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THE WOODSTOCK TORNADOES (AUGUST 7, 1979) EVENT RECONSTRUCTION AND ORGANIZATIONAL RESPONSE

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1. INTRODUCTION

Tornadoes do not occur very frequently in Canada, relative to the United States; somewhere between 20 and 50 cases are reported every year.[1] Their occurrence is largely confined to the summer months (April to September) and late afternoon or early evening in the southern regions of five provinces: Alberta, Saskatchewan, Manitoba, Ontario and Quebec (Emergency Planning Canada 1979). Despite their small number, tornadoes have devastated many communities in Canada.

On August 7, 1979, between 6:00 and 8:00 p.m., two tornadoes swept through part of the City of Woodstock, several surrounding communities and many farms, leaving a trail of destruction unmatched in the area's history. Two persons were killed, another 150 injured and several hundred households left without shelter. Estimates which have been made of the property damage range from $20 to $100 million dollars (London Free Press 1979). The pair of tornadoes were the worst to hit anywhere in Canada in 1979 and were "possibly the worst in southern Ontario since the Sarnia to Stratford outbreak in 1953" (Chinook 1979).

According to Evans and Start (1979), the Woodstock tornadoes mark the eighth recorded tornado occurrence in Oxford County, an area of 2,032 sq. km, in the last 130 years. Residents may, therefore, expect to receive a tornado once every 16 years, although the probabilities with which specific communities within the County can expect to receive tornadoes are much lower. The most recent tornadoes, however, were notable for the scale of damage they brought about. The tornadoes devastated an area of 117 sq. km, causing record amounts of property damage in addition to loss of life and personal injury.

This paper describes the event, the resulting damage, and evaluates the organizational response associated with these events. Analysis of the emergency response can be divided into three general categories: the warning or initiatory phase; the immediate response or "emergency" proper; and the medium and long-term clean-up and restoration. The information on which this analysis is based was gathered by personal (face-to-face) or telephone interviews with the key actors of the participating organizations listed in Appendix 1. The interviews were completed with these key actors by the three authors with the help of Ms. Bev. Jaffray in a period from October 1979 until January 31, 1980.

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[1]The Atmospheric Environment Service is currently involved with a National Tornado Statistics Project to compile information related to tornadoes. This will make available more information about the occurrence of tornadoes throughout Canada (Newark 1980, pers. comm.).

2. DESCRIPTION OF THE EVENT

Several parts of Ontario were affected by severe weather events on August 7, 1979, which led the Ontario Weather Centre to issue thirteen severe weather watches and warnings. The day began with numerous thunderstorms and intermittent heavy rainfall along the north shore of Lake Huron and Georgian Bay. A tornado touchdown was reported during the morning at Powassan, south of North Bay (Taylor 1979). These events were associated with a warm front - characterized by high temperatures and high humidity -which, at 6:00 a.m., lay along a line from Sault Ste. Marie to southeast Michigan. This system was accompanied by thunderstorms and periods of heavy rainfall as it moved east-southeastwards. In the late morning, heavy thunderstorms were reported at Wiarton near Owen Sound; where 26 mm of rain fell during 5 min. This system passed directly over western Lake Ontario accompanied by thunderstorms about mid-day. Funnel clouds were sighted over the Lake near Oakville, while another was reported over Toronto International Airport at Malton.[2] By mid-afternoon, this system had moved into New York State and had shrunk considerably in size (Ontario Hydro 1979).

The severe thunderstorm and tornado activity which struck Woodstock area in the early evening hours of August 7 was set off by a cold front which had moved in from the northwest to central Ontario during the afternoon (i.e. behind the initial warm front). The activity associated with the front culminated in the two tornadoes which cut three damage tracks through parts of Perth, Oxford, Brant and Haldimand-Norfolk counties (Fig. 1).

The first tornado touched down approximately 2 km southeast of Stratford at 6:18 p.m., and after damaging farms northwest of Hickson, it skirted that community and the Village of Bright, 15 km to the east, devastating more farms southwest of Bright. Figure 1 identifies the curved damage path (A-B) cut by this tornado and shows that it left the ground at 6:56 p.m. Four minutes earlier, a second tornado touched the ground in an area northwest of the City of Woodstock. It took almost an hour to cut two damage tracks (C-D, E-F) as it traversed an almost straight path in a southeasterly direction. The two damage tracks shown in Fig. 1 indicate that this tornado was composed of two parallel funnels which both touched ground along the middle portion of its path. This tornado left the ground approximately 6 km southeast of Waterford at 7:58 p.m. (Fig. 1).

The first tornado travelled at a constant speed of 50 km/h, whereas the second tornado travelled the initial two-thirds of track, C-D, at 70 km/h before slowing to a speed of 45 km/h over the last third.[3] Attempts have also been made to estimate the rotational wind velocity of the tornadoes. An Ontario Hydro report estimates that the speed was in excess of 150 km/h.

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[2]These funnel cloud reports prompted the Ontario Weather Centre at Malton to issue a tornado warning for Toronto at 12:55 p.m.; however, this was cancelled at 1:50 p.m. after the warm front passed safely by.

[3]These estimates of the speed of travel are taken from Chinook (1979) and were calculated from weather radar and a log of power outages on lines operated by Ontario Hydro. The London Weather Office followed the second tornado from start to finish on radar (Finch 1979, pers.comm.) while the power outages were caused by the destruction of 29 electric transmission towers by the tornadoes.

