Damage Documentation of Tornado of 9 October 2001 at Cordell, OK

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On October 9, 2001, a tornado passed through Cordell, Washita Co., OK, a town of population 3,000 in west-central Oklahoma. It was one of 19 tornadoes in the area on this date (see Fig. 1a, 1b). The Cordell tornado (C1 in Fig. 1b) touched down at 5:08pm 1.5 miles southwest of downtown Cordell and lifted 3.5 miles northeast of downtown at 5:21pm. Within and close to the 6-mile path, 132 single family homes, 32 businesses, eight mobile homes and six public buildings were considered uninhabitable; 477 single family homes, 40 businesses, 27 mobile homes and 10 public buildings were damaged (Oklahoma Emergency Management 2001). Fortunately no one was killed during the tornado but nine people were injured. Damage was estimated at one hundred million dollars. (NCDC 2001).

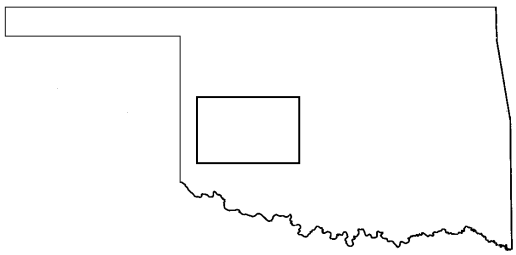

Figure 1a: Oklahoma (Area shown below indicated by box)

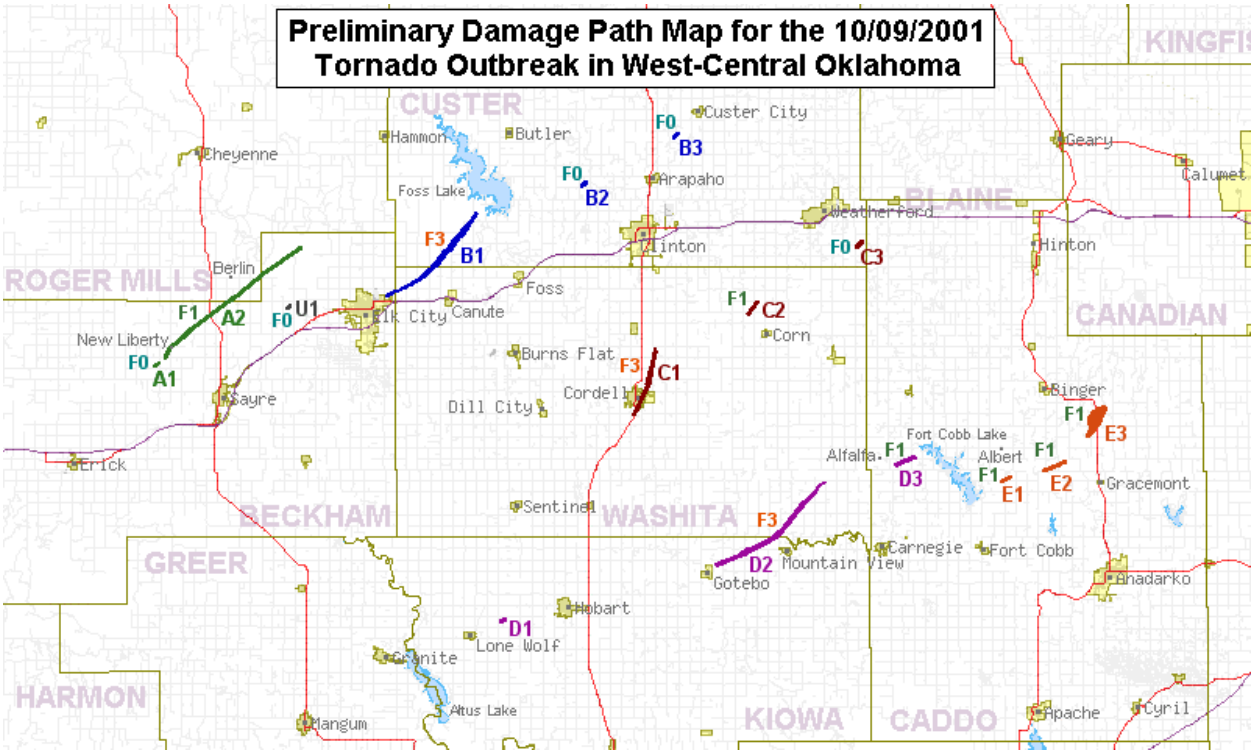

Figure 1b: West-Central Oklahoma Tornado Outbreak of 9 October 2001 (Courtesy of National Weather Service-Norman, OK)

Maps of the path (Figs. 1a, 1b and 2, courtesy of the National Weather Service-Norman, OK) and aerials of the tornado path through Cordell (Figs. 3a and 3b, courtesy of Aerial OK, Inc.) are shown on pages 1-3. The tornado was given a rating of F-3 by the National Weather Service (NWS). An F-4 rating was considered but due to the poor structural integrity of the homes, NWS personnel decided to assign the F-3 rating (NCDC 2001).

