848, the United States assumed the responsibility of protecting traders and travelers on the Santa Fe Trail. The U.S. also needed to protect settlers in northeast New Mexico. In 1851 almost 1,300 soldiers were stationed at 11 outposts in New Mexico, and some consolidation was needed to protect the frontier.

To meet this need, Secretary of War Charles M. Conrad, asked Lt. Col. Edwin V. Sumner to consolidate military posts in the new territory. As soon as he arrived in Santa Fe, Col Sumner issued orders to remove "the troops and public property" to a new location named Fort Union. He consolidated troops from Las Vegas, Albuquerque, Socorro, El Paso, and other posts at the new fort.

Construction of Fort Union began in 1851, and by the end of the first year, more than 30 buildings had been erected. This was the first fort (Figure 2) to be built at Fort Union. Because of its strategic position, Fort Union would be the center of activity in northern New Mexico and along the Santa Fe Trail for almost 40 years.



**Figure 2. Fort Union complex showing locations of the three forts (circa 1868). The last date for the first fort and first date for the third fort are approximate. The move from the first fort to third fort was an evolutionary process from around 1863 until 1868 as facilities were built at the new fort. The hospital moved from the first fort to the third fort in the spring of 1865 (exact date unknown). North is at the top of the page. Distance is approximately two miles across the map (horizontal). From the National Archives and Records Administration.**

When the Civil War began, most officers at Fort Union (who were from the south) resigned from the U.S. Army and joined the Confederacy. During the Civil War, Union soldiers constructed a massive earthen fortification one mile east of the original fort, later to be called the Star Fort (second fort). The Star Fort was built in 1861 to block the Santa Fe Trail against Confederates advancing from the south and was essentially abandoned in 1862 after the Confederate threat to the area subsided.

In early 1862 the Confederates advanced up the Rio Grande Valley, forcing Union troops to evacuate from Santa Fe and Fort Marcy to Fort Union. In late March 1862, a decisive battle was fought in Glorieta Pass, NM, and the Union troops achieved a victory during the 3 day battle, forcing the Confederates to retreat back into Texas, and eliminating the threat to northern New Mexico for the remainder of the Civil War.

In 1863, orders were given to the post to build a new fort one mile east and adjacent to the earthworks Star Fort. This new fort contained three major sections: the Post, the Quartermaster Depot, and the Ordinance Depot. The new fort (or Third Fort) was started in 1863 and completed in 1868. The new buildings at Fort Union were constructed of adobe brick on stone foundations and coated with plaster. The main structures were covered with tin roofs, except the hospital, which was shingled. The new Fort Union was the largest military installation in New Mexico. In addition to normal military functions, Fort Union became the army's supply center for the Territory. The post became the headquarters for the Quartermaster, distributing supplies to forts throughout New Mexico and the Southwest.

During the late 1860s and much of the 1870s, Fort Union was the center of battle with the Mescaleros, Kiowas, Comanches, Cheyennes, and Arapahos. Eventually, the Indians were driven from the western plains or placed on the hated reservations, and the military importance of Fort Union began to diminish.

During the 1880s Fort Union continued to lose its military importance and commercial usefulness, especially after the arrival of the railroad eight miles east of the post (at the present town of Watrous, NM) in 1880. During the 1880s, the number of soldiers stationed at the fort decreased significantly. In 1890 the War Department decided to close many of the old frontier posts, including Fort Union, and on 21 February 1891, Fort Union officially closed, although the hospital did not close until 20 April 1891.

The first weather observation at Fort Union (according to the National Climatic Data Center, i.e., NCDC, database) was 1 August 1851. Weather observations were taken by the Army surgeons most likely near the existing hospital. An almost continuous string of weather observations exists at the fort for almost 40 years, with the greatest gaps occurring from April 1864 through March 1865 and September 1865 through August 1866. The earlier gap was the approximate time the hospital moved from the first fort to the third fort. The last weather observation at Fort Union was 26 February 1891.

## **Goal of the Study**

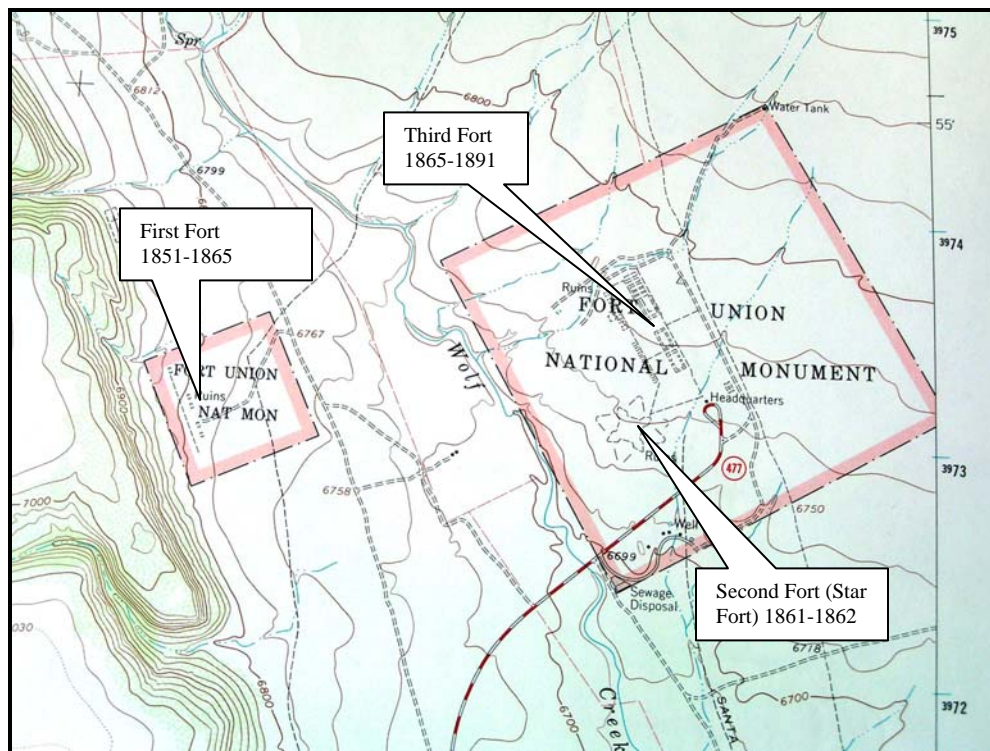
The goal of this study was to document the location and exposure of weather instruments at Fort Union, NM. The scope of this study primarily covered the 19<sup>th</sup> Century. Extrinsic observations related to the Army surgeons' weather observing program also were considered.



