Damage Observations from the Vaughan Tornadoes of August 20, 2009

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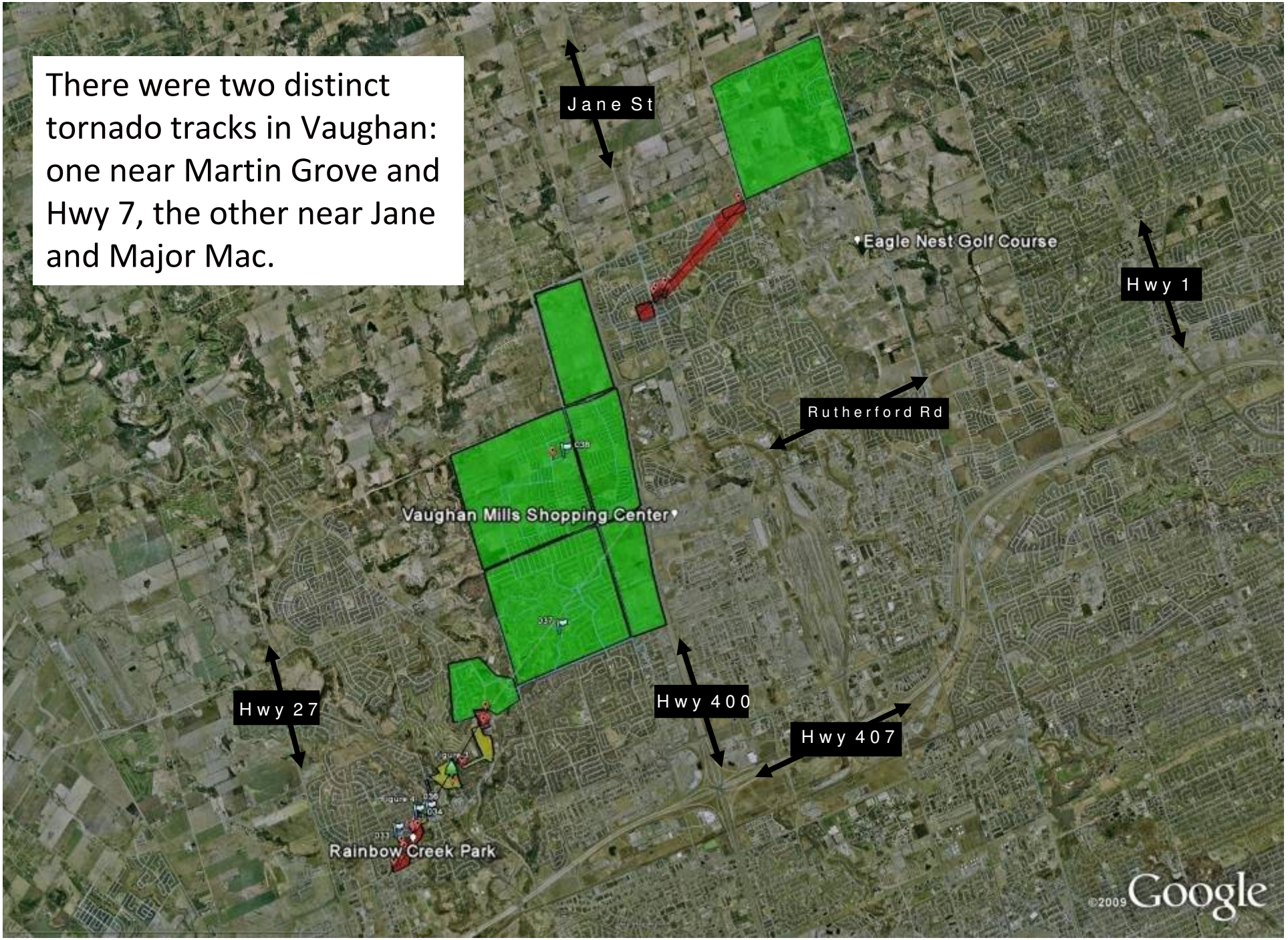
There were two distinct tornado tracks in Vaughan: one near Martin Grove and Hwy 7, the other near Jane and Major Mac.
Jane St
Eagle Nest Golf Course
Hwy 1
Rutherford Rd
Vaughan Mills Shopping Center
Hwy 27
Hwy 400
Hwy 407
Rainbow Creek Park
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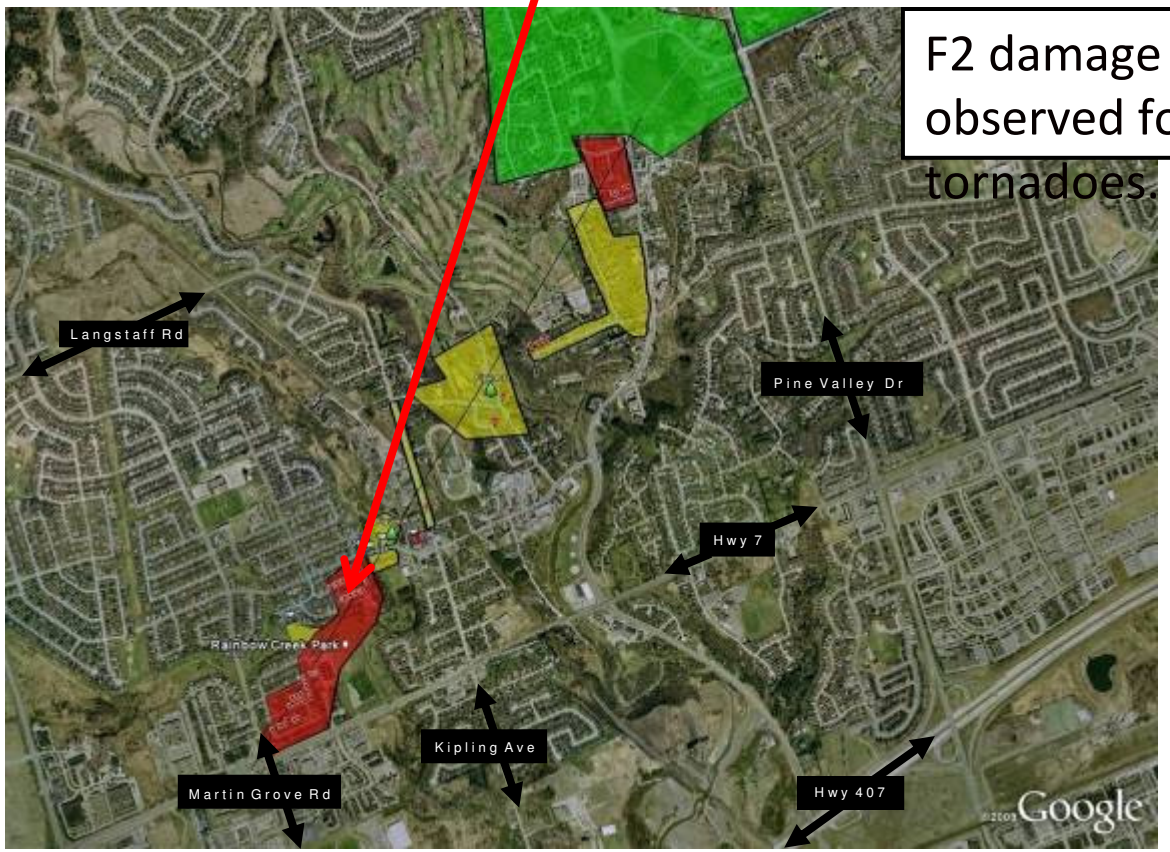