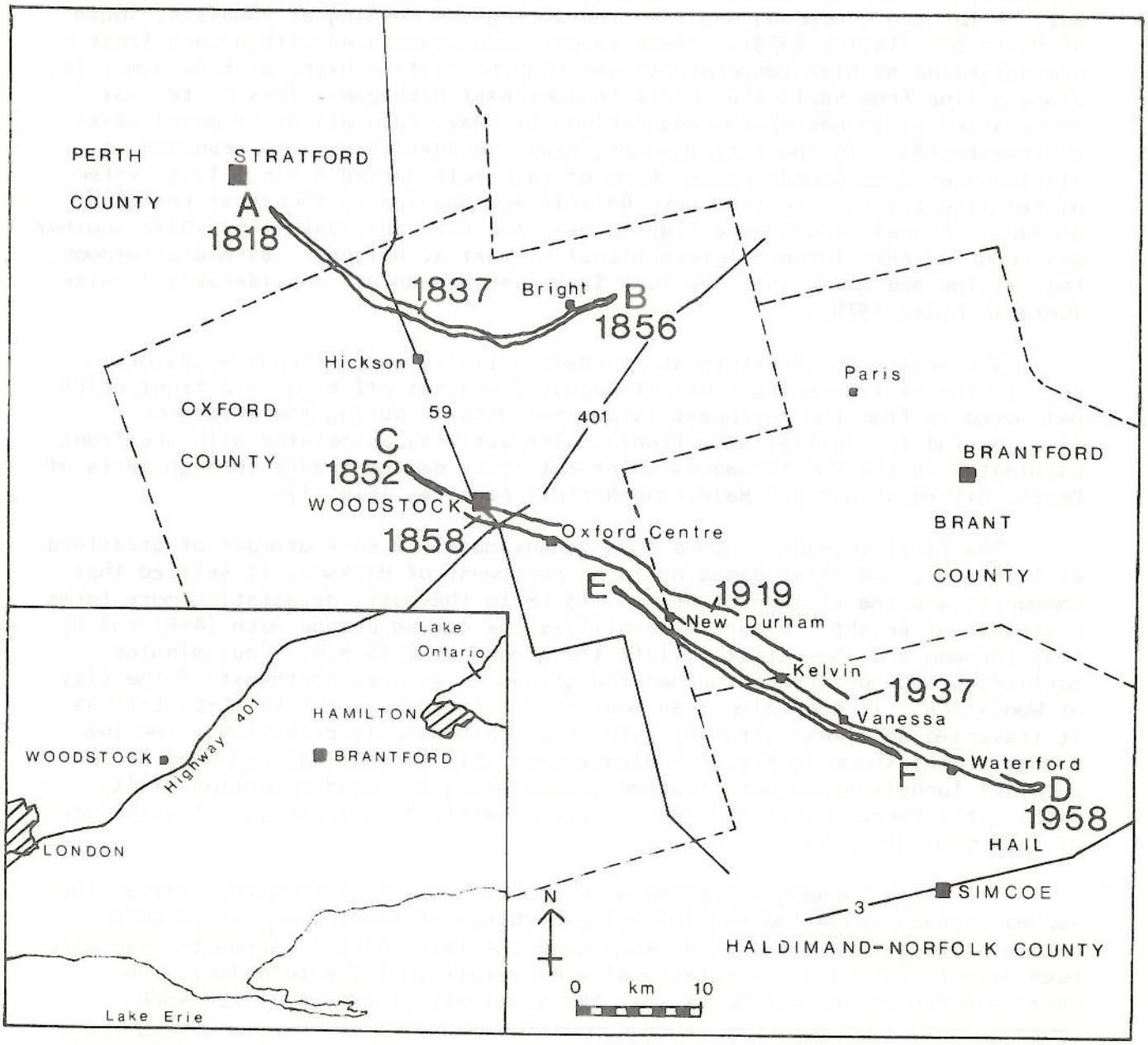

Fig. 1. Location of tornado damage tracks (Chinook 1979)

However, Taylor (1979) has suggested a more precise range of 175-200 km/h.[4] Whatever the actual speed, it was sufficient to cause catastrophic damage over a large area.

Mark Bourrie, a reporter who watched a funnel of the second tornado skirt the Woodstock Fairgrounds (Fig. 2) has described the weather conditions in the area at the time:

> "It was 6:45 p.m. Tuesday... Thunder grew worse and lightning struck around the fairgrounds. The 150 or so people in the area found themselves in the dark as the power failed.
>
> Bogart (a local horse trainer) and I were making small talk about the races that night and whether they would be called off by the rain - when I looked up and saw a cloud about one and a half kilometers wide, turning in a clockwise direction.
>
> (We) stepped around the corner when we saw a funnel come down from the low, black cloud.
>
> The rain, which had been severe, tapered off slightly and the funnel began moving in a northeasterly direction.
>
> The funnel was wide, not like the long, skinny twisters usually thought of in connection with those of the United States midwest. It resembled a monstrous swirling black cloud.
>
> (We) stood aghast as the twister moved. We ran to the south side of the building to get a better view, and by then, word had travelled through the barn. Trainers, drivers, and owners flocked around the door watching.
>
> The twister travelled in a northeasterly direction and, as it grew closer, we could see shingles, branches, and birds being sucked towards the centre.
>
> Some of the material began to fall out behind the funnel and several smaller funnels reached down from the cloud to touch the earth. The tornado continued to move toward us... The twister seemed to make no noise... The tornado didn't reach the fairgrounds but it destroyed trees in the area.
>
> We watched as it passed behind two apartment buildings and realized it was not as close as it seemed... (It) moved in a constant direction and only once did it lift from the ground while it was in our sight.

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[4] This estimate should be viewed cautiously. Taylor derived her estimate from (a) the translational windspeeds given in Chinook (1979), and (b) a comparison of photographs of the damage to buildings in these cases with earlier instances in the United States. The ability to make accurate comparisons can be doubted given suggestions by other researchers, e.g. Brinkman (1975), that minor variations in building design or construction practices can affect the susceptibility of buildings to tornado damage. It is highly unlikely that these would have been discernible in the photographs of buildings in either case.

> We continued to watch it as it moved along the southern horizon until it was gone from the overcast sky.
>
> The whole incident lasted just five minutes... Some people in the building prayed and most of the children hid along the walls. There is no basement in the stable. The nearest basement was about 200 m away.
>
> After the tornado passed, torrents of rain flooded the parking lot in the fairgrounds with about eight centimetres of water. (London Free Press 1979)."

The thunderstorms, lightning and heavy rainfall described by Bourrie probably covered a much wider area than the tornado paths and immediately adjacent areas. These weather conditions probably extended to areas in and around the towns of Simcoe, Jarvis and Hagersville, for example, since minor damage (i.e. lifted shingles and broken tree limbs) consistent with thunderstorms was noted in these areas (Ontario Hydro 1979). A severe hail storm in the Renton-Tyrell area caused extensive crop damage as well (Chinook 1979).

The length, width and areal characteristics of the three tornado damage tracks are given in Table 1. Along the cores of both major tracks (tracks A-B and C-D in Fig. 1 and Table 1) there was almost total destruction of buildings, which left several thousand people without shelter. In total more than 600 houses or farm buildings were destroyed or damaged to an extent which made them unfit for continued occupation or use without major repairs, as well as scores of industrial and commercial premises, nine churches and three schools. The three small communities of Oxford Centre, New Durham and Vanessa were almost completely flattened.

Table 1. Physical characteristics of the tornado damage tracks

Tornado track	Width range (km)	Length (km)	Approximate area (km^2)
A - B	0.2 to 1.0	33	20
C - D	0.5 to 2.0	59	80
E - F	0.1 to 0.9	29	17
Totals	0.1 to 2.0	121	117

Chinook (1979)

The second tornado swung in a C shape striking 15 blocks in the southwestern part of the City of Woodstock (Fig. 2). Over 350 buildings were destroyed or damaged. Table 2 outlines the types of buildings damaged and summarizes the extent of the damage. The tornado left an estimated 1,000 residents seeking shelter on the evening of August 7.

The affected area included houses which were still under construction in the Bridlewood subdivision. Two schools - St. Patrick's Christian Reform and Southside - were severely battered, as was the Church of the Nazarene - while the Christian Reformed Church was flattened (Globe and Mail, August 8, 1979).