## LOCATION OF OBSERVATIONS

Fort Union was located in the Mora valley, about 24 miles northeast of present-day Las Vegas, NM. At Fort Union, the valley was approximately five miles wide, with Wolf Creek in the center, draining the area. The soil around the fort was composed of fine sand, with a slight mixture of yellowish clay, rock, and beds of lava. Army records stated that when digging the water wells for Fort Union, lava was found at varying depths.

The first fort was built just east of the mountains (Figure 3) with approximate elevation 6,790 feet (based on the topographic map). Terrain gently sloped down to the east of the fort and rose rapidly to the west.

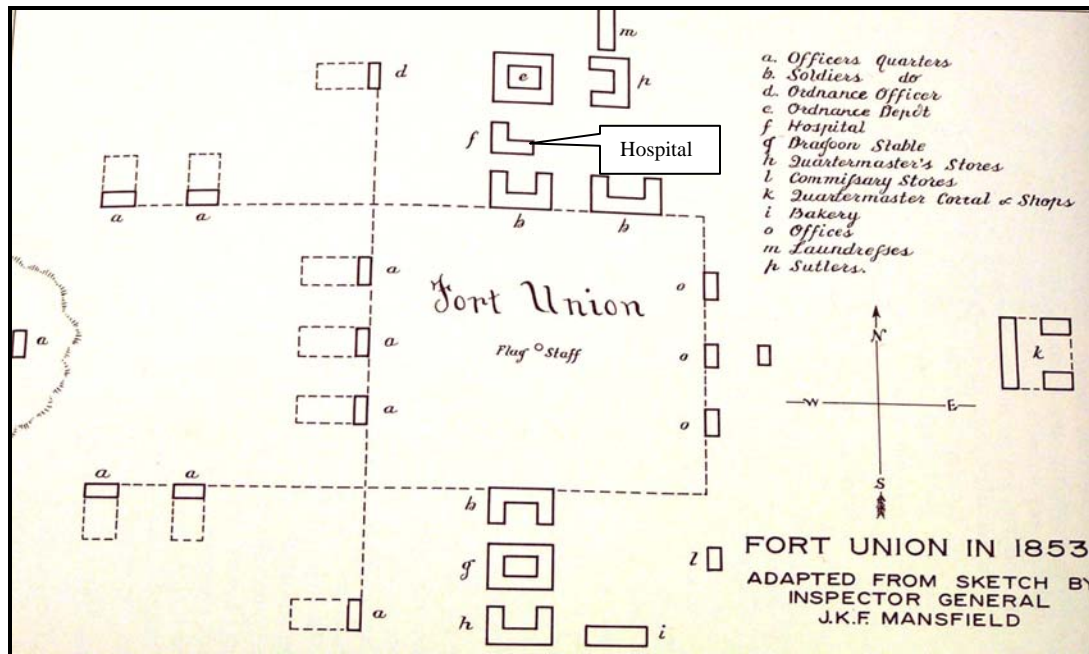


**Figure 3. Topographical map (prepared by the Army Map Service and USGS; 1963) for the Fort Union area. North is at the top of the page. Distance is approximately two miles across the map (horizontal).**

The second fort (Star Fort) and third fort were located approximately one mile east of the first fort and across the Mora Valley with Wolf Creek in the center. Elevation of the second fort was approximately 6,760 feet and elevation of the third fort approximately 6,780 feet. Terrain at both forts gently sloped upward toward the northeast. Hospitals, where weather observations most likely were taken, were located at the first and third forts.

## First Fort Hospital

The first fort was oriented primarily east-west (Figure 4) with the hospital located on the northern part of the fort complex



**Figure 4. Schematic of first Fort Union (circa 1853). North is at the top of the figure. From the Fort Union National Monument, National Parks Service.**

Available resources indicate the hospital was completed in late 1851 or early 1852. Prior to the completion of the hospital, medical services were provided out of tents. Since meteorological records began at Fort Union in August 1851 (according to the NCDC database), it is possible some of the observations were taken while the surgeons operated out of tents (exact location of the medical tents is unknown).

Buildings at the first fort were constructed from lumber that was not allowed to cure properly. The hospital originally had an earthen roof, but was replaced with wood after a couple of years. The early hospital was considered “comfortable” by the surgeon, but after a time, the building, and especially the roof, began to leak. In 1856, the post surgeon stated that during rains, not a room remained dry, and that the property had to be covered by tents for protection.

By around 1860, the condition of the hospital had deteriorated to a point of being uninhabitable. In the early 1860s (exact date unknown but prior to 15 June 1862) the hospital was moved to the old commanding officer’s quarters (at the first fort), who had in turn moved to the second fort that was under construction. The new location of the hospital could not be determined, but was likely somewhere on the square of the first fort, i.e., southeast, south, or southwest of the previous hospital position.