F2 damage was observed for both tornadoes.


Teston Rd
Keele St
Jane St
Major Mack

Classification of Observed Damage

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Roof cover – shingles/flashing
Roof structure – sheathing
– trusses/roof-to-wall connections
– gravel ballast roofs
Wall structure
Garage Doors
Windows
Role of Debris
Air Conditioners on Institutional Buildings
Cars
Utility Poles
Trees
Business Signs

Structural Roof Damage

In Woodbridge, houses all had masonry block walls clad in brick

There appear to be issues with roof-to-wall connections

Missing roof-to-wall connections.


Top plate is missing from top row of blocks

Roof likely lifted and wall fell outwards

Structural Roof Damage

In Maple, houses all were wood frame, clad in brick

There appear to be issues with roof-to-wall connections…
…but debris impacts played an important role

Fujita Scale classifies complete roof failures of houses as F2;

It is not clear to us that similar wind speeds caused this damage;
we are working at analyzing this.

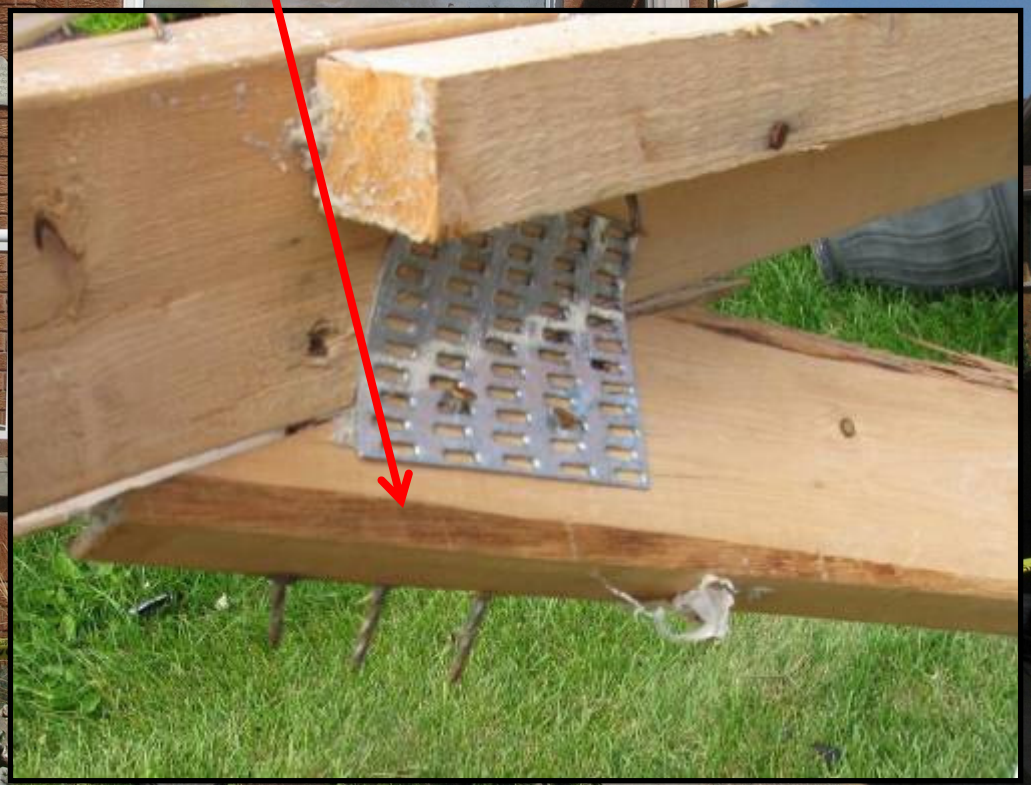

Debris impact – internal pressurization – roof failure
25

Debris impact – internal pressurization – roof failure


Debris impact – internal pressurization – roof failure ??
This one, we are not sure about - it could have been that the double doors blew in…

There were the correct toe nails…

….Maybe wind was more intense here



Debris impact – internal pressurization – roof failure

Garage Doors, Windows & Debris

In both regions, debris played a major role in many failures.

The vast majority of roof failures had garage doors or windows which were broken by debris


