



## FORENSIC ANALYSIS

### CLAIM

Location: 123 Sample Road, Brooklyn Center, MN

Event Date(s): June 29, 2015

Prepared for: Sample PLLC

Scope: Determine the possibility of severe, damaging hail impacting the Property on June 29, 2015.

All data, observations and conclusions included in this report are based on the following data and materials:

- Watches, warnings and storm reports issued by the National Weather Service (NWS) in the Twin Cities accessed via Iowa Environmental Mesonet (IEM)
- Historical KMPX Doppler Radar located in Chanhassen, MN accessed via GR2Analyst
- National Weather Service (NWS) hourly reporting stations accessed via the Iowa Environmental Mesonet (IEM)
- Archived social media reports via Twitter
- Eye witness reports and photographs (Sample PLLC)
- Sample Engineering Report (Sample PLLC)

### OVERVIEW

Sample PLLC has requested a professional meteorological analysis of strong thunderstorms and subsequent hail damage that occurred at their Property located at or around 123 Sample Road, Brooklyn Center, Minnesota. We refer to this location as “the Property” in this report. We have been asked to review the weather conditions on June 29, 2015.

Based on our analysis, the Property was subject to a severe thunderstorm on the evening of June 29, 2015. A series of strong storms impacted the north Minneapolis metro late that afternoon/evening with multiple Severe Thunderstorm Warnings in the region. Large, damaging hail was confirmed with these thunderstorms as a sequence of storm damage reports recorded by trained weather spotters (Figure 1). The Property was grazed by a core of large hail produced by a severe thunderstorm between 7:14 PM and 7:19 PM on June 29, 2015.

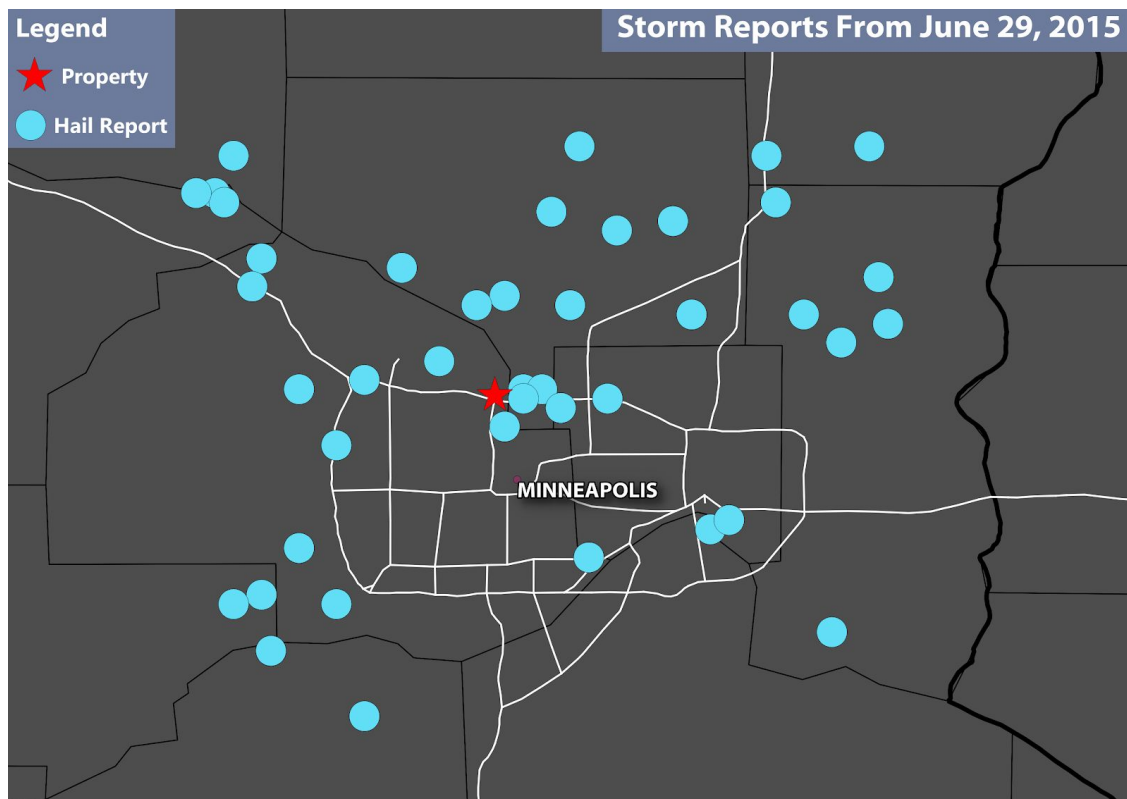


Figure 1. Cumulative storm reports June 29, 2015. Source: NWS Twin Cities.