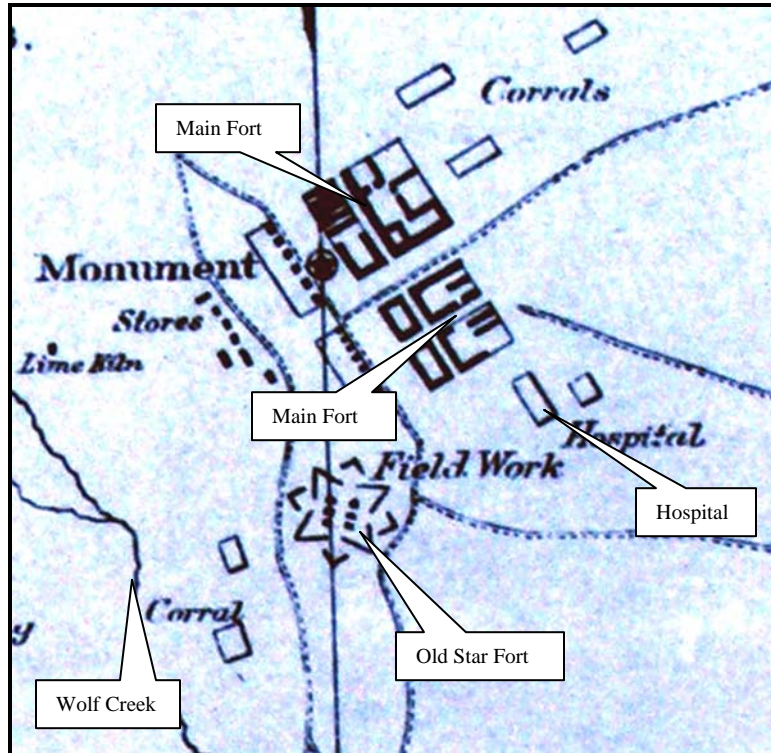
First mention of coordinates for Fort Union was on the June 1852 forms, and was listed as 35°54'21"N, 104°57'15"W. From the 1850s into the early 1860s, latitude/longitude and elevation changed occasionally, most likely reflecting the lack of refinement in measuring those parameters. Below are listed the changes in coordinates from the early 1850s until the mid 1860.

January 1852	35°54'21"N	104°57'15"W
July 1854	35°44'21"N	104°51'15"W
March 1855	35°44'21"N	104°57'15"W
October 1856	35°54'21"N	104°57'15"W
May 1860	35°54'21"N	104°51'15"W
December 1860	35°54'21"N	104°57'15"W

Initial elevation was listed as "6,670 feet approximate" on the July 1862 form, with the elevation remaining unchanged until 1870.

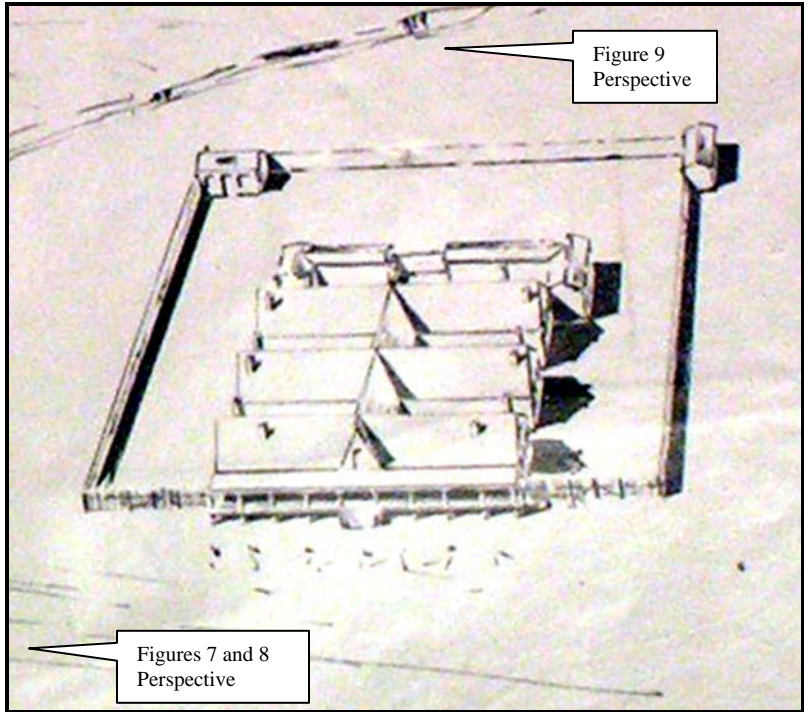
### **Third Fort Hospital**

During the period of the Star Fort (1861 – 1862), the hospital remained at the old first fort. However, the condition of the hospital (at the former commanding officer's quarters) continued to deteriorate. In June 1863, the commanding officer appointed a board of officers to design and select a site for a new hospital at the new (third) fort. The hospital was completed during the spring of 1865 (Figure 5).



**Figure 5. Third Fort Union (1874). Hospital was approximately 300 yards southeast of the main post. North is at the top of the page. From the National Archives and Records Administration.**

The hospital (where the surgeons likely took the weather observations) was located approximately 300 yards to the southeast of the garrison enclosure and also faced southeast (Figure 6). It consisted of a central building approximately 16 feet wide and 130 feet long with a 12 foot hall inside. Attached to each side of this central hall were three wings, each 31 feet wide and 39 feet long. The wings were separated from each other by approximately seven feet. The hospital differed from the other buildings on the post by having a roof of shingles with slope of the roof being a different pitch. Figures 7 through 9 show the hospital from various perspectives.



**Figure 6. Fort Union hospital (circa late 1870s). North is to the upper right of the figure. From the New Mexico Highlands University Library.**



**Figure 7. Front view of Fort Union hospital (circa mid 1860s) looking north. From the Fort Union National Monument, courtesy of the National Museum of Health and Medicine, Armed Forces Institute of Pathology.**



**Figure 8. Front view of Fort Union hospital (circa late 1880s) looking north. From the Fort Union National Monument, courtesy of the National Museum of Health and Medicine, Armed Forces Institute of Pathology.**



**Figure 9. Rear view of Fort Union hospital (circa late 1880s) looking southeast. The small white building on the left may have been the location of the meteorological instruments (see text). From the Fort Union National Monument, courtesy of the National Museum of Health and Medicine, Armed Forces Institute of Pathology.**

The exact location of the weather instruments at the hospital could not be found. However, it is possible the small white building to the left of Figure 9 housed the instruments, at least after January 1877. The January 1877 Medical History Report from

the Fort Union surgeon stated, “New House for safe keeping of Meteorological (sic) observations was erected on Jan. 3<sup>rd</sup>, 1877,” and the March 1877 report stated, “A meteorological instrument house constructed.” Instructions in place from the Army Surgeon General’s Office required instrument shelters to be painted white, and since the building in Figure 9 is the only building in the hospital complex painted white, it is possible this structure housed the weather instruments, although this building does not meet other requirements established by the Surgeon General’s Office (see section on instrumentation). All available resources indicate weather observations were taken in the vicinity of this hospital from early 1865 (when the surgeons moved from the hospital at the first fort to the third fort hospital) until the last observation was taken 26 February 1891.