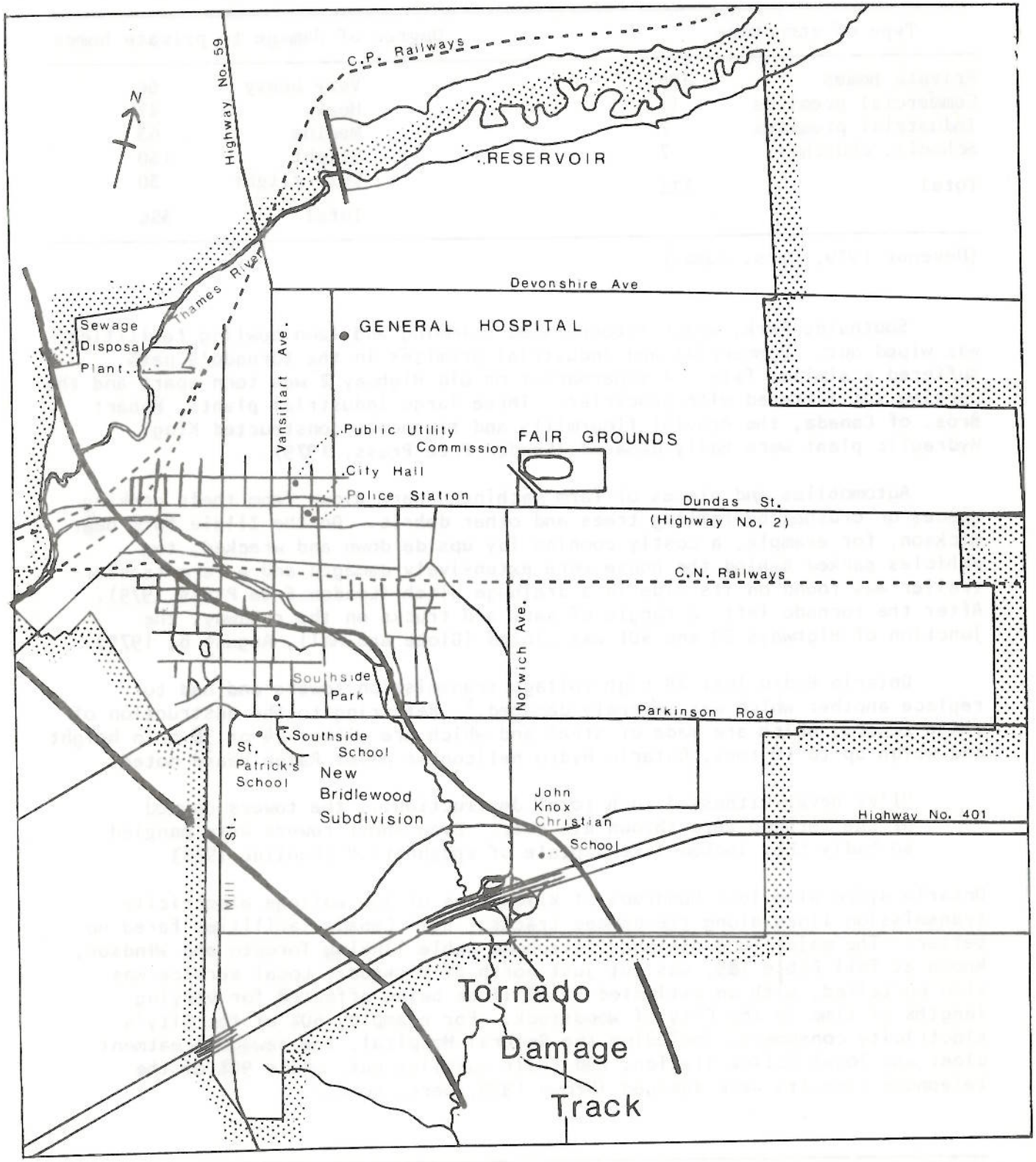

Fig. 2. Extent of damage and location of key facilities in City of Woodstock

Table 2. Structural damage suffered by buildings in the City of Woodstock

Type of structure		Degree of damage to private homes	
Private homes	356	Very heavy	66
Commercial premises	13	Heavy	47
Industrial premises	7	Medium	63
Schools, churches	7	Slight	150
Total	373	Very slight	30
		Total	356

(Hevenor 1979, pers. comm.)

Southside Park, which incorporated swimming and lawn bowling facilities, was wiped out. Commercial and industrial premises in the tornado's path suffered a similar fate. A supermarket on old Highway 2 was torn apart and the parking lot littered with groceries. Three large industrial plants, Hobart Bros. of Canada, the Provini flourmills and the newly constructed King Hydraulic plant were badly damaged (London Free Press, 1979).

Automobiles and pieces of farm machinery were blown from their parking spaces or crushed by falling trees and other debris. On the Zilkie farm near Hickson, for example, a costly combine lay upside down and wrecked, two vehicles parked behind the house were extensively damaged and a farm tractor-trailer was found on its side in a drainage ditch (London Free Press 1979). After the tornado left a tangle of cars and trucks on the roadway, the junction of Highways 59 and 401 was closed (Globe and Mail, August 8, 1979).

Ontario Hydro lost 28 high voltage transmission towers and had to replace another which was severely damaged.[5] Referring to the destruction of these towers, which are made of steel and which are either 24 or 38 m in height and weigh up to 10 tons, Ontario Hydro helicopter pilot Ralph Heard noted:

> "I've never witnessed such total destruction... the towers downed by the tornado were thrown all over. Even short towers were mangled so badly they looked like a plate of spaghetti." (Paoline 1979)

Ontario Hydro also lost hundreds of kilometres of low voltage electricity transmission lines along the damage tracks. Bell Canada facilities fared no better. The major long distance telephone cable linking Toronto and Windsor, known as Toll Cable 185, was cut just north of Hickson. Local service was also curtailed, with an estimated 1,100 lines being affected for varying lengths of time in the City of Woodstock. For example, 60% of the City's electricity consumers, including the General Hospital, the sewage treatment plant and local Police Station, had their supplies cut, while 90% of the telephone circuits were damaged (Brown 1979, pers. comm.).

[5]High voltage line repair work, which included replacement of these towers, was estimated by Ontario Hydro (1979) to have cost approximately $1,200,000.00 Ontario Hydro incurred total expenses of nearly $2 million dollars.

In rural areas, hundreds of cattle and pigs were killed by the collapse of barns and trees. In Vanessa, Gerald Dierick said that "chickens from a neighbour's poultry farm were going past me like bullets", when describing the loss of 90% of the 50,000 chickens from a neighbouring chicken farm. Not a trace of the missing birds could be found. Dierick had weathered out the storm in his truck. His family miraculously emerged from their home which looked as though it had been hit by a bomb (Chinook 1979).

Crops of corn and tobacco along the tornado track were levelled and orchards uprooted. Hundreds of trees of all shapes and sizes were shattered and twisted, their trunks adorned with the debris from homes, barns and other buildings upwind along the tracks. The entire area was littered with evidence of tornado missiles: countless examples of holes left in windows, walls, roofs and cars, plus impact marks on bricks and stucco were testimony to the quantity and sizes of flying debris. Flying debris also appears to have been responsible for at least one of the two fatalities (London Free Press 1979).

