JAY HARRIS:

Ten Plus A Year...

MOST OF THE scars of Lubbock's blackest day and night are gone. But the memories, and scientific studies go on...

It was 11 years ago today, 9:46 p.m. to be exact, when the clocks stopped in the downtown area. One of the most devastating tornadoes ever to hit a major U.S. city had left Lubbock in ruins.

In the space of a few seconds to a few minutes, depending on the area, a tornado of "incredible" size and destructive power, did its thing. Some say not one, but as many as three or four funnels may have been responsible.

For those who lived through it, it remains as vivid as the moment it happened. For those who were injured and lost property, it was one of the most traumatic turning points in their lives. For those who died, and there were 26, it was a tragedy that shocked the nation.

For the city, it was a challenge met.

THERE HAVE been numerous studies and scientific looks taken at what has become known as The Lubbock Tornado.

And like the Lubbock Lights, it is something unique in its field.

We've read, and helped write, many of the stories on both events, including a booklet on the tornado. But most recently, we were handed one of the more unusual and readable studies we have seen on the storm.

It was written by Ruth E. Nicholson, daughter of the Rev. and Mrs. Bob Nicholson of Lubbock. The Rev. Nicholson, who has been pastor of the First Presbyterian Church in Lubbock for 10 years, as of this Sunday, is quite understandably proud of Ruth, who is a student at the University of Washington in Seattle.

THE REV. Nicholson was a bit nonplussed, however, when he went to the George and Helen Mahon Library to see how much data was available there on the tornado.

He says he was only able to locate a number of clips from The A-J, the booklet and a few other items. It is ironic that there isn't a complete shelf or more on the tornado when one considers that the library sits in an area most heavily hit.

But, back to Ruth's treatise, which does reflect considerable research. Ruth is a sophomore at the University of Washington, and the paper was prepared for an Atmospheric Science course.

What Ruth has to say about tornadoes in general and the Lubbock one, in particular, makes for some fascinating reading...

THERE ARE some 600 to 1,200 tornadoes a year in the U.S., Ruth notes.

"About two-thirds of these are small tornadoes whose winds range from 40 mph to 112-mph," her study observes. "The normal life span of these small tornadoes is usually one to three minutes, and their damage paths are generally less than one mile long and 100 yards wide.

"The other third of these tornadoes is mostly comprised of medium-sized tornadoes, whose winds vary from 113-mph to 206-mph. Their damage paths usually are in the range of 10 miles long and 300 yards wide.

"Maximum tornadoes make up one to five percent of all reported tornadoes. These tornadoes are rare, but they account for 70 percent of all tornado-related deaths.

"Although they are the easiest to detect, maximum tornadoes are the most destructive. The wind speeds in a maximum tornado can be as much as 300-mph. They may exist as long as three hours and leave damage paths up to 200 miles long and a mile and a half wide..."

THE LUBBOCK Tornado definitely was in the "maxi" class as far as wind speed and damage was concerned.

Ruth notes that wind intensity in storms is figured on an "F scale." Winds have to reach the 72-112 mph range before moderate damage results.

Winds of 113-157 mph can cause considerable damage; 158-206 mph, severe damage; 207-260 mph, devastating damage; 207-318 mph, incredible damage, and anything above 318 mph, "inconceivable damage."

The Lubbock storm, or storms, had estimated wind speeds of from 163 to 290 mph, putting it in the severe to incredible range. The storm was "unique in four ways," Ruth says: "1. The conditions which gave rise to the tornado, 2. The widespread severity of the wind, 3. The disorganized patterns of structural damage, and 4. The magnitude of the impact of the tornado on the economic, sociological and political systems in the Lubbock area."

THE STORM has been studied perhaps as closely as any such disaster in the nation's history.

One such study was by T. T. Fujita, a tornado authority from the University of Chicago. Another was by a group of Texas Tech professors. Both studies support the more than one tornado theory.

Just for the record, as noted in Miss Nicholson's article, the storm caused damage estimated from $125 million to $200 million. A 15-square mile area was affected, roughly one-fourth of the city then.

Twenty-six persons were killed, 1,500 injured, 3,000 left homeless. Most deaths and injuries were caused by flying debris.

There was damage to or destruction of 119 small planes, thousands of autos, 600 commerical structures, 100 mobile homes, 1,000 family units totally destroyed, 9,000 family units damaged, 220 street light poles damaged, 25,000 phones put out of order, massive power plant damage, which in turn shut off the water supply temporarily.

But out of the bitter ashes, Lubbock and its citizens arose to the challenge, a phoenix of determination and hope reflected in today's Memorial Civic Center area and a bigger, better city.

Ruth Nicholson has added an interesting post script to a memorable chapter among many in Lubbock's history.

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OUR PLEDGE

We pledge allegiance to the Flag of the United States of America and to the Republic for which it stands, one Nation, under God, indivisible, with Liberty and Justice for all.

On the Occasion of the 40th Anniversary of the Lubbock Tornado
For the City of Lubbock Web site dedicated to this historic event

The Lubbock Tornado, May 11, 1970

A Paper for
Atmospheric Science 101
Presented
February 23 1981
by
Ruth E. Nicholson

A Biographical Note on the Author

Ruth E. Nicholson was the
1979 Highest Honor Graduate
Monterey High School
Lubbock, Texas

This paper was written two years later
when she was a sophomore at the University of Washington
Seattle, Washington.