Latitude/longitude listed on the weather observation forms for this location were 35°54’21”N, 104°51’15”W. Elevation was listed as 6,670 feet. In July 1870 the elevation was changed to 6,835 feet above sea level, and changed to 6,700 feet in December 1874 where it remained until the last observation in 1891. GPS coordinates for the remains of the hospital are 35°54’20”N, 105°0’39”W. GPS elevation for the hospital remains is 6,787 feet.

## **INSTRUMENTATION**

### **Army Surgeon Observations**

The first observation available in the NCDC database for Fort Union was on 1 August 1851.

Initial weather measurements/observations at Fort Union consisted of the following parameters:

1. Temperature (Fahrenheit) – Measured four times daily (Sunrise, 9:00 a.m., 3:00 p.m., and 9:00 p.m.).
2. Clearness of the sky – Four times daily (the amount of clear sky at the hour of observation expressed from “0” to “10,” with “0” indicating no clear sky and “10” indicating no clouds)
3. Wind direction and force – Four times daily (direction expressed on an eight-point compass and wind force (subjectively determined) expressed on a scale from “0” for calm conditions, to “10” for a “violent hurricane”; e.g., SW4)
4. Clouds – Four times daily (direction from which the clouds were moving (eight-point compass) and cloud movement expressed on the same scale used for the force of the surface wind, i.e., “0” for no movement to “10” for movement corresponding to a “violent hurricane,” e.g., NE2 or SE1)
5. Daily rainfall – Beginning, ending, and amount
6. Significant weather recorded in the “Remarks” section.

Pressure and atmospheric moisture initially were not measured at Fort Union. Figures 10A and 10B are examples of the initial observations.



1851		Barometer.				Thermometer attached.				Thermometer detached.					Clearness of the Sky.				Wind	
Day	Month	Sun rise.	9 A. M.	3 P. M.	9 P. M.	Sun rise.	9 A. M.	3 P. M.	9 P. M.	Sun rise.	9 A. M.	3 P. M.	9 P. M.	Daily Mean.	Sun rise.	9 A. M.	3 P. M.	9 P. M.	Sun rise.	9 A. M.
1										46	69	77	49	61.5	4	6	8	4	NE	NE
2										45	72	81	52	63	3	7	6	2	WS	WS
3										49	76	82	44	68.5	8	9	10	5	NI	WS
4										52	70	89	50	70.5	7	10	8	4	NI	WS
5										50	67	75	49	62.5	5	9	8	5		WS
6										44	70	75	46	59.5	5	9	9	4	NI	WS
7										47	59	65	46	56	5	9	6	3	WS	SE
8										50	75	69	47	59.5	5	10	9	5	SE	WS
9										45	64	70	46	57.5	7	9	10	4	ES	
10										47	65	67	50	57	4	9	10	5	NI	WS
11										52	69	74	52	63	7	10	9	3	NI	
12										48	58	67	44	57.5	5	7	8	3		S

Figure 10A. Weather observation form for Fort Union, NM for September 1851 (left side of observation form). The August 1851 form was not clearly legible in the NCDC database. From the official station history files at the National Climatic Data Center.

FORM NO. 3		METEOROLOGICAL REGISTER.												FORM NO. 3.			METEOROLOGICAL REGISTER.												37 225		
Clearness of the Sky.		Wind.				Clouds.				Wet Bulb.		Rain.			REMARKS.																
8 A. M.	9 P. M.	Sun rise.	9 A. M.	3 P. M.	9 P. M.	Sun rise.	9 A. M.	3 P. M.	9 P. M.	Sun rise.	3 P. M.	Began.	Ended.	Quantity.																	
8	4	NE	NE	SE	SE	NE	NE	SE	SE																						
6	2	WS	WS	WS		WS	WS	WS	NI			8 am	3 pm	0.25																	
10	3	NI	WS	WS	WS		WS	WS	WS																						
8	4	NI	SE	NI	SE	NI	SE		NI																						
8	5		WS	SE		WS	WS	WS	SE			3 pm	5 pm	0.47	Thunder & lightning not very remote on S. W. direction 30-40° from horizon. (in the evening)																
9	4	NI	WS		WS		WS	NI				6 am	10 am	0.45																	
6	3	WS	SE	SE		WS	SE	SE																							
9	5	SE	WS		NI	SE	SE	WS	NI																						
10	4	ES		WS		WS	NI	WS																							
10	5	NI	WS		SE		WS	WS	SE																						
9	3	NI		SE	WS	NI	WS	WS																							
8	3		S	SE	E	NI	WS	WS				5 am	3 pm	0.70	Thunder preceding the rain for about 2 hours.																

Figure 10B. Weather observation form for Fort Union, NM for September 1851 (right side of observation form). From the official station history files at the National Climatic Data Center.

Based on observations in the NCDC database, it appears the Fort Union surgeons initially had a thermometer, rain gage, and possibly a wind vane.

Based on available information, Army field surgeons were given considerable flexibility in locating the station's detached (or exposed) thermometer. According to instructions from the Army Surgeon General in effect in the early 1850s:

“The Thermometer will be placed in a situation having a free circulation of air, not exposed to the direct or reflected rays of the sun, and sheltered from rain. Its situation should be remote from massy walls, which slowly imbibe or part with caloric. In making observations avoid breathing on the instrument, or touching it; and at night manage your lamp so as not to cause a rise of the mercury by its heat.”