## FORENSIC ANALYSIS

It is important to include an overview of some of the products provided by Doppler radar that help meteorologist confirm the presence of strong wind and hail. Radar measures the reflectivity of objects in the atmosphere. Doppler radar has the ability to detect all forms of precipitation. Specifically, hail can be detected on radar based on the fact that ice is more reflective than liquid (rain). The radar product known as the Vertically Integrated Liquid (VIL) is used to assess the presence of hail and intensity of precipitation within a thunderstorm. High VIL values indicate the presence of hail in a thunderstorm, as shown in Figure 2.

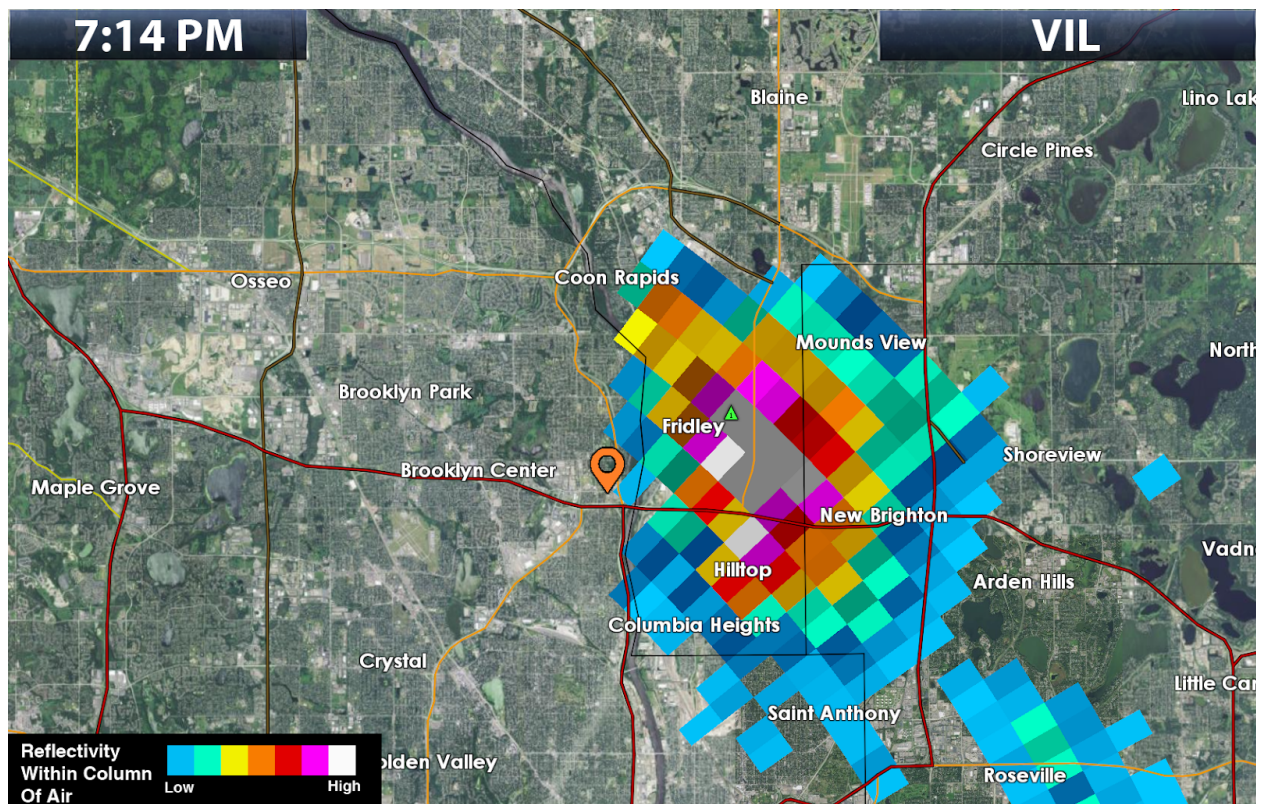


Figure 2. Examples of high Vertically Integrated Liquid (VIL) near the Property during a severe hail event on June 29, 2015. Source: KMPX.