3. DESCRIPTION AND EVALUATION OF THE ORGANIZATIONAL RESPONSE

The occurrence of tornadoes is associated with the occurrence of severe thunderstorms. Tornadoes are characterized by very rapid onset, high energy output and relatively short tracks. The highly localized nature of tornadoes has provided little incentive for governments and the public to invest in protective measures. The likelihood of protection being needed in any one place is small; and given the nature of a major tornado, such measures are often not effective (Burton *et al.* 1978). However, tornado shelters do save lives, if not property.

The destructive power of a tornado lies primarily in its high wind velocities and sudden changes of pressure. In addition, tornadoes frequently contribute to the compound hazard situation, since their association with storm systems often means that they are accompanied by hail, torrential rain, thunder and intense lightning (Brinkman 1975). The Woodstock occurrences were no exception, as the preceding description shows.

Three major categories of methods: modification of a hazard; strengthening of the man-made environment; and the encouragement of man to be more responsive; may be used to bear or reduce losses from tornadoes (Brinkman 1975). The physical attributes of tornadoes, combined with a lack of development of suitable science and technology, have precluded the opportunity to cope by modifying the hazard. Kessler (1972) concludes that, while modification appears conceptually possible, there is insufficient information on the basic physics and climatology of tornado evolution and formation to predict whether it is technically possible or economically feasible.

Similarly, the low frequency and high energy outputs of tornadoes have severely limited the scope for using modification of the man-made environment as a coping strategy. Nevertheless, some structural modifications are available to limit structural damage, even for highly susceptible wooden frame buildings. However, the emphasis placed on the provision of cheap affordable family dwellings since World War II has produced buildings which have few, if any, of these modifications (Brinkman 1975).

The limited potential of the first two strategies make the third strategy (the encouragement of man to be more responsive) particularly important as a societal strategy for coping with the tornado hazard. Man's response to the hazard is set in the social system in which he lives. The adaptability of these systems to external stresses, such as tornadoes, is extremely complex, embodying responses by individuals, households, neighbourhoods, communities, regions and nations. For each of the last three levels, a distinction can be drawn between formal organizations and overlapping sets of "masses" or "publics" - large unorganized aggregates of people acting with reference to common goals (Barton 1969).

The remainder of this paper analyses how formal organizations contributed to the emergency brought by the tornadoes on August 7, 1979. The discussion of this response is divided into the three phases outlined in the Introduction.

3.1 THE WARNING PHASE

The Atmospheric Environment Service (AES), part of Environment Canada, is responsible for weather observation and monitoring in Canada. These tasks are directed in Ontario from the Ontario Weather Centre located at Toronto International Airport (Malton). This station is supplemented by a network of eleven regional weather offices distributed throughout the Province.[6]

The responsibilities of the Ontario Weather Centre include the prediction of severe weather conditions in the Province and the dissemination of this information to the public. Two types of messages are issued: forecasts and warnings. A forecast indicates that a particular meteorological phenomenon will probably occur in a particular place during a specific time period. Forecasts are generally based on interpretations of synoptic conditions from the Canadian Meteorological Centre in Montreal. These messages are information based on scientifically observable facts and offer no prescription as to how people should respond. In contrast, a warning is a message which advises the public to take steps in preparation for the severe weather events mentioned. All warnings are based on forecasts, but very few of the forecasts are followed by warnings.

In the case of tornadoes, the Ontario Weather Centre follows an American practice and distinguishes between weather "watches" and "warnings". A "tornado watch" is intended to alert the public to the possibility of tornadoes occurring in the area for which the watch is issued. In Ontario, the decision whether to issue a watch is based upon a number of explicit criteria relating to the presence or absence of certain meteorological conditions (Pender 1980, pers. comm.). These watches seldom mention tornadoes explicitly, as forecasters fear that the failure of tornadoes to materialize in the majority of cases would adversely affect the credibility of these watches, and thus affect future public response.

A "tornado warning", in contrast, is issued to indicate that a tornado has been sighted, and that persons within the area should take protective action immediately. The Ontario Weather Centre requires the presence of a distinct radar echo hook, or an eye-witness sighting of a funnel, before it will issue such a warning. Although the Centre relies primarily on its own efforts and those of its regional weather offices to determine whether these conditions exist, it has also set up the Summer Severe Weather Watch Programme to improve its ability to issue appropriate warnings based on eye-witness accounts. This programme, which was initiated in 1979, currently has approximately 2,000 members - these members carry cards with an unlisted telephone number which they call to report severe weather directly to the Ontario Weather Centre.[7]

Severe weather information is disseminated according to the communication system outlined in Fig. 3. Once the messages are transferred from the Ontario

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[6]Regional weather stations are located at Sault Ste. Marie, Copper Cliff, North Bay, Ottawa, Peterborough, Kingston, Guelph, Hamilton, St. Catharines, London and Windsor.

[7]This programme has been reasonably successful during its first two years of operation. During this period, the probability of detecting a severe weather event, such as a tornado or thunderstorm, was 0.480, while the false alarm ratio (# false alarms/# forecasts) was 0.195 (Pender 1980, pers. comm.).

Although warning problems cannot be solved simply by introducing great quantities of detection hardware and by taking innumerable measurements, they can be reduced. One possibility is to equip television sets with radar equipment for the detection of severe weather events such as tornadoes (Eagleman *et al.* 1975). Another possibility is to increase the scale of the Summer Severe Weather Watching Programme. The Ontario Programme is modelled on the successful Project Skywarn launched in 1969 in the United States. The Ontario Weather Centre has recently undertaken an intensive drive to increase participation in the programme, and a special effort has been made to recruit OPP and conservation authority personnel and CB radio operators as watchers, although these people would still report on the special telephone lines. The reliance of this system on telephones, however, makes it highly susceptible to failure even when weather watchers have spotted a tornado and attempt to report it. The Woodstock experience shows that telephone communication is particularly susceptible to disruption by tornadoes. Consequently, a proposal by the Oxford Amateur Radio Operator's Club and its London equivalent to establish a CB radio system in conjunction with the programme and the Ontario Weather Centre warrants serious consideration.[10]

The second stage comprises warning dissemination. At this stage the decision is made to warn, and appropriate messages are constructed and distributed. In this case, the appropriateness of the three weather watches can be queried since none of them explicitly mentioned the possibility of tornadoes occurring. The rationale is that such a warning would only generate panic. On the other hand, not mentioning tornadoes has the effect of failing to elicit any response whatsoever, as shown in the case of CKDK radio. The radio station did not broadcast severe weather watch No. 78 because it felt these messages were too common, that nothing hardly ever materializes after such a message, and that they are unpopular with its teenage listening audience (Bell 1979, pers. comm.).