It appears the exposure of the thermometer was changed in May 1852. A note on the May 1852 observation form (observer's handwriting was difficult to decipher) indicates temperature readings at 3:00 p.m. seemed too high to the observer and was the result of “faulty exposure of the instruments.” The observer indicated he discerned “...this fact only on the 27<sup>th</sup> of May and since then have had the thermometer put in a proper place.”

The following is a description of rain gages used by Army surgeons in the early 1850s along with instructions issued by the Army Surgeon General's Office for taking rainfall observations:

“The instrument employed is the conical rain gauge of De Witt; and observations are ordered to be made immediately after every shower or fall of rain or snow.’

‘The instrument used to measure the quantity of rain which falls, is the conical rain gauge. It will be kept remote from all elevated structures at a distance at least equal to their height, and still further off, where it can be conveniently done. It is to be suspended in a circular opening, made in a board, which is to be fixed to a post, eight feet from the ground; the opening to be five inches in diameter, and beveled, so as to fit the side of the gauge, into which the cap is to be fixed, base downwards, to prevent evaporation.’

‘In freezing weather, when the rain gauge cannot be used out of doors, it will be taken into the room, and a tin vessel will be substituted for receiving the snow, rain, or sleet that may then fall. This vessel must have its opening exactly equal to that of the rain gauge, and widen downwards to a sufficient depth, with a considerable slope. It should be placed where nothing can obstruct the descending snow from entering, and where no drift snow can be blown into it. During a continued snow storm, the snow may be occasionally pressed down. The contents of the vessel must be melted by placing it near the fire, with a cover to prevent evaporation, and the water produced poured into the gauge to ascertain its quantity, which must then be entered into the Register.”

On 8 September 1856, Fort Union surgeons began making hygrometric observations. The fort's surgeons were operating under the following instructions from the Army Surgeon General's Office:

“The hygrometer adopted by this Department consists essentially of a thermometer, the bulb of which is covered with floss silk enclosed in a piece of thin muslin, the ends of the silk sufficiently long to dip into water contained in a brass reservoir secured immediately below the bulb. In the top of this reservoir is a small opening to admit the silk, and to the front is attached a cylinder communicating with the interior by a small hole. The reservoir is to be kept always supplied with water poured into it through the cylinder, and the bulb will be constantly moistened by capillary absorption.”

Significant gaps in the observational data for Fort Union occurred from April 1864 through March 1865 and September 1865 through August 1866. The earlier gap was the approximate time the hospital was moving from the first fort to the third fort.

In 1868, the Army Surgeon General's Office issued updated and detailed information regarding the thermometer, rain gage, and hygrometer in use at field posts, including Fort Union.

#### Thermometer

“The thermometer should be placed in the open air, but under a roof of some kind, and should be well sheltered toward the South. It should be protected not only from the direct rays of the sun, but from the influences of all surfaces which strongly reflect the sun's heat, and of all bodies, such as thick walls, large rocks, etc., which become great reservoirs of heat during the day, and of cold during the night.’

‘...The height which it is deemed best to fix upon is that of four feet from the ground to the thermometer bulb, and the surface under the thermometer should be of short grass, sufficiently exposed to the sun and wind to keep it from habitual dampness.’

‘A thermometer box, in which most of the thermometers observed and recorded at the station are suspended, is generally used for the best conducted meteorological observations, and one should be made and set up at every post where there are means of constructing it. This box, which should be at least two feet square, is preferably made of louver-boards or overlapping slates, but ordinary boards pierced with numerous half inch holes may be used instead. It should be open at the bottom, and have a roof which will shed rain. One of the sides should be hinged for convenience of access to the interior, or the box may be left permanently open toward the North, a piece of board or of canvas being used to protect it against driving winds from that quarter. This box is to be well secured on posts, at the proper height from the ground. It should be sheltered from the sun

between sunrise and 7 AM, and between 11 AM and 3 PM, special screens being erected for the purpose if necessary. These screens, as well as the box itself, should be whitewashed or painted white.”

### Rain Gage

“The rain gauge now issued by the Department is a brass cylinder seven and a half inches high, and with a diameter at its mouth of one and ninety-seven hundredths (1.97) of an inch; this diameter being fixed upon for the reason that one inch of rain falling through such an aperture will measure exactly fifty cubic centimeters (50 cc), and centimeter graduates are furnished with each gauge for the purpose of making such measurement.’

‘The most desirable place for a rain gauge, other things being equal, is at the surface of the ground, but since it is not easy to protect an instrument in that situation, the gauge will be placed on the top of a post eight feet high,...

‘For measuring very heavy snow falls, a snow gauge must be used having a mouth of the same size with that of the rain-gauge, but wider at the bottom, so as not to be easily overfilled. The snow which falls in it is to be melted and measured in the centimeter graduate.’

### Hygrometer

“An apparatus for swinging a pair of thermometers – a wet and dry bulb – has been constructed at this Office, and will be issued to a certain number of posts for making specially accurate observations. In using this apparatus the covering of the wet bulb is to be moistened with a soft brush before each observation, and the apparatus then whirled round for a few minutes...’

‘When a stationary wet bulb is used it is to be placed in the box with the other thermometers, but far enough from them not to communicate cold to their bulbs. All casings around the lower part of such a thermometer should be removed, and a piece of wick which dips by one end into a receptacle of rain water, should have its other end coiled around the stem and resting on the top of the bulb, in such a way as to keep the muslin covering uniformly and sufficiently wet. If the wick is connected with the lower part of the bulb, the wetting is more apt to be unequal.’

The Army Surgeon General’s Office also provided the following updated directions and instructions in 1868 regarding taking wind observations:

“The direction of the wind is to be determined in the usual way by a vane or weathercock placed as far above the ground as practicable and at a distance from all buildings, trees, etc., higher than itself. The staff of the wind vane should have attached to it bars indicating the direction of each of the four points of the compass.’