She is a Cum Laude Phi Beta Kappa Graduate of
U of WA with a BS in Forestry With a focus on
Land Use Management and
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Environmental Law and Land Use Management

She is a veteran of 25 years service in natural resource management
and environmental problem solving with
The National Park Service, The US Forest Service and
Environmental Protection Agency.
She is a Certified Professional Facilitator (CPF) and owns her own
Facilitation Company
<www.Nicholsonfacilitation.com>

GENERAL CHARACTERISTICS OF TORNADOES:

Six hundred to twelve hundred tornadoes occur in the United States each year. Approximately two-thirds of these are small tornadoes whose winds range from 40 to II2 m.p.h. The normal lifespan of these small tornadoes is usually one to three minutes, and their damage paths are generally less than one mile long and I00 yards wide. The other third of these tornadoes is mostly comprised of medium-sized tornadoes whose winds vary from II3 to 206 m.p.h. Their damage paths usually are in the range of ten miles long and 300 yards wide. "Maximun tornadoes" make up one to five percent of all reported tornadoes. These tornadoes are rare, but they account for 70% of all tornado-related deaths. Although they are the easiest to detect, maximum tornadoes are the most destructive of all tornadoes. The windspeeds in a maximum tornadoe can be as much as 300 m.p.h. They may exist as long as three hours and leave damage paths up to 200 miles long and a mile and a half wide.(I)(I0) No area is more favorable to the formation of tornadoes than the midcontinent of North America.(see Figure I) No month is free of these violent storms, but the number of tornadoes reaches a peak in May. The second largest number of tornadoes occurs in April and June. The "tornado season" runs from April to June because two-thirds of all tornadoes occur in these months. September is also a "good" month for tornadoes, but fall tornadoes are a bit different from spring tornadoes and are generally weaker. The lowest frequency of tornadoes is found in the months of December and January. Generally, the best time of day for tornado formation is in the late afternoon and early evening.(2)(I0)

In order for a tornado to form, some specific meteorological conditions must be met. These conditions are:

I. mass convergence near surface

2. mass divergence aloft

3. a buoyant air mass

4. wind sheer in the vertical

5. moist air mass in the lower layers

6. a "trigger" mechanism

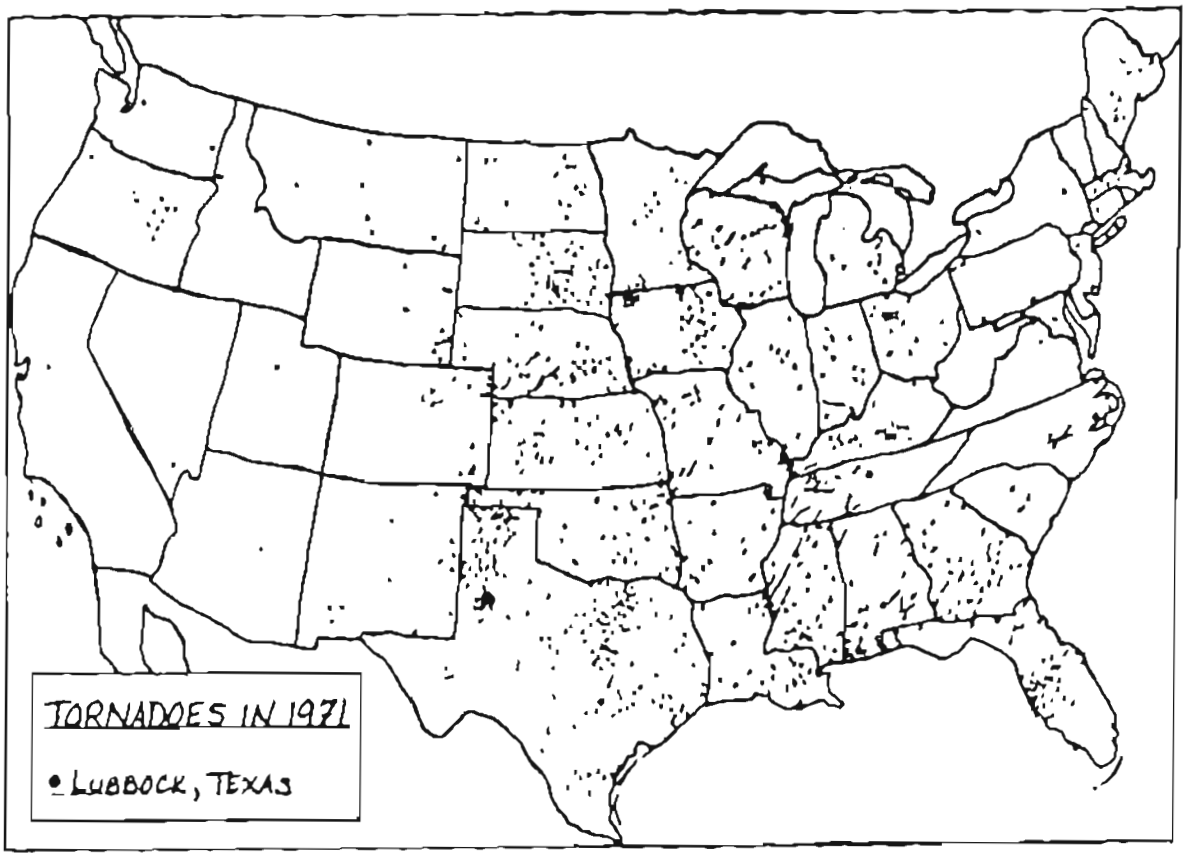
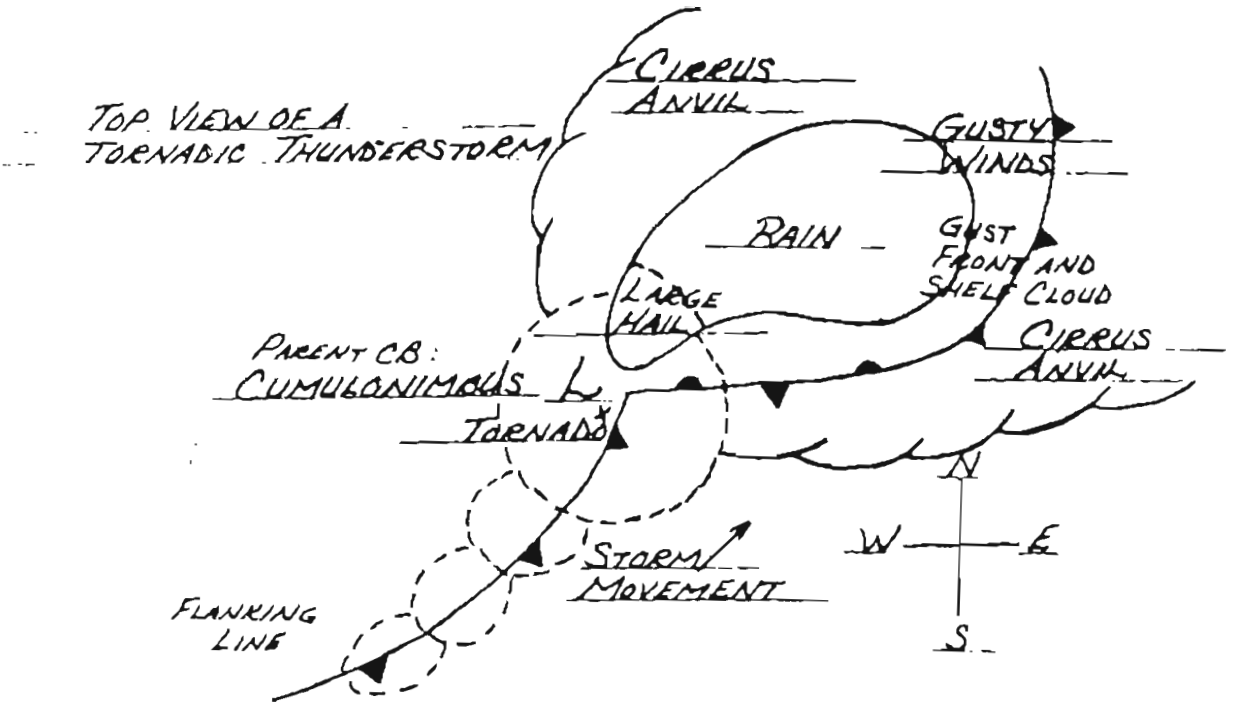


FIGURE I: Typical Tornado Distribution in the United States (3)

7. surface cyclogenesis (IO)(II)

Tornadoes form in the middle portion of very intense thunderstorms. Warm, moist air feeds the thunderstorm at the rear of the storm while wind, rain, and hail are produced at the front. The usual weather sequence preceding a tornado is high winds, rain, and then hail. The tornado itself is a center of extremely low pressure surrounded by high winds. These winds rotate counter-clockwise in the northern hemisphere due to the Coriolis force. Eighty percent of tornadoes are formed from a wall cloud that is located near the rain-free base of the storm.(see Figure 2) The wall cloud is usually one to three miles wide and often forms 20 to 30 minutes before a tornado appears. If and when the wall cloud begins to rotate, it is called a funnel. A tornado that is formed from a funnel or wall cloud may form as much as 20 to 30 minutes before it descends to the ground. Note that a funnel or funnel cloud differs from a tornado in that a funnel is a violently rotating column of air that does