FIRE LINE
DO NOT CROSS
Vaughan Fire
& Rescue Service
FIRE LINE
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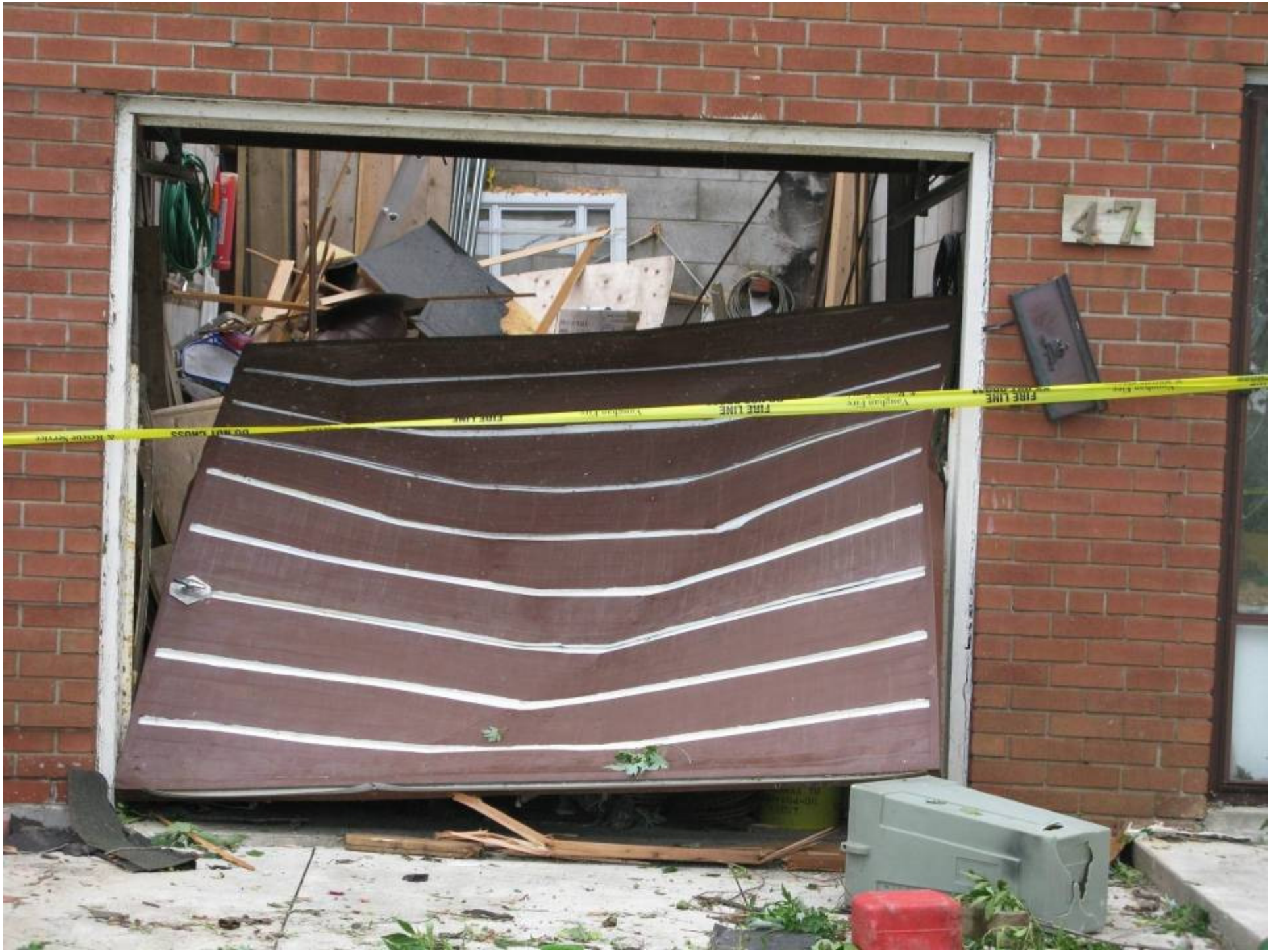
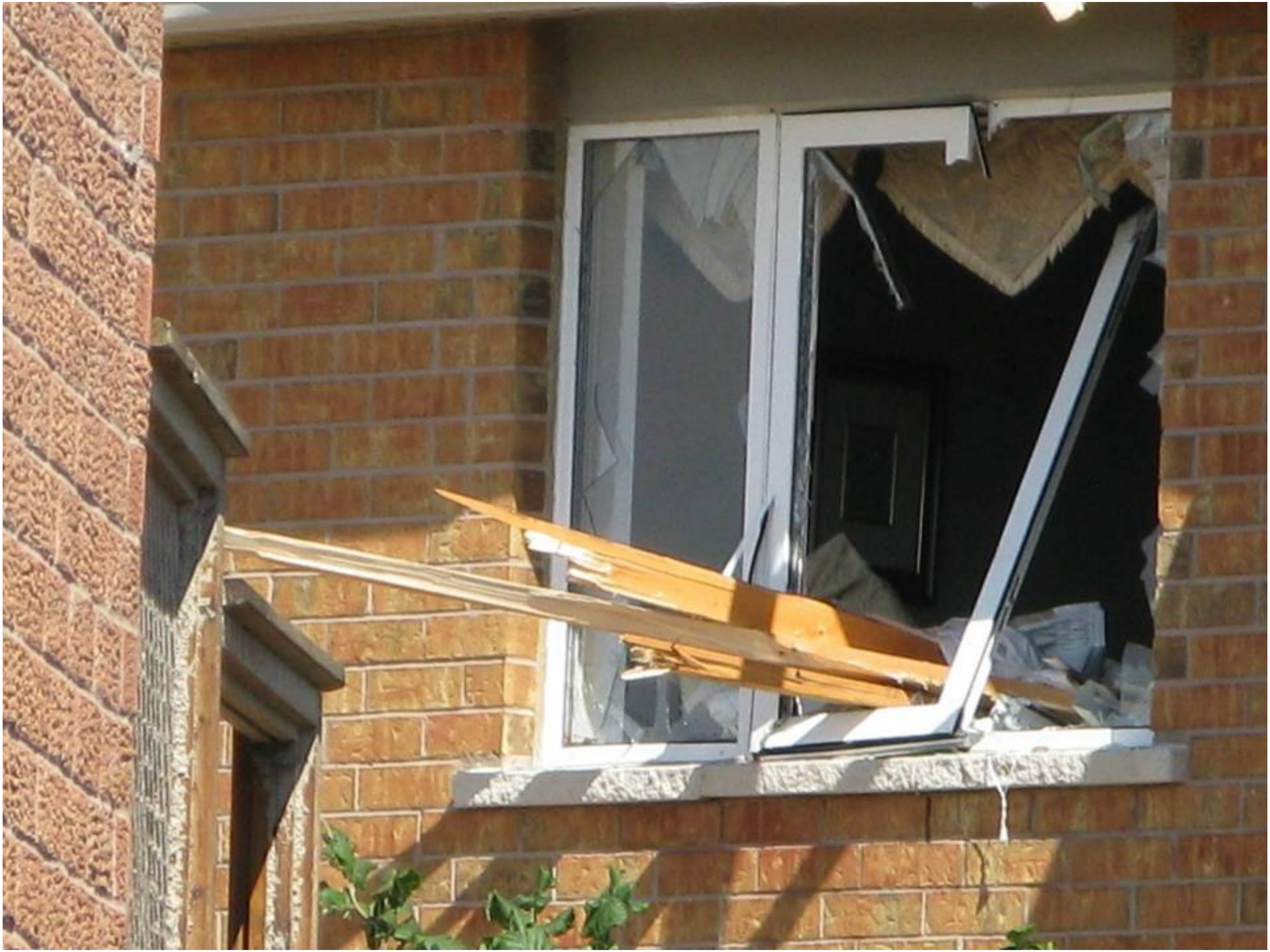