The last part of this dissemination stage, distribution of the messages, also failed on August 7. As a result, most of the residents of Woodstock and surrounding areas had no advance warning of the severe weather events they endured. The communication system needs to be upgraded so that the information reaches its intended public. In particular, modifications can be suggested which would substantially reduce the possibility of failure. These are:

1. expanding the responsibilities of the organizations involved to increase the interrelations of the system and thereby minimize the chance of the system breaking down because of the failure of one or more specific links. For example, the London Weather Office received all three messages on August 7, but was relatively ineffective in disseminating them to the public because of its narrowly defined functions. Its task of checking that local television and radio stations have broadcast watches and warnings could be made mandatory;

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[10] The Citizen Band (CB) radio clubs are still negotiating with the Atmospheric Environment Service in connection with this proposal.

2. there is a need for more durable communications paths. The closer a message gets to the public at present, the greater the reliance on the telephone as a means of communication (Fig. 3). There are two ways in which the current system could be strengthened:
   (a) by making regional weather offices responsible for distribution of the messages as well, or
   (b) by extending the coverage of Weatheradio Canada.[11]
   These modifications would reduce reliance on the land-based communication systems which are susceptible to disruption by tornadoes;

3. increased liaison between the Ontario Weather Centre and television and radio stations to ensure that the latter organizations broadcast these messages in an appropriate manner. The news media are most efficient at reaching a large segment of the general populace; and

4. the establishment of stronger formal feedback paths. These are particularly important in the case of tornadoes since the warning phase does not end until the tornado dies. Up until that time it may be possible to warn residents and organizations of their existence elsewhere in adjoining areas which are likely to be affected as well.

It is not possible to comment on the effectiveness of the third and final stage, the response in this case, since few members of the public were warned in advance of the possibility of tornadoes. However, the response by the local radio station, CKDK, to weather watch No. 78 and by the crowd at the Woodstock Fairgrounds when they sighted a tornado funnel approaching them[12] does not generate much cause for optimism. Consequently, there may be a need for public education so that people take appropriate protective action when threatened by a tornado.

By way of conclusion, it is important to stress that all three stages in a warning system are crucial, since the effectiveness of a warning system can be measured only in terms of the degree to which the protective response is elicited in the threatened public (Mileti, 1975, 15). Therefore, it is necessary to evaluate the benefits and costs of proposed changes in terms of the whole system and not just the specific stage in which the improvement is to be made.

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[11] It is estimated that 90 per cent of the population in Ontario could be reached if 5 or 6 studios and 10 repeater stations were constructed. However, the initial capital investment is currently considered prohibitive (Pender, 1980, pers. comm.).

[12] From the quotation on page 6 it is clear that the crowd did not take the appropriate protective action that they should have taken; that is, taking cover in the nearest available basement. Instead they stood in the doorway to the barn and watched the spectacle.

3.2 THE IMMEDIATE RESPONSE

Immediately after the tornadoes, a large number of local emergency services were activated to fulfil three tasks:

1. rescuing the injured and locating possible dead;

2. restoring the power and communications in the area; and

3. assisting the displaced and dispossessed victims.

The first of these tasks was performed by the Woodstock City Police Department and the Ontario Provincial Police, who followed the damage tracks looking for people trapped in the wreckage of their homes. All local policemen were called in, and the local forces were supplemented with OPP personnel from London. Due to the disruption of telephone services, and the failure of the ambulance radio network, the OPP also provided a vital communications link between rescue crews, ambulances, and Woodstock General Hospital. This was accomplished by routing a relay system from ambulances to the police cars, and in turn to Police Headquarters, and finally to Woodstock General Hospital. However, there was a delay of several hours before the link was completed, during which the hospital operated "blind".

The majority of Woodstock General Hospital staff who were not on duty reported to the hospital as soon as they heard the news of the tornadoes. The first patients arrived at 7:10 p.m., and as a result eighteen "non-essential" hospital patients were relocated in the chapel adjoining the hospital, where they were attended to by Salvation Army volunteers. The hospital partially implemented its emergency plan, which sets out procedures for the deployment of staff and equipment, the operation of an advance medical team, and regulation of the patient's arrival at the hospital. The plan is summarized in Appendix 2.

The hospital could not implement the second and third procedures mentioned above, since victims arrived at the hospital by themselves. Those who were not seriously injured and those who could by driven directly arrived first. All patients were assisted in completing triage tags when they arrived.[13] Between 7:10 p.m. and 11:00 p.m., an estimated 187 victims arrived at the hospital seeking medical attention. Two of the victims were dead on arrival, and another six were seriously injured. Three of the latter required immediate surgery, and one was transferred to London General Hospital to have a leg amputated at the groin. Of the 187 patients treated, a total of thirty were admitted overnight, and all but eleven were discharged the next day.

The hospital was able to cope with these extra duties with relative ease although it was inconvenienced by the difficulty of communication with the outside world and by the disruption of its water supply. The lack of communication, for example, at one point led the hospital to make an unnecessary set of preparations to accommodate an expected influx of one hundred

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[13] Approximately fifty patients inadvertently took their tags with them on leaving the hospital, however.

seriously injured patients when it was rumoured that the fully staffed Hobart Brothers of Canada industrial plant had been demolished by the tornado. The rumours turned out to be false, as the plant sustained only structural damage, from which the staff walked away with mostly minor injuries. The hospital relied on a Silverwood milk truck filled with water to replace its normal water supply until this was restored the next day; and it had to rely on its emergency generator to supply electricity for several hours during the evening of August 7 as well.

The police were able to account for everyone living in the damaged areas within approximately two to three hours (Captain Scott 1979, pers. comm.). Woodstock and Ontario Provincial Police sought to prevent looting and set up a mobile headquarters in the affected area of Woodstock. The Sandbaggers Club[14] helped patrol these areas to discourage looting as well. The Woodstock Fire Service also had a busy time. Up until 11:00 p.m., when the seventeen "off-duty" firemen were sent home, a total of twenty-five firemen, four trucks, a van, and two private cars were involved, assisting to clear roads and investigating reports of natural gas and propane leaks in the area. During the two hours up until 9:00 p.m., the Fire Service responded to twenty-two calls of leaks; and in doing so, encountered numerous access difficulties caused by fallen trees, power lines, and the presence of thousands of sightseers who converged upon the affected areas. The fallen lines proved less of an obstacle after 8:00 p.m., when the Fire Service was informed that they were no longer electrified. The police, assisted by the Woodstock Board of Public Works, had some difficulty trying to control the sightseers until the affected areas were cordoned off the next morning.

The second priority, restoring power and communications in the area, was met by Ontario Hydro, the local Public Utilities Commission (PUC), and Bell Canada. The collapse of twenty-nine high-voltage electricity transmission towers, described earlier, affected supply to nine circuits. Ontario Hydro's first task was to reroute electricity through the Hydro network. Within two hours of the first outages a central control emergency response group was formed in Toronto, with a smaller group established at the Western Region headquarters in London. The Woodstock transformer station whose supplies were cut at 6:58 p.m. had almost normal power levels restored by 7:35 p.m. All the affected transmission stations had normal power restored by 2:08 p.m. on August 8. In the meantime, maintenance and operation crews were sent out to assess the damage and set up temporary distribution lines.