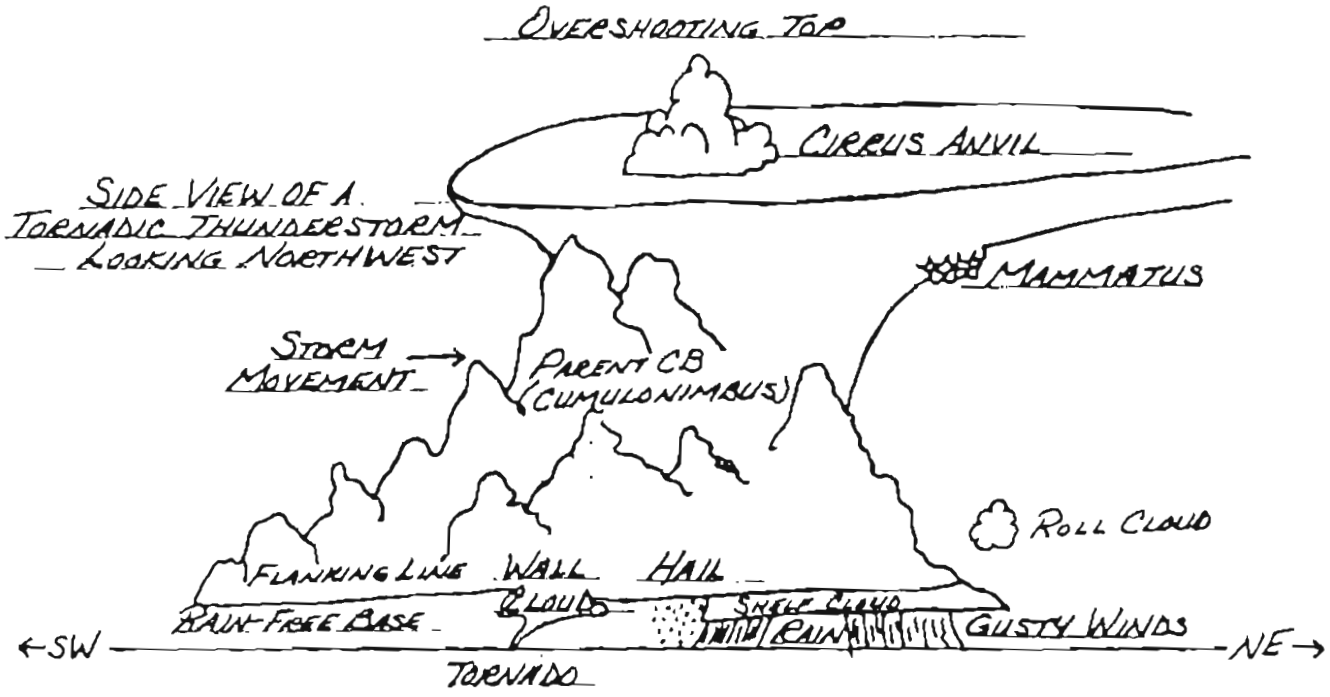


FIGURE 2: A Tornadic Thunderstorm (9)

not touch the ground or cause any damage. The visible part of a tornado is comprised of small water droplets, dust, and debris, but tornadoes are not always visible. The tornado has a characteristic life cycle. During the first half of its "life" the tornado increases in size and intensity; the second half, it contracts into a rope-like structure and tilts before dissipating. Tornadoes are capable of splitting into two separate tornadoes or forming five or six smaller tornadoes inside the main tonado. Separate tornadoes can also combine to form a single tornado.(IO)(II)

Tornadoes have three scales of motion: the movement of the tornado as a whole, the tornado cyclone, and suction vortices. Generally, tornadoes move from the southwest to the northeast. The tornado cyclone is the parent cyclone from which tornadoes form. Suction vortices form inside large tornadoes. A suction vortex is a small, spinning mass of air usually less than 30 feet in diameter. Suction vortices are accompanied by an excessive rate of pressure change due to their small size and fast traveling speed. The pressure in a suction vortex often differs from the pressure of the tornado as a whole. Suction vortices are capable of picking up debris but are unable to carry debris for long distances. Therefore, suction vortices usually leave a litter line in their damage path. Small tornadoes behave very much like suction vortices and actually cannot be differentiated from suction vortices. The rotation of the individual vortices within the tornado is believed to determine the tornado's damage pattern.(see Figure 3) (4)(IO)

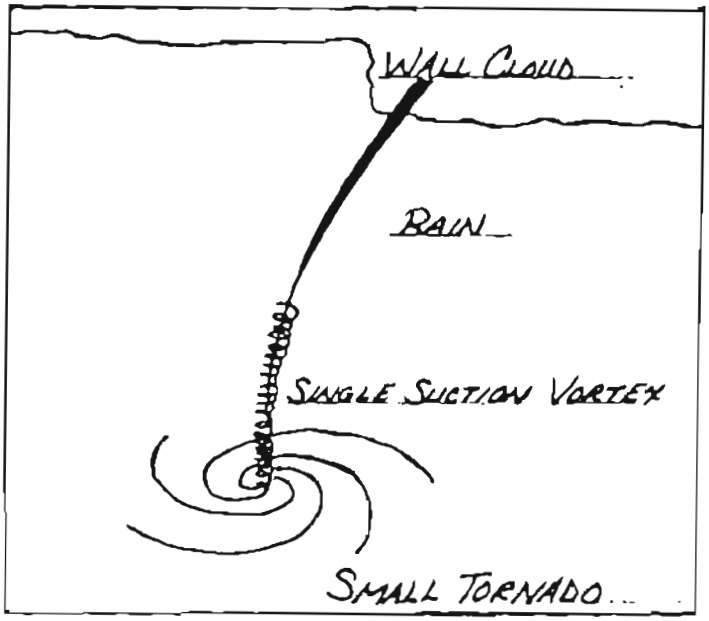
There are four causes of tornado damage: pressure differences that cause wall and roof failure, airborn "missiles", collapse of high structures such as chimneys, and high winds. Wind intensity is classified according to the F-scale as shown below.

(F-) 40 m.p.h. or less. Little or no damage. Doubtful tornado.

(F0) 40-72 m.p.h. Light damage. Very weak tornado.

(F1) 73-112 m.p.h. Moderate damage. Weak tornado.