47
FIRE LINE


South
West
East
North



Roof Sheathing

Loss of sheathing can lead to complete roof failure…

but more importantly, allows a lot of rain to enter


West
East


Sheathing without enough fasteners … not even the shingles came off here


Edge nails seem to have less capacity due to pull-through

This air conditioner unit travelled 70m

Nothing was holding them down… except their own weight


We have had a lot of debate about cars… many moved, this one rolled…

Testing at the Insurance Research Lab for Better Homes allows strength of structure and components to be evaluated; and to find solutions to problems.

Closing Remarks

Damage surveys help to reveal problems with construction, as well as yielding source information pertaining to tornado climatology.

Windborne debris is a major issue in tornadoes and leads to much subsequent damage, including complete roof failures as well as substantial water ingress.

Garage doors are a significant point of vulnerability from debris impacts.

Sheathing remains a problem…a new observation is that the end nails may have lower capacity. This needs further examination.

Nailing errors (and missing connections) play a significant role in roof and sheathing failures. Solutions need to be found which are less error prone.

We will examine much of this through testing at IRLBH…and expect to find prescriptive solutions which could be implemented.

Acknowledgements

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We are grateful for Environment Canada allowing us to work with them to conduct these surveys, and to participate in many post-event discussions pertaining to damage scales and number of tornadoes.