The Woodstock PUC was responsible for dealing with low voltage line disruptions. It has been estimated that sixty per cent of Woodstock's consumers were without electricity and that rural consumers fared even worse. In Woodstock the local police station, water supply pumping stations[15] and

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[14] This club has about sixty-five members throughout Oxford County. A CB radio group, it places a large amount of emphasis on social activities and functions.

[15] Woodstock relies on eight wells at four pumping stations for its water supply, although it also maintains a reservoir. Two of these pumping stations, located outside the City, provide the bulk of the City's water supply and also provide better quality water than the two smaller pumping stations.

sewage lift stations[16] did not have power. Priority was given to restoring electricity to these facilities (Rousom 1979, pers. comm.).

The Woodstock PUC response did not commence until approximately 8:00 p.m., when the Woodstock Police Chief called the PUC accountant[17] to inform him that the south end of the city had been hit by a tornado and was without power. Local PUC crews and a six-man crew from the nearby Ingersol PUC worked most of the night to restore power to the key facilities listed above. Power was restored at the local Police Station by 9:15 p.m., to the two smaller pumping stations just before midnight on August 7[18], and to the sewage lift stations by 3:00 a.m. on August 8. In all, the Woodstock PUC was able to restore supply to approximately one-third of the consumers affected by daybreak on August 8.

The possibility of a large operation was excluded due to the accountant's limited knowledge of the cooperative emergency assistance program which has been set up between Ontario Hydro and other PUC's[19]. The plan, on file in the General Manager's office, is activated by calling Ontario Hydro's regional headquarters in London. The plan gives this office responsibility for coordinating the response and assessing the extent of the damage. It also makes provision for supplementing local manpower with personnel from other PUC's in the immediate area if necessary. In this case the accountant, unaware of any program, waited until 6:00 a.m. on August 8 before contacting other PUC's for assistance.

Bell Canada restored most of the damaged telephone circuits within twelve hours, although the Toronto-Windsor long distance cable was severed for two days. Telephone communications were restored to the Woodstock General Hospital and the local OPP office by 9:30 p.m. and 11:06 p.m. respectively.

The third priority, assisting the displaced and dispossessed victims, was mostly carried out at this stage by the Red Cross, which set up a registration and inquiry service. It also provided an emergency shelter and compiled an emergency accommodation list. The emergency shelter was not required, since only two of the more than one thousand people left homeless required this service. The remainder stayed with friends, neighbours, and relatives (London Free Press 1979, 3). However, the other two services were used extensively. The accommodation list was later forwarded to the Woodstock City Housing Department.

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[16] Woodstock's sewage system relies on gravity and strategically located lift stations, which lift the sewage to higher levels and allow gravity flow from these higher elevations, to regulate flow into the treatment plant. There was concern that the lack of power to lift stations could cause a back-up of sewage in residents homes.

[17] The accountant was the acting manager in the absence of the General Manager and Engineer, who were both away on vacation.

[18] The failure to restore power to the other two pumping stations caused water supply problems the next day. These are described in Section 3.3.

[19] The program was established by the Municipal Electrical Association on March 3, 1965.

In providing the registration and inquiry service, the Red Cross was assisted by local CB radio clubs. The Radio Emergency Action Centre Team (REACT) set up their command at the Red Cross headquarters and provided communication service on an emergency CB channel.[20] This group worked closely with the OPP and Red Cross, sifting and sorting emergency calls for assistance and reports of damage. This group also established a CB radio service for the hospital with the outside world by placing a CB radio equipped vehicle in the hospital grounds. The Oxford County Amateur Radio Operators Club used its longer-range equipment to relay information between the affected areas and interested friends and relatives further away. Three other CB groups - the FLAKE club, the Sandbaggers Club, and the Committee of Five group - also provided assistance. Another volunteer organization, the 600 Club, formed after a 1977 snowstorm emergency, provided four-wheel vehicle service for the Red Cross.

Politically, response at the municipal level was different in all three of the affected jurisdictions. Senior officials of the City of Woodstock, which has no emergency plan, depended upon the police and the Red Cross. The Mayor spent this period going between the Police Station and the Red Cross headquarters nearby, acting as impromptu liaison officer. In Burford Township (Brant County), the Clerk became the Chief Administrative Officer for the coordination of local relief. Burford Township has a disaster plan and avails itself of the services of an Emergency Planning Officer. The Officer in Brantford offered emergency support and came on scene. The Clerk initiated calls to various politicians, including the local MPP, Mr. Robert Nixon (L, Brant, Oxford, Norfolk). He also appears to have been the first to request disaster relief assistance.

In Haldimand-Norfolk, which also has an emergency plan and Emergency Planning Officer, the Emergency Planning Officer's role was as part of the "fan-out" procedure. As in other areas, the immediate municipal response was to assist regional and local police.

Evaluation and Comments

The sudden destruction of buildings and facilities by tornadoes creates a large number of urgent new individual needs - for rescue, medical care, and reassurance about the safety of loved ones. At the same time it damages the means by which normal needs are met, by destroying shelter, household equipment, and supplies of food and clothing, thereby creating a need for substitute facilities. In addition, hurricanes often damage the facilities by which economic and governmental organizations carry on their normal activities and deal with emergencies.

Consequently, the first few hours after a disaster, such as a tornado, are characterized by the crushing overload of needs and the importance of rapid action. In theory, at least, organizations can do many things beyond the power of unorganized groups or individuals during this period, because they have coordination, special skills, and equipment. The role of organizations

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[20] The REACT team undergoes a rigorous training and screening procedure specifically designed for emergency.

in disasters is to gather personnel together quickly, to get men and equipment into the disaster areas, and to fulfil their proper functions as organizations, with internal communications, division of labour, and leadership. A prior condition is, of course, that an organization have men, equipment, and skills which are useful in disasters, and that among its responsibilities is action to help the community in the type of disaster which has occurred (Barton, 1969).

Overall, the organizations involved in the immediate response to the Woodstock tornadoes responded in an appropriate manner, coping adequately with their responsibilities. Nevertheless, the description of the immediate response highlights several problems which arose during this period. Table 3 summarizes these problems and groups them into three categories.

These problems were not critical because of the limited scale of the event. The tornado which swung through Woodstock left many more unharmed than harmed, and left the emergency organizations with undamaged facilities and equipment and almost full emergency staffs. Would the response have been as adequate if the tornado had taken a path through a more heavily populated part of Woodstock or key facilities such as Woodstock General Hospital (see Fig. 3), or if lightning had triggered a major fire? Probably not, as experience with major tornadoes elsewhere has shown (e.g. Form and Nosow's 1958 study of the Flint-Beechers tornado).