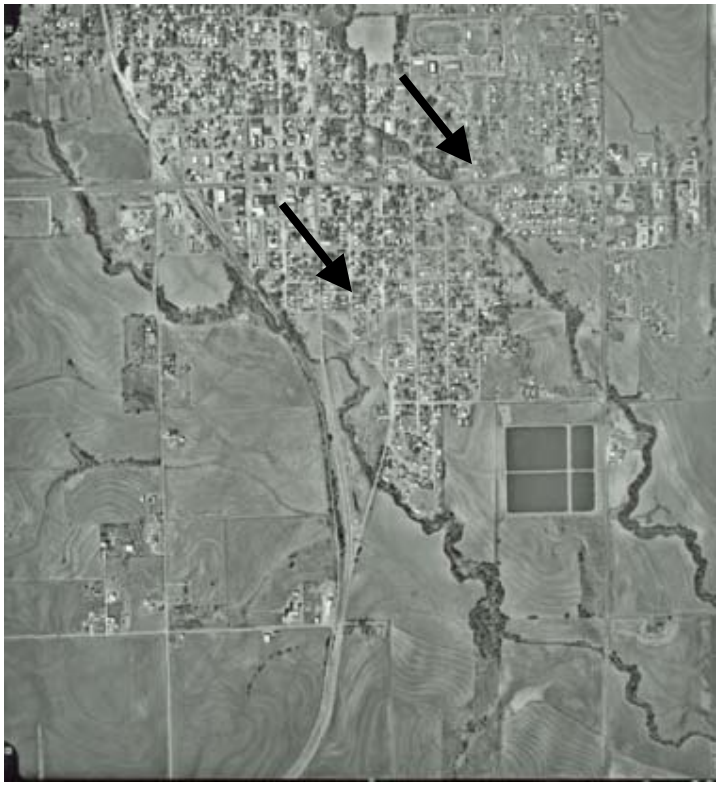

Figure 3a. Aerial of tornado damage path through the City of Cordell, OK
(Courtesy of Aerial OK, Inc.)

Figure 3b. Close-up aerial of tornado damage path through City of Cordell, OK
(Courtesy of Aerial OK, Inc.)

Personnel from WISE visited Cordell six days later and documented damage to four structures: two day care centers with shelters, a nursing home facility and a motel. These buildings are of significance as they housed or were designed to house multiple individuals. The building locations are shown in Figure 2 to indicate their proximity to the center of the tornado path. Damage to these structures is described below.

Lil Learners Day Care Center (1204 E. 3rd St.)

This day care center was outside of the path of the tornado and did not suffer any significant damage. Upon hearing the warning, the teachers led the students around the fence to the underground cellar in the back. A fence separated the day care center from the cellar necessitating a fairly long walk to the cellar. The manager indicated she was planning on having a gate cut into the back fence so the children could walk directly from the center to the cellar when future warnings are posted. See Fig. 4 which shows the cellar in the foreground and day care center behind the fence in the background.

Fig. 4. Lil Learners Day Care Center in background; storm cellar used by students and teachers in foreground. Note fence between the two.

Day Care Depot (511 E. Kiowa)

This day care center was located within the portion of the path rated F0/F1 damage (Fig. 5). It was built in approximately1999 with an interior safe room. There were no buildings around the day care center for some distance to the north and west. Upon hearing the tornado warning, the teachers led the children into the interior safe room (described below). A total of 11 adults and 17 children remained in the shelter during the storm.

Several windows of the building were broken during the storm. The windows had been boarded up and glass cleaned up by the time WISE personnel arrived. A 2x4 missile penetrated the roof of the center but did not extend down through the ceiling. The roof appeared otherwise undamaged. The builder mentioned that hurricane clips were installed at the time the structure was constructed. Additional damage included scattered removal of some vinyl siding and a hole in the west wall (where an air conditioner was probably installed). The most significant damage noted by the owner was the loss of an extensive set of playground equipment from the backyard (to the west).

Fig. 5: Day Care Depot. Note broken windows and plastic on roof where a missile penetrated. Entrance to safe room just inside the front door.