(F2) 113-157 m.p.h. Considerable damage. Strong tornado.



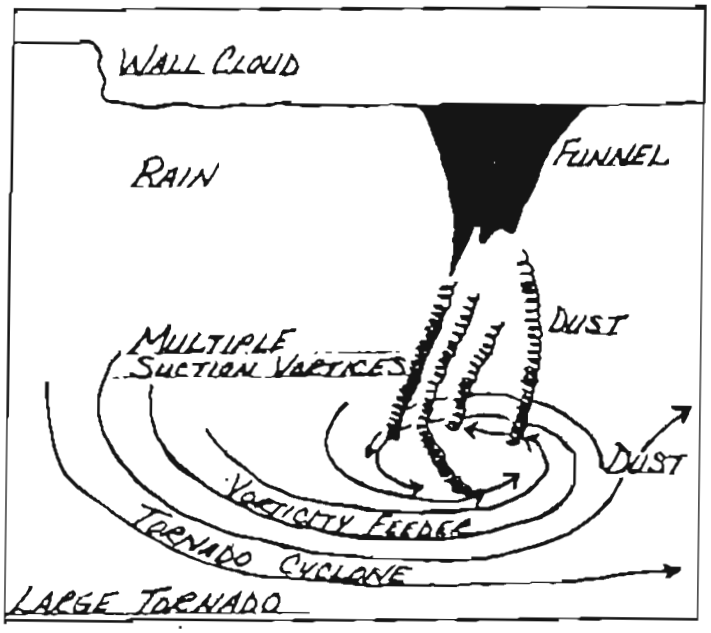


FIGURE 3: Suction Vortices (4)

(F3) 158-206 m.p.h. Severe damage. Severe tornado.

(F4) 207-260 m.p.h. Devastating damage. Devastating tornado.

(F5) 207-318 m.p.h. Incredible damage. Incredible tornado.

(F6)-(F12) 319 m.p.h. to sonic speed. Inconceivable damage. Inconceivable tornado.

Although winds in the lower F-scale range are the most common, flying debris is the cause of most tornado-related deaths.(3)(10)

The four methods of tornado detection are weather radar, spotters (visual sightings), satellite detection from geostationary satellites, and detection of sferics (electrical discharges emitted from tornadoes--not all tornadoes give off sferics, though). The National Weather Bureau issues two types of bulletins concerning tornadoes. One is the Tornado Watch which is issued after determining that there is a potential for a tornado-bearing storm to develop in a particular area. Tornado Watches are issued from one to eight hours in advance of any development. The Tornado Warning is the second type of bulletin. It is issued only after an existing tornado or tornado-bearing storm has been detected.(1) When a tornado has been sighted, it is wise to take shelter immediately. If you are out in the open, find a ditch, ravine, or culvert to lie in. Do not stay in an automobile. If you are in or near a building, go to the nearest tornado shelter, basement, stairwell, central closet, bathroom, or hallway. These structures usually have more reinforcement than other parts of the building and are safer.(4)(10)

Below are some Spotter Rules and Clues.

1. Overshooting tops are indicators of a very strong storm.
2. A rain-free base denotes the storm's intake area, the place to watch.
3. Wall clouds form from the rain-free base often 20-30 minutes before a tornado.
4. Differentiate tornadoes and funnels! Funnels don't touch the ground or do damage.

5. Large hail often falls just in advance of a tornado.
6. The direction of the storm's movement is generally indicated by the cirrus anvil.
7. Tornadoes generally move toward the northeast at 25-35 miles per hour.
8. Poor visibility, ponding, and running bar ditches are indicators of heavy rain.
9. The first gust of wind from a thunderstorm is usually the strongest.
10. Cars are safe places in case of lightning, but not in case of tornadoes.

Always Have a Freidy-Hole Picked and Handy. (2)

THE LUBBOCK TORNADO: MAY 11, 1970

Lubbock, Texas is a city of 150,000 people located on the South Plains of West Texas.(see Figure 1) The city itself covers an area of 10 by 8.5 miles. It is a major trade center for sorghum and cotton grown in the area.(12) The Lubbock tornado of May 11, 1970 was unique in four ways:

- the meteorological conditions which gave rise to the tornado
- the widespread severity of the wind
- the disorganized patterns of structural damage
- the magnetude of the impact of the tornado on the economic, sociological, and political systems in the Lubbock area.

Because the storm occurred after dark, no photographs or films were taken of the tornado. Instead, information on the storm was taken from radar, verified spotter observations, and analysis of the damage. There are three meteorological views on the configuration and path of the storm. An additional engineering viewpoint focuses on the disorganized damage patterns and differs somewhat with the meteorological views of the storm.(7)(9)

An average of two tornadoes a year touch down in the Lubbock area.(13)

The meteorologist in charge of the Lubbock Weather Bureau Office has said that tornadoes are a way of life at the office. Personnel are scheduled so that a professional meteorologist and two meteorological technicians are on duty from mid-afternoon until midnight in the time of greatest danger.(2) The sequence of events in Lubbock on May II, I970 are as follows. (All times are given in Central Daylight Time.)