‘Anemometers, or instruments for measuring the velocity of the wind, with instructions for their use, will be issued by the Department to those posts where observations on the winds are of the most importance.’

‘Where special instruments are not furnished for the purpose, the velocity of the wind may be estimated by observing the horizontal motion of light bodies – as clouds of smoke, the pollen of plants, handkerchiefs thrown in the air, etc., when blown before the wind. A motion of one yard per second may be estimated as equal to two miles per hour.’

‘If means can be found for estimating the pressure on a surface of known size, as on a piece of board held perpendicularly to the direction of the wind, or an open umbrella with its concave surface toward the wind, the velocity may be calculated from it. The square root of two hundred times the pressure expressed in pounds per square foot, will give the velocity expressed in miles per hour.’

In July 1870, observations using maximum and minimum temperatures were first taken at Fort Union. The following instructions from the Army Surgeon General’s Office in 1868 describe the instruments and their use:

“Maxim and minimum registering thermometers will be supplied to certain posts for the purpose of enabling the greatest cold of the night and the greatest heat of the day to be recorded. They are to be hung in a horizontal position, and observed once a day, preferably in the morning, when they will give the minimum of the preceding night and the maximum of the preceding day. After the readings have been taken the instruments are to be set and not disturbed until the same time the next day.’

‘The maximum thermometer is of the same plan as the maximum clinical thermometer furnished to Medical Officers, and special instructions will be sent with it when issued.’

‘The minimum is a spirit thermometer, in the bore of which a double-headed rod of black enamel floats. This rod or index is drawn back when the alcohol recedes, by reason of the resistance of the surface of the liquid to rupture or change of form, and thus reaches the lowest point to which the thermometer falls...’

After July 1870, Fort Union surgeons had the following weather instruments on station:

1. Thermometer
2. Maximum and minimum thermometers
3. Hygrometer
4. Wind vane\*

\* A note was included in the April 1877 Medical History Report from Fort Union that stated, "...a new vane or weather cock was erected April 21." Some type of wind vane likely was in place in mid 1870.

A note on the October 1871 form stated, "The minimum thermometer broken by accident October 1871." Minimum temperature observations ceased to be recorded after 5 October 1871. In January 1875 maximum temperatures ceased to be recorded with no explanation. Both maximum and minimum temperatures were recorded again beginning 1 April 1876.

Between December 1874 and February 1876, a barometer and attached thermometer were added to the station. Exact date was not apparent due to missing data in the NCDC database.

The following instructions (issued by the Army Surgeon General's Office) described the barometers used by field Army surgeons in the 1850s, 1860s, and 1870s:

"The instrument adopted by the Department is the siphon Barometer of Bunten. ...The Barometer will be suspended perpendicularly in a good light, in an apartment having an equable temperature, and a dry atmosphere."

Instructions issued by the Surgeon General's Office on 1 July 1868 stated that two types of barometric observations were taken at Army field stations—a cistern barometer for low altitudes (below 2,000 feet) and one for high altitudes (above 2,000 feet) that applied to Fort Union. The primary difference was that when taking a high altitude observation, the observer had to adjust the level of the mercury in the cistern (by means of an adjustment screw) until the mercury touched the ivory point. This was not required for the low altitude observation.

The November 1876 observation form stated, "No rain gauge," and a note on the December 1876 form indicated the rain gage had been destroyed. Beginning in January 1877, rainfall was measured as cubic centimeters. The rainfall continued to be recorded in cubic centimeters until June 1880, when measurements were recorded in hundredths of an inch.

Maximum temperatures ceased being recorded 3 October 1877 (no explanation given) and started 1 March 1880. Hygrometric readings ceased 31 December 1878 and started 1 April 1880.

In October 1881, rainfall was recorded in two ways. The amount was listed with "cc" following, assuming reference was to cubic centimeters. In addition, rainfall in inches was written above the previous amount. It could not be found how the precipitation was measured during this period. This method stopped in August 1883.

On 1 August 1888, the Army Medical Department changed observing requirements for field surgeons, including Fort Union. The form was simplified with the following parameters recorded:

1. Maximum and minimum temperatures
2. Precipitation – Beginning, end, and daily amount
3. General direction of the wind (one value listed for the day)

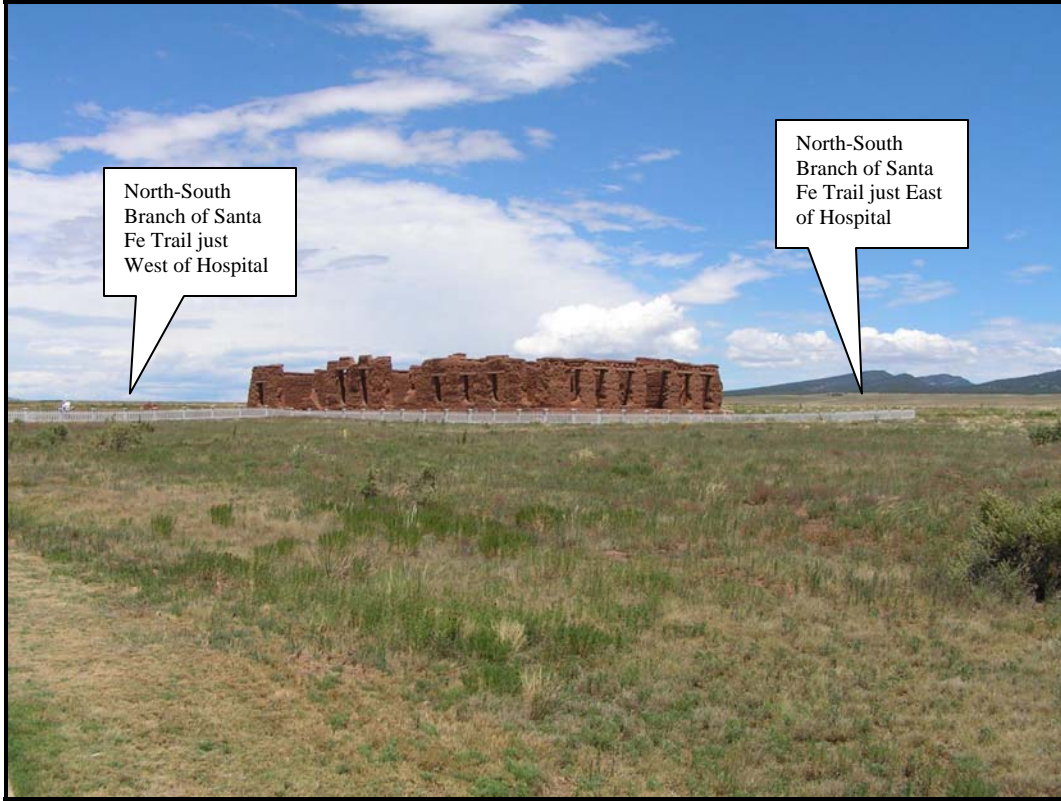
A note was attached to the March 1889 observation form that stated: “The minimum thermometer was broken through accident March 8, 1889; new instrument received March 27, 1889 and observations with minimum thermometer resumed March 28, 1889.”