## FORENSIC ANALYSIS

The Maximum Expected Hail Size (MEHS) is another dataset provided by Doppler radar (Figure 3). MEHS is another way to help estimate the size of hail within a thunderstorm. When multiple parameters (such as MEHS and VIL) are exhibiting elevated values, it is a good indication that the storm is producing large and potentially damaging hail.

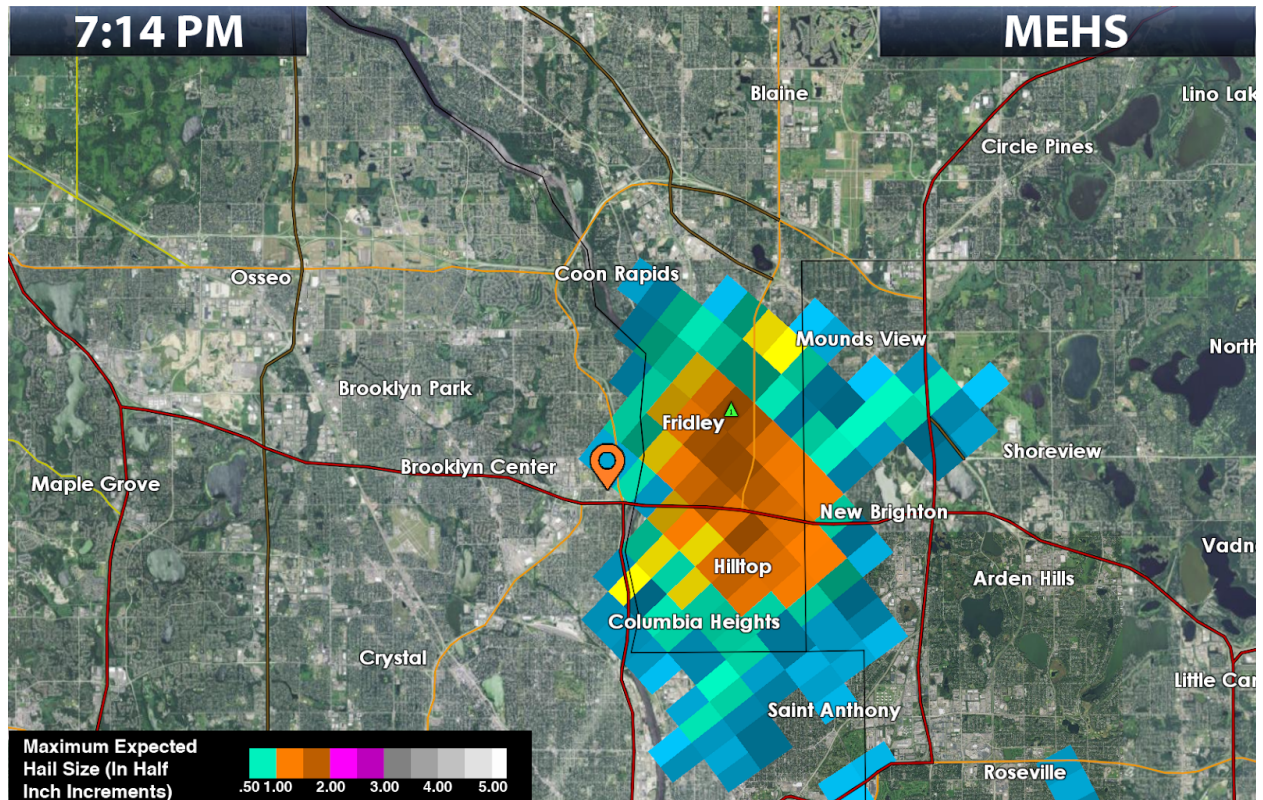


Figure 3. Examples of high Maximum Expected Hail Size (MEHS) near the Property during a severe hail event on June 29, 2015. Source: KMPX.