It is frequently suggested that the level of preparedness of emergency organizations has a major influence on the nature and quality of their response (e.g. Barton, 1969; Brinkman, 1975; A.J. Taylor, 1979). This literature suggests that there are four critical questions in this regard:

1. Does the community or organization have an emergency plan?; and if so,

2. Is the plan adequate? (An adequate plan will define responsibilities, lay down procedures, and systematize communications);

3. Does the organization have the necessary mechanical, technical, and human resources to implement this plan?;

4. Is the plan understood and appreciated, and regularly used or practised?

The level of preparedness would have been much greater if there had been one general plan to cover the responses of all the organizations likely to be required. A satisfactory plan would minimize the probability of the problems outlined in Table 3 occurring in an actual emergency. The City of Woodstock did not have such an emergency plan at the time of the Woodstock tornadoes. However, six of the groups which did respond in the emergency had plans to regulate their own responses in emergency situations. The evaluation of these plans in Table 4 highlights how these plans, with one exception, contained questionable elements.

The plans of Woodstock General Hospital and the OPP did not retain enough flexibility or include enough alternatives to cope with the tornado hazard of August 7. Both plans related primarily to "point" disasters. The OPP plan, for example, envisaged setting up a command at the scene of the disaster, whereas the Hospital plan envisaged sending out an advance medical

Table 3. Problems encountered during the immediate response phase. Categories (underlined) and examples.

Uncertainty:
The Woodstock General Hospital preparations for the arrival of one hundred seriously injured Hobart Brothers employees.
Response duplication:
The OPP and Red Cross both set up registration and inquiry services.
The Red Cross provided emergency shelter which only two individuals required. The remainder were accommodated by friends, neighbours, and relatives.
Non-existent or delayed response:
The failure to regulate the access and movements of sightseers adequately on the night of August 7 in the damaged areas.
The delay by Woodstock PUC in responding in the first place, and also before calling adjacent PUC's for assistance.

team to the scene to assess injuries and regulate the victims' arrival at hospital. In this instance the damage extended over an area of 117 square kilometres, and neither plan was appropriate. The OPP did not even implement its plan (Table 4).

Two organizations had plans which did not make adequate provision for communications. Communications should be systematized in two directions: across organizations in a community and across neighbouring communities for similar organizations. The Woodstock General Hospital does not have a strong communications link with nearby hospitals[21], while the Red Cross has to rely almost entirely on the cooperation of local CB radio groups in this regard.

The effectiveness of a plan will also be limited if the organization lacks the resources necessary to enable it to fulfil its responsibilities and if its staff are unfamiliar with or do not understand a plan. The former is closely tied to the nature and scale of the disaster, and in this case only the Red Cross and PUC were pressured to fulfil their roles. The lack of knowledge of the Woodstock PUC plan by staff and the impact this had on this organization's response has already been referred to.

This evaluation suggests that the absolute level of preparedness of all the emergency organizations in Woodstock could be improved, irrespective of the relative level of their preparedness on August 7, 1979 (Table 4). Indeed, some organizations have taken steps in this regard, most notably the Woodstock PUC,

[21] The Ontario Ministry of Health has refused for the past four years to finance an Ontario Hospital Assocation proposal to install a province-wide radio network between all hospitals in the province at an estimated cost of $1000 per hospital.

Table 4. Evaluation of existing emergency plans

Criteria	Organizations with plans					
	Ontario Hydro	Woodstock General Hospital	Red Cross	REACT	Woodstock PUC	O.P.P.
1. Was plan implemented on August 7?	Yes	Yes	Yes	Yes	Yes	No
2. Is the plan adequate? i.e. define responsibilities?	Yes	Yes	Yes	Yes	Yes	Yes
lay down procedures?	Yes	Some, for "point" disasters	Yes	Yes	Yes	Some for "point" disasters
systematize communications?	Yes	Some, those within hospital	No	Yes	Yes	Yes
3. Does the organization have necessary resources?	Yes	Yes	Yes, except for communication facilities	Yes	Limited supplies of manpower and equipment	Yes
4. Is the plan understood, etc.?	Yes	Yes	Yes	Yes	No, only some of managerial staff knew of its existence	Yes

which has begun staff familiarization programmes to ensure its plan is understood and appreciated. In addition, the Mayor (Ms. Wendy Calder) initially proposed that City Council begin developing a comprehensive emergency plan for the city in January, 1980. However, other business forced its postponement. The Mayor has indicated that the plan will be developed from the London/St. Thomas plan to meet local needs and circumstances. (Mayor Calder, 1979, pers. comm.). It would be based on a hierarchical structure with a predetermined scheme of delegation and coordination of responsibilities. The plan would also specify a control communications headquarters, and special consideration would be made in the budget to equip such a facility. The Mayor suggested that one possible location for the facility is the new police station, and that the Council might contribute towards the cost of emergency equipment such as an auxiliary generator. Finally, various scenarios including airplane crashes, floods, tornadoes, and snowstorm events would be provided for in the plan, and a unique set of responses prepared for each one (Mayor Calder, 1979, pers. comm.). An important omission from the list of scenarios is technological accidents, especially those connected with the transportation of hazardous materials.

It is not possible to assess in detail the adequacy of these proposals until they emerge in their final form. On the credit side, the proposals seem to cover most of the areas considered by the four critical questions earlier. However, a word of caution is warranted: the plan will be inadequate if the Council resolves to prepare for the next disaster simply by learning the lessons of the previous one. Instead, Woodstock should critically review the experience of other jurisdictions such as the City of Mississauga, whose plan has already been linked to the success of responses to particular disasters (Timmerman, 1980). Valuable insights can be gained from these sources and also federal and provincial government agencies which offer assistance in the preparation of emergency plans (e.g. Emergency Planning Canada). Finally, imagination is needed as well as experience.

3.3 THE RECOVERY AND RESTORATION

The restoration of normal services in the communities and the provision of assistance to the dispossessed constituted the major priorities of the response agencies from August 8 onwards.

Early in the morning of August 8 repairs to the high voltage and low voltage transmission and distribution lines in the damaged area were begun on a large scale with approximately 240 men dispatched from Toronto, Pickering, London, Belleville, and Woodbridge, plus local staff. Ontario Hydro and the Woodstock PUC were able to restore power to all their rural and city customers by August 12. Some were without electricity for five days.

One of the major problems caused by the loss of electrical power was the disruption of the Woodstock water supply. As noted previously, Woodstock relies on water pumped from eight wells at four pumping stations for its supply, and also maintains a reservoir. The two smaller pumping stations (and two wells) inside the city had their power supply restored just before midnight on August 7, and these two wells and the reservoir remained on line during the night. However, these two wells provide poor quality water and the reservoir was only partially filled.