The last observation at Fort Union was taken 26 February 1891. A note was written on the February 1891 form stating: “Instruments were packed up February 26 1891 for shipment to Fort Stanton, New Mexico.” Although a form was listed for March 1891, no observations were taken.

### **Impact of the Santa Fe Trail**

Since Fort Union was built to protect traffic on the Santa Fe Trail, the post was always the center of attention. During the height of its importance during the 1870s, on average, one wagon train per day left the fort. The area immediately around Fort Union was a center for wagon trains as settlers prepared to travel farther west and traders moved both east and west.

Fort Union was the confluence of the Mountain Branch of the Santa Fe Trail that extended just west of the third fort. The Cimarron Cutoff of the Trail was located just east of the post. According to available sources, including maps at the Fort Union National Monument, the Cimarron Cutoff split just north of the hospital (at the third fort) with one branch located immediately east of the hospital and another branch immediately west (Figure 11). Considering the number of campfires which may have been burning at one time, some impact on temperature readings may have occurred at night.



**Figure 11. Ruins of the hospital at the third fort looking north. Photograph by the author (July 2005).**



## OTHER OBSERVATIONS

According to the Weather Bureau Substation History for New Mexico, three Cooperative Observers took weather observations in the immediate vicinity of Fort Union after the post was closed in 1891. C.C. Everhart took observations from April 1895 through August 1895, H.A. Leonard took observations from October 1895 through May 1896, and M.C. Needham took observations October 1896 through January 1919. Listed elevations for all three observers were 6,885 feet, and listed locations were nine miles north of Watrous Post Office (see Figure 12). Coordinates were listed as 35°54'N, 105°2'W, i.e., same coordinates as given for Fort Union. Each had a standard rain gage, as well as maximum/minimum thermometers in a cotton region instrument shelter.

A cooperative observing site was established near the Watrous, NM Post Office (located approximately nine miles south of Fort Union; see Figure 12) on 17 July 1893. Mr. E.J. Pimy was the observer and Mr. Pimy took observations until 31 October 1893, instruments consisting of a standard rain gage and maximum/minimum thermometers in a cotton region instrument shelter. The listed coordinates for Mr. Pimy's observations were 35°47'N, 104°59'W, with an elevation of 6,400 feet above sea level.

On 1 November 1891, a cooperative station was established at the Halls Peak, NM, Post Office located approximately 4 miles north of Ocate, NM and 22 miles north of Fort Union. The observer was Mr. E.M. Cosner. Mr. Cosner took observations until 28 January 1895, with instruments consisting of a standard rain gage and maximum/minimum thermometers. The publication, *Substation History*, stated the instrument shelter was "non standard" and that no records were available until February 1893. Listed coordinates for this site were 36°15'N, 105°4'W, with an elevation of 8,000 feet above sea level. Beginning in the mid 1890s, Mr. Cosner's observations were used by the Territorial Weather Service of New Mexico in preparing its monthly publication of the New Mexico weather and crop service (see the Albuquerque report, or the reference, for a more extensive explanation of this territorial service).