## FORENSIC ANALYSIS

An additional product that helps meteorologists determine the presence of damaging hail in a thunderstorm is the Probability of Severe Hail (POSH), which is included in this analysis (Figure 4). The POSH categorizes severe hail as 0.75" or larger. It should be noted that the NWS changed its criteria for severe hail from 0.75" to 1.00" (quarter size) on January 5, 2010.<sup>1</sup>

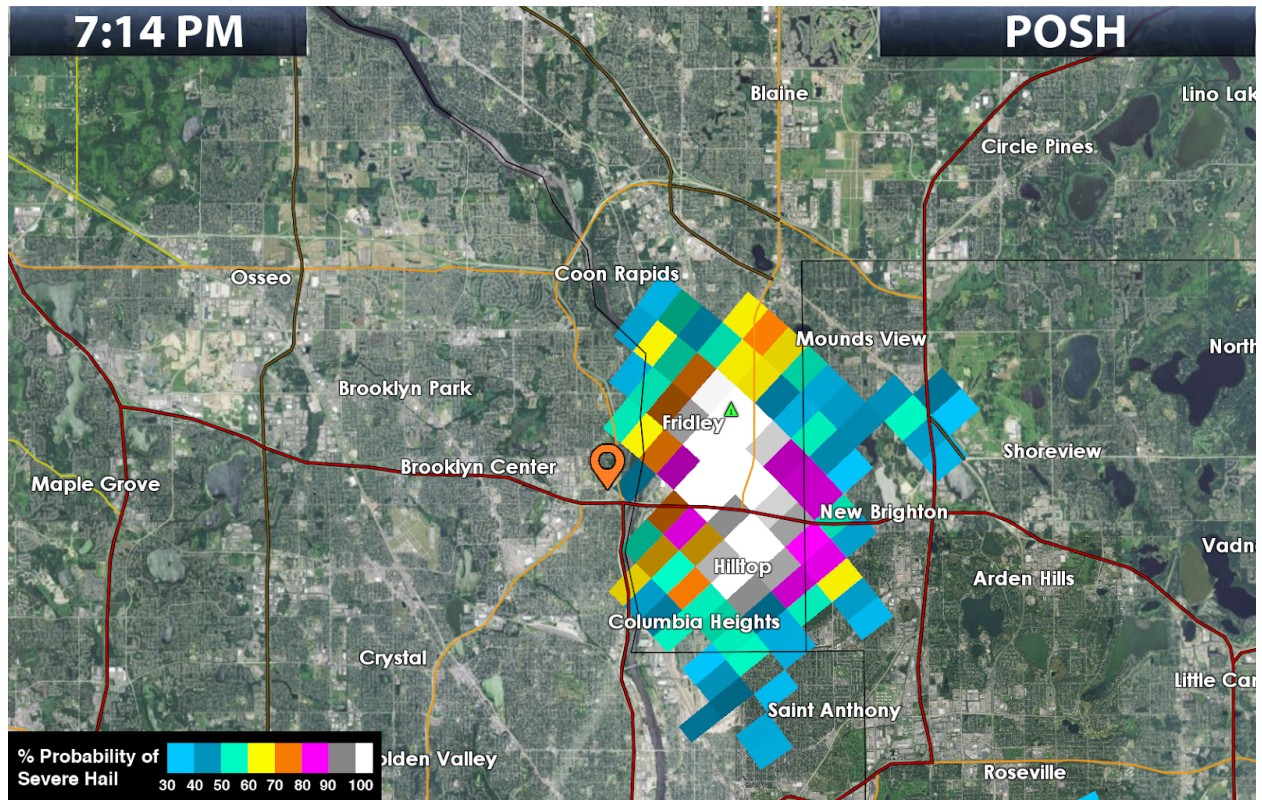


Figure 4. Examples of high Probability of Severe Hail (POSH) near the Property during a severe hail event on June 29, 2015. Source: KMPX.