6:00 pm - Cumulus clouds began to gather

6:55 pm - Thunderstorm spotted five miles south of city

7:50 pm - Severe Thunderstorm Warning issued to be in effect until 9:00 pm

8:00 pm - Egg-sized hail reported south of city

8:I0 pm - Grapefruit-sized hail reported five miles south of city

- Baseball-sized hail reported in southeast Lubbock

- Funnel cloud reported seven miles southeast of airport.

8:I5 pm - Storm moving northeast at 25 m.p.h. with large hail and possibly a tornado

- Two more thunderstorms spotted eight miles southwest of the airport moving northeast at 25 m.p.h.

- Tornado Warning issued to be in effect until 9:00 pm

9:00 pm - Funnel in southeast Lubbock moving north at I5 m.p.h.

- Funnel cloud reported seven miles south-southeast of airport moving northeast at I5 m.p.h.

- Tornado Warning extended until I0:00 pm

9:35 pm - New funnel spotted seven miles south of airport

- Warning sirens sounded in Lubbock (not all the sirens sounded due to powerline damage due to tornado)

9:50 pm - All communications lost at Lubbock Weather Bureau Office

II;30 pm - All tornado warnings cancelled (2)

The maximum estimated windspeeds vary from I63 m.p.h.(6) to 290 m.p.h.(I0).

The differences in opinion in interpreting the damage patterns have also led to differing opinions concerning the tornado's structure and windspeeds.(see Figure 4)

One of the meteorological views on the Lubbock tornado is given by T.T. Fujita, a recognized authority on tornadoes from the University of Chicago. His "two tornado theory" says that Lubbock was hit first by a small tornado and then by a giant one that traveled between downtown and the airport.(5)(7) The tornadoes were formed behind an advancing moist front that had a very small temperature difference across it. It was not a front where moist air was meeting cold air as is usually the case with tornadoes. The first tornado was a forerunner of the second. It had approximately 75 m.p.h. winds and left a two mile long damage path.(5) Fujita claims that the first tornado occurred at around 8:10 pm, but the Weather Bureau did not report a hook formation until 9:00 pm and never received confirmation on that report.(7) The larger tornado that followed touched down in downtown Lubbock. The storm's core shrank from two miles to 0.4 miles in diameter while over the downtown area. This increased the windspeed. The tornado made a loop just north of Texas Tech University and then headed northeast at 21 m.p.h. When the tornado passed the Weather Bureau Office in northeast Lubbock, the pressure of the tornado was recorded at 996.9 mb, and the pressure field aroung the tornado extended for ten miles. Fujita estimates that the tornado contained three to five suction vortices, and that the tornado's rotational speed was between 145 m.p.h. and 290 m.p.h., depending on how many suction vortices actually existed.(5)(6) The disorganized pattern of structural damage is believed to have been caused by these suction vortices.(7) Because there are no films of the tornado, there is no direct physical evidence of the suction vortices in the Lubbock storm, but 95% of the deaths due to the tornado (i.e., all but one) occurred along the path of Fujita's suction vortices that led from the downtown area to the airport.(5)(6)

Another meteorological theory on the Lubbock storm was proposed by

N.F. Somes, R.D. Dikkers, and T.H. Boone. This two tornado theory holds that two tornadoes touched down simultaneously east of Texas Tech University: one right near Jones Stadium and another southeast of the stadium. Both tornadoes headed for downtown Lubbock and were in discontinuous contact with the ground. The tornadoes merged just north of the city center and continued traveling northeast. This large combination tornado stayed in contact with the ground until it passed the airport and the Weather Bureau Office.(see Figure 4) (7)(12)

The third meteorological theory was hypothesized by J. Neils Thompson, Ernst W. Kiesling, Joseph L. Goldman, Kishor C. Mehta, John Wittman, Jr., and Franklin B. Johnson. This theory considers the possibility of three different tornadoes. According to this theory, the storm lasted from 9:35 pm to 10:06 pm. The first tornado was formed aloft and moved from the south-southwest to the north-northeast of downtown Lubbock. This tornado damaged tall buildings but left short ones relatively untouched. It reached its greatest intensity just north of the downtown area. The second tornado formed just northeast of Jones Stadium. It moved eastward, leaving a one mile wide damage area until it joined the first tornado just north of downtown. This newly-formed tornado then moved north, leaving a one and a half mile wide damage path.(see Figure 4) A third tornado could have formed just north of the merger point and would have then been responsible for the damage in north Lubbock. The existence of a third tornado is supported by observations of damage patterns and the recorded times of arrival of severe winds at various locations.(7)(13)

The Institute of Disaster Research at Texas Tech University has its own viewpoint concerning the damage patterns of the Lubbock tornado. The meteorological data supports all three meteorological views, but after surveying the damage, the Institute concluded that the disorganized pattern of structural damage was due to the differing abilities of different structures to resist wind forces. The damage patterns do not seem to support theories that assume that the storm was a "clean", axis-symmetric funnel. The Institute believes