Fig. 6. Day Care Depot: Saferoom
(Items from the building were stored in this room during renovation.)

The safe room walls and ceiling consisted of 6" thick concrete placed in one pour, reinforced with rebar 12" o.c., with footings 12" deep. The total dimensions were about 8' x 10'. The door had steel plates on both sides, 3/16" on the outside and 1/8" on the inside. There was only one lock. The builder said that the door jam was steel, anchored into the wall with horizontal rebar. The safe room was located just off the entrance hallway of the building.

The building was repaired and continues in use as a day care center.

Cordell Care Center

Figure 7: Aerial view of Cordell Care Center following the tornado. (the tornado moved from the right side to the left side of the photo; courtesy Aerial OK, Inc.)

According to personnel at the City Hall, this facility was originally constructed about 15 to 20 years ago, closed about a year and a half ago, and was being renovated. It had not yet opened for business but was scheduled to open in about a month's time. The building was designed with a central area of offices and nurses stations with the residents' rooms along several long wings (Fig. 7). Each wing consisted of a hallway with rooms on each side. The building was oriented facing about 80^{o} east of north.

During the tornado, the only people in the building were the administrators. They took refuge in the beautician's room which had no windows and which was located near the central core of the building. This room did not suffer any damage.

Roof: Significant damage occurred to the gable ends of the long wings (see Fig. 8). In at least three cases, the roof at the end of the wings had apparently lifted up and set back down. Cracks could be seen along the roof-wall connection (Fig. 9). Shingles were lost. No bolts, clips, or screws were observed. Some missiles (2x4) were noticed penetrating through the roof into the rooms (see Fig. 10)

Fig. 8: Cordell Care Center: Failure of gable end wall. (left)

Fig. 9. Cordell Care Center: Gable end roof damage from the interior. (right)

Fig. 10. Cordell Care Center: Missile penetrating ceiling of resident room. Headboard of bed is visible underneath missile. (below)

Windows: Approximately ¾ of the windows were broken. In some cases it appeared that glass from broken windows along one side of the building blew out into the hallway and across into the other room. Breakage varied from small holes and subsequent cracks to near complete collapse of the window. Several large windows along the dining room were almost completely broken out. The only windows that were not broken were most of the windows along the north side of the two wings which protruded out in the back of the building.

Dining Room: The dining room suffered significant damage. It was at the north side of the building. Large windows along the west side of the room were broken in. Portions of the roof were missing.

Maintenance Room: This room was on the outer northeast corner of the building. This room collapsed entirely (see Fig. 11). The gable end room was removed. The brick cladding collapsed, as did the frame wall. All connections that could be seen were attached with nails only.

Fig. 11. Cordell Care Center: North end of building showing collapsed maintenance room and dining room just behind it.

Motel 41 (719 E. Main)

The motel formed an open rectangle with all rooms facing inwards (Fig. 12a). The east wing sustained the majority of the damage. The exterior wall, consisting of 8" unreinforced masonry block, and roof collapsed (Figs. 12a & b). The interior walls were tied, not bonded to the exterior wall thereby providing no lateral support.

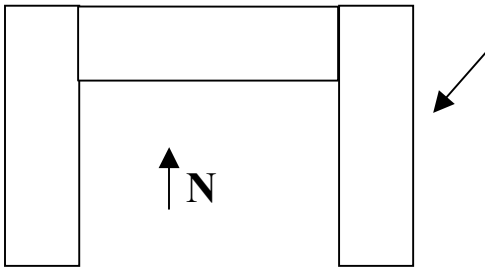

Fig. 12a. Motel 41: Plan view to left showing location of demolished wall.

Fig. 12b. Motel 41: Demolished exterior wall (view from southeast

Conclusions

While damage incurred during this event was not particularly unusual and severe damage was limited, the event still has some lessons for emergency managers and city planners. Even in a relatively small town, a number of community-type structures can be affected. Fortunately in Cordell some provision had been made for the possibility of a tornado. The Day Care Depot was the best prepared with a shelter built within the structure. However, the other day care center had also made provisions for relocating to a place of safety by having an outdoor storm cellar. Teachers in both facilities seemed to have had adequate warning and acted quickly though students at the latter center had to walk a significant distance outside. As mentioned, the owner planned to address this problem for the future.

Of more concern, however, was the situation at the elderly care center. It was fortunate that no residents were in the building since it is likely that significant injuries would have resulted from flying glass. FEMA 361, *Design and Construction Guidance for Community Shelters* (FEMA 2000), provides guidance for design of community shelters appropriate for elderly care centers.

Acknowledgements
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References

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