## FORENSIC ANALYSIS

Radar scans sometimes display green triangles. A filled green triangle indicates a probability of severe hail greater than 50% (over a 50% chance hail is occurring in that storm).<sup>2</sup> Additionally, these triangles also provide a radar estimate of hail size (Figure 5 & 6).<sup>3</sup> It should be noted, however, that ground reports are needed to verify hail size, since radar correlation to hail size is not cut and dry—it greatly depends and varies on season, synoptic environment, elevation, storm speed, storm structure and more.<sup>4</sup>

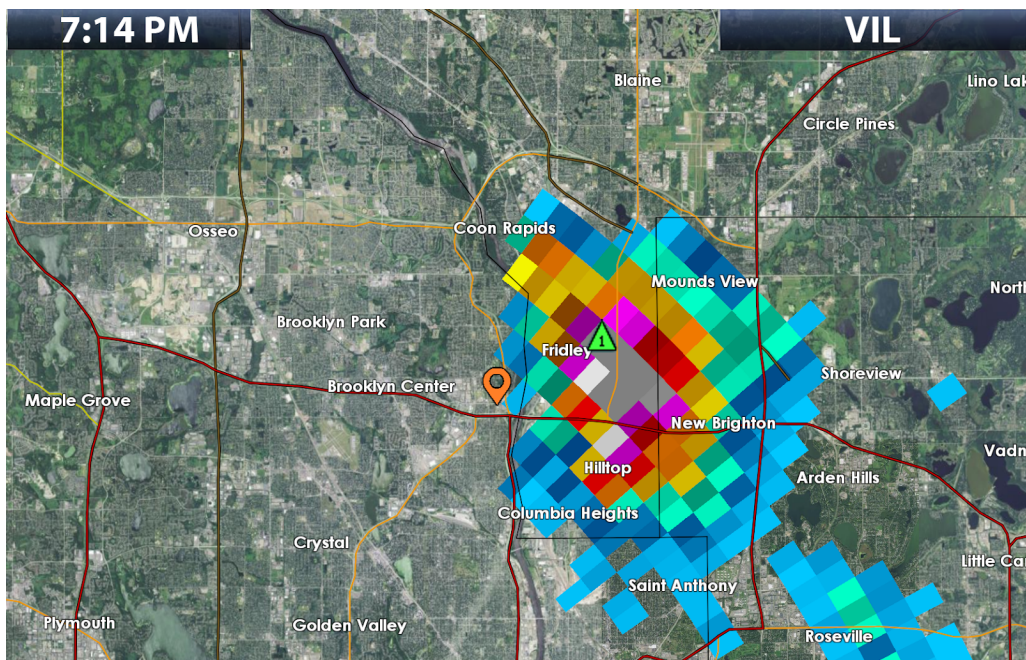


Figure 5. Example of a large hail marker shown as a green triangle (enlarged) near the Property on June 29, 2015. Source: NWS Twin Cities.



Figure 6. Examples of hail probability and size estimate symbols on radar. Source: GRLevelX.

## FORENSIC ANALYSIS

As a final note, radar scans in 360° horizontally at multiple elevations. The radar scans in this report are taken at the standard 0.5° angle. At this angle, the radar is able to successfully scan thunderstorms as close to the ground as allowed at the Property. KMPX radar in Chanhassen, Minnesota is our main radar source. Using this radar site, the elevation of the beam is approximately 1130 ft above the surface at the Property.<sup>5</sup>

### WEATHER ANALYSIS

**1:55 PM CDT on Monday, June 29, 2015:** The Storm Prediction Center (SPC) issued a Severe Thunderstorm Watch effective until 8:00PM CDT (Figure 7), which outlined the potential of *“large hail events to 1.5” in diameter possible”* and *“isolated wind gusts to 70 mph possible”* (Figure 8). The Property was included in this watch and conditions were favorable for severe thunderstorm development.