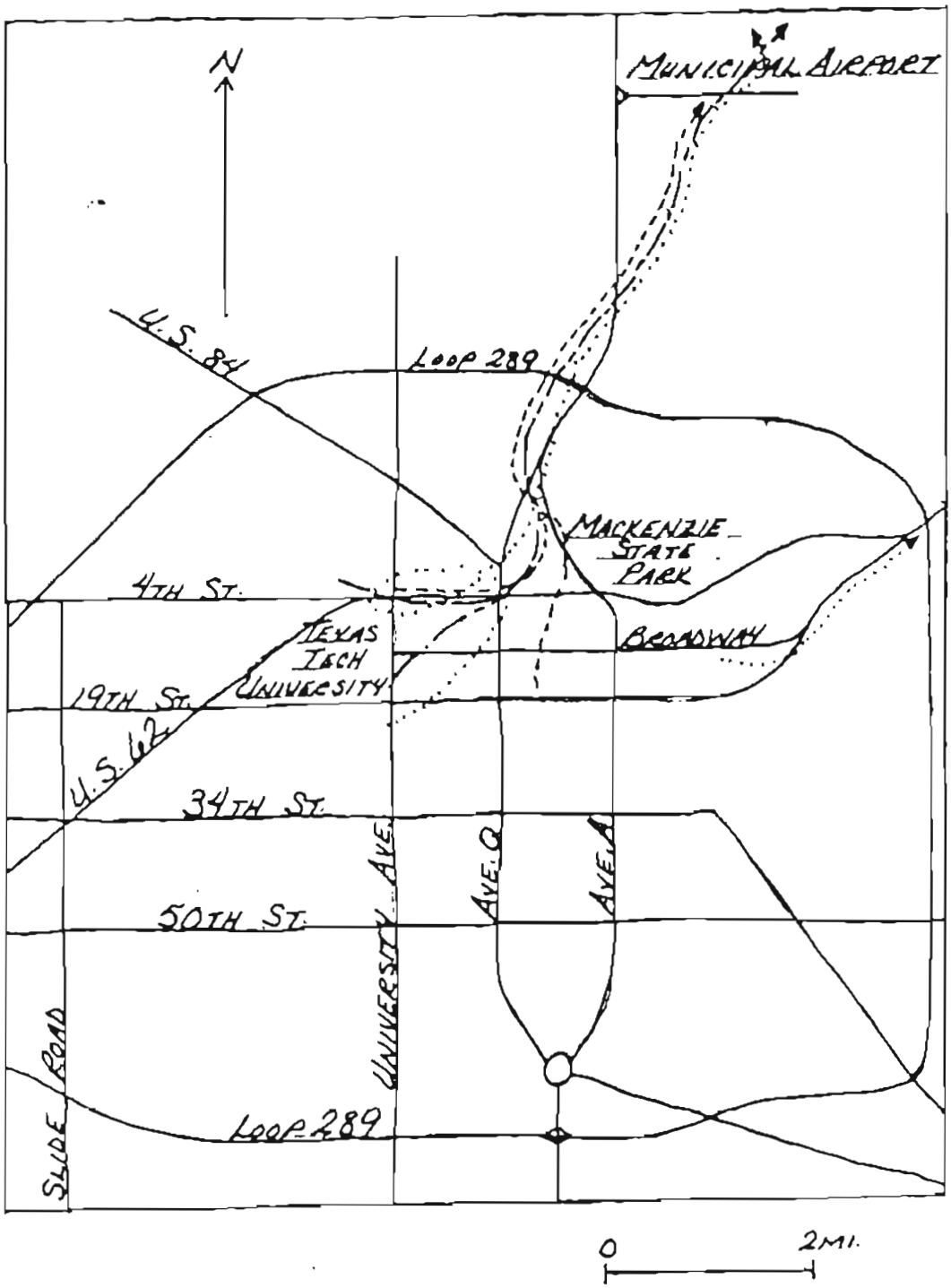


FIGURE 4: Theories Regarding the Configuration and Path of the Lubbock Storm (7)

. . . . . Fujita

— — — Somes, Dikkers, and Boone

- - - - - Thompson, Kiesling, Goldman, Mehta, Wittman, and Johnson

that the Lubbock storm was intense but disorganized over the downtown area. It intensified and became more organized as it moved to the northeast. Using information from the damage survey, the maximum windspeed was between 163 m.p.h. and 200 m.p.h. Most of the damage was believed to have been caused by winds between 75 m.p.h. and 125 m.p.h.(6)(7)

The May 11, 1970 tornado was the worst in Lubbock's history.(12) The damaged areas were classified into three destruction zones: scattered, moderate, and extensive. The scattered zone contained only a small percentage of structures that were significantly damaged, whereas in the moderate zone, about half the structures were significantly damaged. In the extensive zone, a high percentage of structures were affected and a majority of these were either destroyed or severely damaged. The extensive zone in Lubbock stretched seven miles between the downtown area and the airport, an area which included downtown, an industrial section of town, and medium and low density residential areas. The damage area ranged from a quarter mile to a mile and a half in width. The zones grew progressively narrower as the storm moved northeastward.(see Figure 5) The most extensive destruction was found in the northernmost portion of the tornado's path due to the progressively intensifying storm. The severe damage covered nine square miles, and other damage covered an additional six square miles. A total of fifteen square miles was affected, which is roughly 1/4 of the city of Lubbock.(2)(7)(12)

Property damage estimates range from $125 million to $200 million. These figures include:

- damaged utilities
- 119 small aircraft
- thousands of private automobiles
- 600 commercial structures
- 100 mobile homes
- 1,000 totally destroyed family units
- 9,000 damaged family units