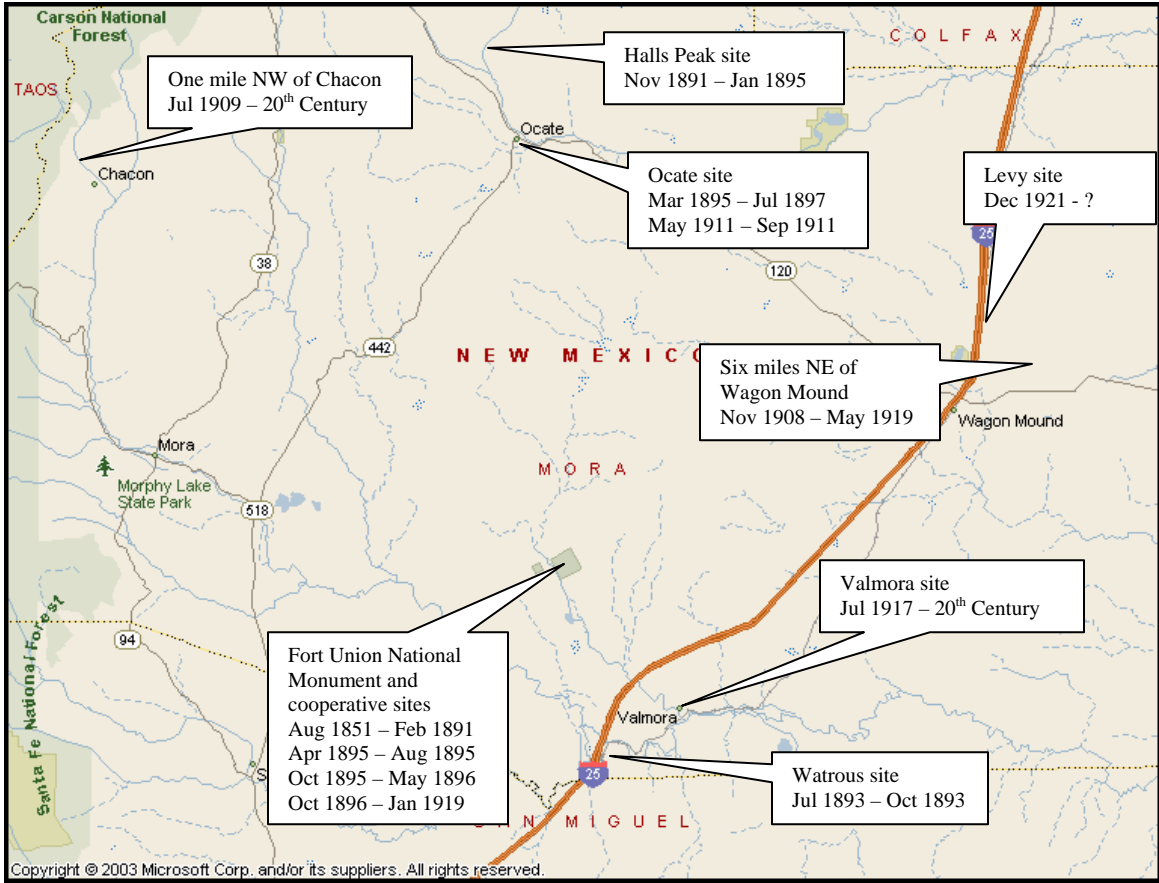
On 1 March 1895, the station was moved to the Ocate, NM Post Office (4 miles south) located approximately 18 miles north of Fort Union. Mr. Cosner remained the observer until observations ceased 31 July 1897. Instruments were the same as used at Halls Peak. Listed coordinates for this site were 36°11'N, 105°3'W, with an elevation of 7,500 feet above sea level. From 1 May 1911 through 30 September 1911, Ms. J.R. Strong recorded rainfall (standard rain gage) at the same Ocate Post Office location.

A cooperative observing site was established 6 miles northeast of Wagon Mound (25 miles northeast of Fort Union) on 11 November 1908. Guy L. Barnes was the initial observer, continuing through October 1916. W.G. Crockett was the observer from November 1916 through October 1917, and Kenneth Homsher the observer from November 1917 through May 1919. A standard rain gage and maximum/minimum thermometers (in a cotton region instrument shelter) were at this site. The observing site was located on open prairie land near the house. The listed coordinates were 36°4'N, 104°37'W and the elevation was listed as 6,300 feet.

On 22 July 1909, a cooperative observing site was established one mile northwest of Chacon, NM, approximately 22 miles northwest of Fort Union. The listed coordinates for this site were 36°9'N, 105°23'W and the elevation 8,510 feet. This site had a standard rain gage and was located in mountainous country, approximately 500 feet above the valley floor. The observer was Alfred Lucero. Mr. Lucero was a Cooperative Observer through October 1938, starting an observing program in the immediate Chacon area that lasted well into the 20<sup>th</sup> Century. These observations are described in the Weather Bureau publication, *Substation History*.

On 1 July 1917, a cooperative station was started at the Valmora, NM Post Office (located approximately four miles northeast of Watrous and eight miles southeast of Fort Union) with Ms. Alice Brown the observer. Weather instruments at this station also were a standard rain gage and maximum/minimum thermometers (in a cotton region instrument shelter). Listed coordinates for this site were 35°49'N, 104°56'W, with an elevation of 6,300 feet above sea level. Ms. Brown's observations began an extended path of cooperative observations in the Watrous/Valmora area that lasted well into the 20<sup>th</sup> Century. These observations are described in the National Weather Service publication, *Substation History*.

Another observer was listed at the Levy, NM Post Office (21 miles northeast of Fort Union), beginning 1 December 1921. No information could be found indicating if/when this site was closed. Listed coordinates were 36°5'N, 104°41'W and the elevation listed at 6,252 feet. The station had a standard rain gage and maximum/minimum thermometers (in a cotton region shelter).



**Figure 12. Location of Cooperative Observers nearby to Fort Union. North is at the top of the page. Distance across the figure (horizontal) is approximately 48 miles. Information is plotted on a current map of New Mexico.**

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# Appendix

## Methodology

Specific information regarding specific weather instrument location and exposure at Fort Union during observations by Army surgeons was almost non-existent. The NCDC database was the primary source of weather observations for this report.

General information regarding weather instruments used by the Army surgeons and procedures used to take the observations came from publications by the Army Surgeon General's Office (1844, 1850, 1851, 1856, and 1868). This general information was included with the assumption that the military surgeons followed those instructions closely.

Annual reports by the U.S. Army Surgeon General were reviewed for the years 1825 through 1875 with only bits and pieces of revealed information. The primary exception was the annual report for 1844 which contained a summary of instructions for taking weather observations; however, a more detailed document was obtained from the National Library of Medicine in Bethesda, MD. Several publications by the Army Surgeon General were obtained from the extensive government library microfiche collection at Oklahoma State University.

Archives at the Fort Union National Monument contained considerable information regarding the three forts, as well as locations of the hospitals at the first and third forts. Also, old photographs and maps of the forts were very helpful.

The James W. Arrott collection at the University of New Mexico Highlands Library (Donnelly Library) contains numerous letters and documents on Fort Union. These documents were critical for background information and to answer specific questions regarding the transition from the first fort, to the Star Fort, to the third fort. The library also possesses USGS topographical maps for the area that were very helpful.

Other information and data sources checked (by person, telephone, or through the Internet) during this study were the NOAA Library, University of New Mexico Zimmerman Library, the Albuquerque Public Library, New Mexico State University Library, Chavez history Library, State of New Mexico Library, and State of New Mexico Archives. Also, relevant information regarding the Army Medical Department was obtained from the Dallas, TX Public Library, Oklahoma State University Library, and the National Library of Medicine at Bethesda, MD.