Consequently, on the morning of August 8 a PUC official appealed over the radio for conservation of water by city residents and local industries. City residents immediately increased their water consumption by filling bathtubs, sinks, etc. By 3:00 p.m. the PUC was forced to advise voluntary closure of industries and also disconnected the city reservoir in order to maintain an adequate water supply for possible fire-fighting. Ontario Hydro and the PUC were now working in close contact (in contrast to the evening of August 7). The London regional Ontario Hydro office obtained a 500 KV generator for the outer-city wells, which functioned until power was restored at 10:00 p.m. Normal water supplies were available by the morning of August 9.

Bell Telephone continued its efforts to restore telephone services, directing its efforts from a storm centre and supplying materials from Brantford. Reconstruction of the phone system demanded coordination with Ontario Hydro and PUC crews. Use of existing lines had nearly doubled, and CB and ham radio operators were constantly at work throughout this period.

The Red Cross and other volunteer agencies began sending out personnel on Wednesday with blankets and food, both for bulk distribution to affected families and to support the emergency crews. Because of their registration service, inquiries to the Red Cross became a major problem, which was partly solved through the use of amateur radio groups. The emergency accommodation list was transferred to the City Housing Department, which, according to Red Cross spokesmen, was unprepared to use this information (McBride, 1979, pers. comm.). Outside the city, the rural townships organized food relief. Burford, for instance, became a centre for feeding emergency crews from all over the affected area.

After August 8 OPP involvement in the response was directed by supervisory officers who arrived from Toronto. Fifty personnel, including auxiliary regional officers, were also brought in to assist. Restriction of access, reconnaissance over affected areas, prevention of looting, and regulation of

traffic were continuing responsibilities over the next few weeks. The Woodstock Police and OPP caught and prosecuted three people for looting during this period. They also had the news media broadcast messages describing the restriction of access to the damaged areas in order to discourage an influx of sightseers from Toronto and the United States. These messages were effective, especially on the first weekend after the tornado occurrence.

After midnight on August 7, the Provincial Cabinet became involved. A meeting between the Solicitor General, the Honourable Roy McMurtry, and the Minister of Intergovernmental Affairs, the Honourable Thomas Wells, resulted in the Ministry of Intergovernmental Affairs (MIA) being designated as the "Lead Ministry". This designation appears to have been based on the view that since the tornado had crossed through several jurisdictions, and since the relief effort would be substantial, MIA would be the appropriate "Lead Ministry"[22]. Cabinet declared the area a "disaster area" the next day and approved the setting up of a Disaster Relief Assistance Programme. The Technical Coordinator, Mr. Fred Hamblin of MIA, had direct access to Cabinet through his minister. Hamblin immediately proceeded to the area, and after holding a meeting with all the local Heads-of Council on August 9[23], he set up an Intergovernmental Affairs Coordination Headquarters in Woodstock on August 13.

This headquarters monitored two newly formed committees. One was made up of the local Heads-of-Council and civil servants from various Ontario Ministries, including Agriculture, Health, Housing, and Natural Resources, to process requests for assistance. The second committee was the Disaster Relief Committee, also chaired by Mr. Hamblin. This committee, composed of two citizens from each of the cities and/or townships involved, was responsible for raising the monies which would be matched by the Ontario Government (set by Order-in-Council at 3 to 1) and for the appraisal and disbursement of claims. It was the negotiations and raising of funds that followed which took up most of the effort of the local political figures[24].

This Committee, officially named the "Oxford, Brant, Haldimand-Norfolk Disaster Relief Committee", opened two offices on Monday, August 13 to handle donations and claims for assistance. These offices were located in Woodstock and Waterford. The latter was closed on September 15, but the Woodstock office will not close until all the affairs of the Committee are finalized. The last of the claims were settled on July 31, 1980, and this office was expected to close shortly after this date. Residents who felt they had eligible claims were asked to submit at least their names by September 15, as full claims could be processed when time permitted. On August 16 and 17 the Committee held public meetings in Woodstock and Waterford respectively to explain the disaster relief

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[22] See Timmerman (1980, 26-38) for a fuller description of this concept.

[23] Hamblin met with the Heads-of-Council from the Cities of Nanticoke and Woodstock, the Townships of Blandford-Blenheim, Burford, Delhi, East Yorra-Tavistock, Norwick and Southwest Oxford, the Counties of Brant and Oxford, and the Regional Municipality of Haldimand-Norfolk.

[24] However, local politicians, particularly Woodstock Mayor Calder, were very effective in dealing with the news media as well.

assistance program and the Disaster Committee's role. The information bulletin published by the MIA on this program is included in Appendix 3.

The Fund Raising Subcommittee continued collecting funds up until December 31, 1979, when it had raised $3,547,888.71, which - when matched by the province - came to approximately $14 million. Due to the criteria for the matching of funds, such as counting costs covered by insurance as ineligible, claims with insurance companies and others had to be settled to the extent possible before disbursements could begin. By November, 1979 no monies had yet been paid out, and complaints began to multiply about the funding system. However, in December, the Subcommittee and its adjusters settled with some 260 of the 415 eligible claimants for an average settlement of approximately $19,000 each. All claimants were paid the maximum proportion (ninety per cent) of their claims allowed under the program. The Subcommittee settled with the remaining claimants in January, 1980, and also agreed to reconsider the 235 claims which it initially deemed ineligible. In addition the Subcommittee decided to assist the owners of five orchards for their losses (after deciding orchards are capital assets and not crops), seven churches which were damaged by the tornadoes, and a number of cemeteries.[25]

The financial assistance program has been the major provincial effort in the emergency. Other provincial ministries such as the Ministry of Agriculture and Food (MAF) also provided assistance. The Ministry of Agriculture and Food offered both information[26] and financial assistance in the form of a low interest rate loan program. This program is outlined in Appendix 4. The fact that the MAF did not release local staff from their normal duties severely limited their ability to be directly involved in the restoration effort. The bulk of the restoration work was done by local farmers, farm organizations, and the Mennonite Disaster Relief Committee.

Local farm organizations (e.g. the Federation of Agriculture, the Oxford Soil and Crop Improvement Association, and United Cooperatives of Ontario) organized feed and grain assistance programs. The feed assistance program, for instance, had collected enough feedstock by October 22 to meet seventy to eighty per cent of farmers' anticipated needs for the winter months.

The Mennonites, with Mr. Delmar Zehra as Service Coordinator, began organizing manpower within thirty minutes of the tornadoes. A volunteer was stationed on every concession on August 7, while other volunteers assessed how much help was required. These volunteers were coordinated from the Mennonite Church in Tavistock. On August 8, requests went out for more volunteers, and by the next day five hundred volunteers from as far afield as the United States were available. Mennonite clean-up operations initially focused on damaged areas between Tavistock and Bright, and Hickson and Waterford, respectively; but they later shifted to the Oxford Centre area, which was severely damaged (Fig. 1). By October 24, 1979 sixty-five per cent of the farmers whose

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[25] However, there may not be sufficient monies available to pay ninety per cent of the uninsured losses in these cases.

[26] For example, the local MAF engineer provided plans for new farm structures.