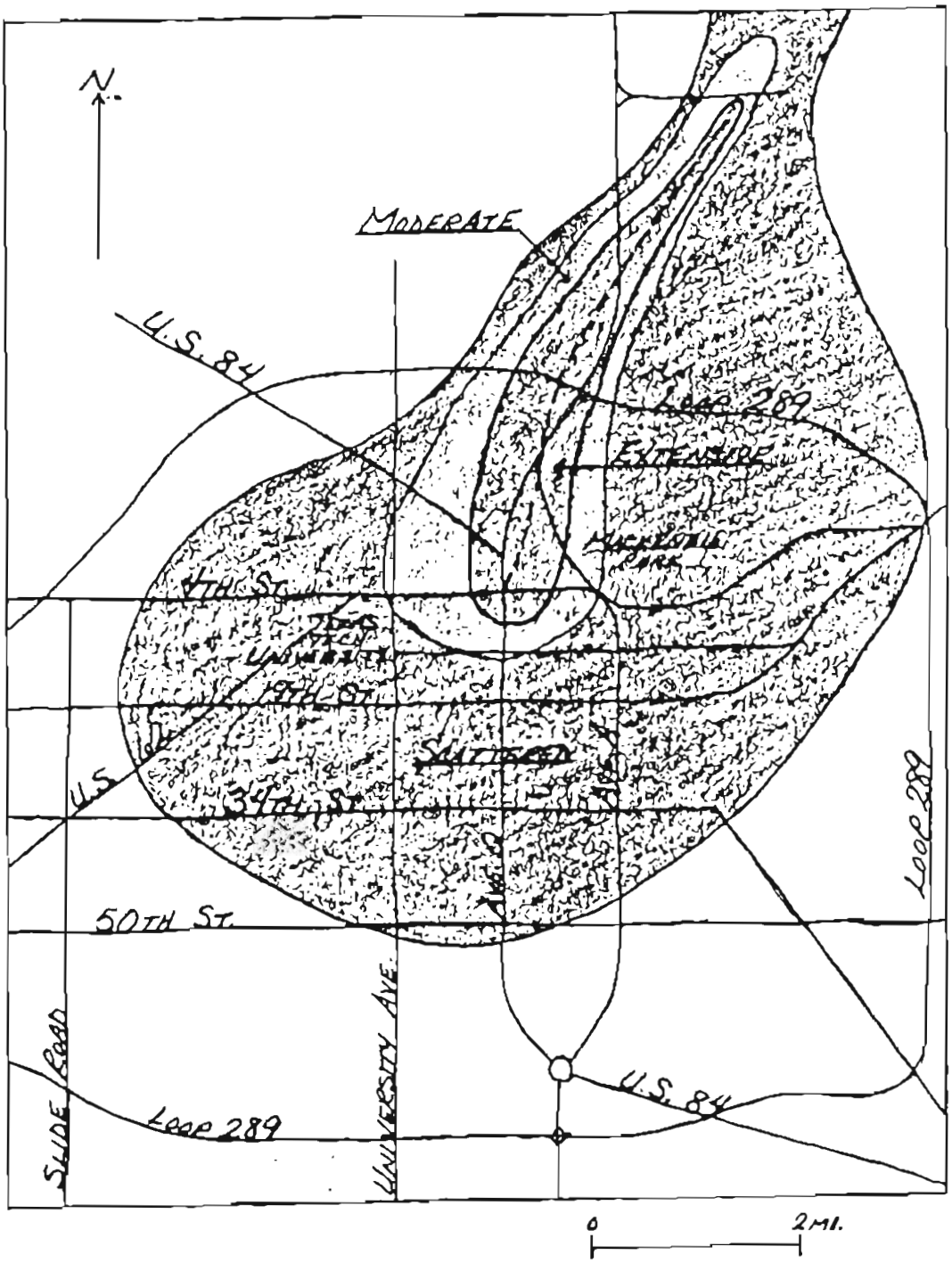


FIGURE 5: Damage Areas (7)

- 220 street light poles
- 25,000 telephone stations
- destroyed long distance lines
- power plant damage
- cut off water supply (2)(7)(I2)(I3)(I5)

An example of some of the damage in the downtown area lies in the 20-story Great Plains Life Building. The building's steel frame was bent so that the top of the building is now twelve inches out of plumb.(6) The building is still standing, and in addition to office space, it now has a restaurant on the top floor.

Twenty-six persons died as a result of the tornado, and another I,500 persons were injured.(2) Most of the casualties were due to flying debris. The storm left 3,000 people homeless. These people were sheltered and fed in the municipal coliseum. President Nixon declared the city of Lubbock a disaster area on May I4, I970.(8)(I3)

One of the social impacts of the Lubbock tornado was its affect on the segregation found in north Lubbock. The tornado path crossed a low-income, predominately Mexican-American community on the north side of the city. This community was a highly segregated, close-knit section of town, and the tornado shattered its way of life. Seven hundred homes were destroyed, leaving only 83 homes in Lubbock's "barrio". The damage was so extensive that many families were relocated to the northeast side of town made up of predominately Negro and Anglo families. This "natural" integration provided not only some problems, but some unforeseen benefits as well.(7)(8)

This is an excellent paper! It is very well written and very well organized. It is refreshing to find one student still knows how to spell, write in complete sentences, and knows how to provide continuity throughout a paper. Your research has been extensive with the paper being all the better for it.

4.0

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