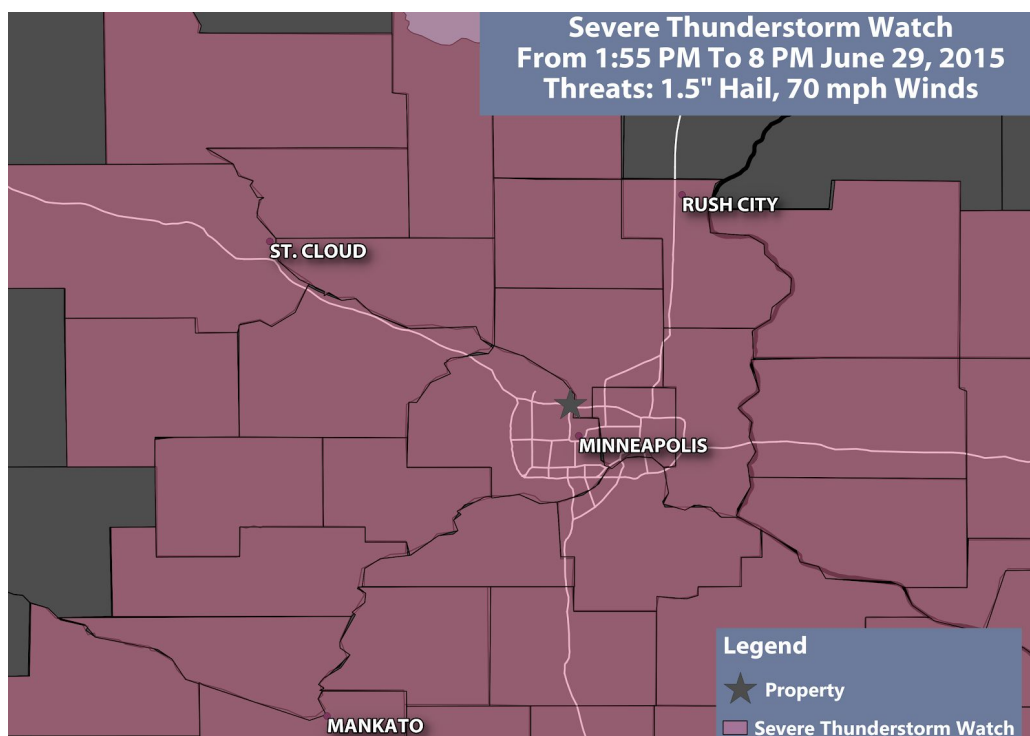


Figure 7. Illustration of Severe Thunderstorm Watch issued on June 29, 2015 at 1:55 PM CDT which included the Property. Source: Storm Prediction Center.



## FORENSIC ANALYSIS

URGENT - IMMEDIATE BROADCAST REQUESTED  
SEVERE THUNDERSTORM WATCH NUMBER 370  
NWS STORM PREDICTION CENTER NORMAN OK  
155 PM CDT MON JUN 29 2015

THE NWS STORM PREDICTION CENTER HAS ISSUED A

- \* SEVERE THUNDERSTORM WATCH FOR PORTIONS OF  
CENTRAL AND SOUTHEAST MINNESOTA  
WESTERN AND CENTRAL WISCONSIN
- \* EFFECTIVE THIS MONDAY AFTERNOON AND EVENING FROM 155 PM UNTIL  
800 PM CDT.
- \* PRIMARY THREATS INCLUDE...  
SCATTERED LARGE HAIL EVENTS TO 1.5 INCHES IN DIAMETER POSSIBLE  
ISOLATED DAMAGING WIND GUSTS TO 70 MPH POSSIBLE

SUMMARY...THUNDERSTORMS ARE INCREASING IN COVERAGE OVER PARTS OF  
CENTRAL MN INTO NORTHERN WI. THESE STORMS WILL INTENSIFY AND TRACK  
SOUTHWARD ACROSS THE WATCH AREA THIS AFTERNOON...WITH A RISK OF  
DAMAGING WINDS AND HAIL.

THE SEVERE THUNDERSTORM WATCH AREA IS APPROXIMATELY ALONG AND 75  
STATUTE MILES NORTH AND SOUTH OF A LINE FROM 45 MILES WEST  
NORTHWEST OF MANKATO MINNESOTA TO 25 MILES EAST OF MOSINEE  
WISCONSIN. FOR A COMPLETE DEPICTION OF THE WATCH SEE THE  
ASSOCIATED WATCH OUTLINE UPDATE (WOU564 KWNS WOU0).

PRECAUTIONARY/PREPAREDNESS ACTIONS...

REMEMBER...A SEVERE THUNDERSTORM WATCH MEANS CONDITIONS ARE  
FAVORABLE FOR SEVERE THUNDERSTORMS IN AND CLOSE TO THE WATCH  
AREA. PERSONS IN THESE AREAS SHOULD BE ON THE LOOKOUT FOR  
THREATENING WEATHER CONDITIONS AND LISTEN FOR LATER STATEMENTS  
AND POSSIBLE WARNINGS. SEVERE THUNDERSTORMS CAN AND OCCASIONALLY  
DO PRODUCE TORNADOES.

&&

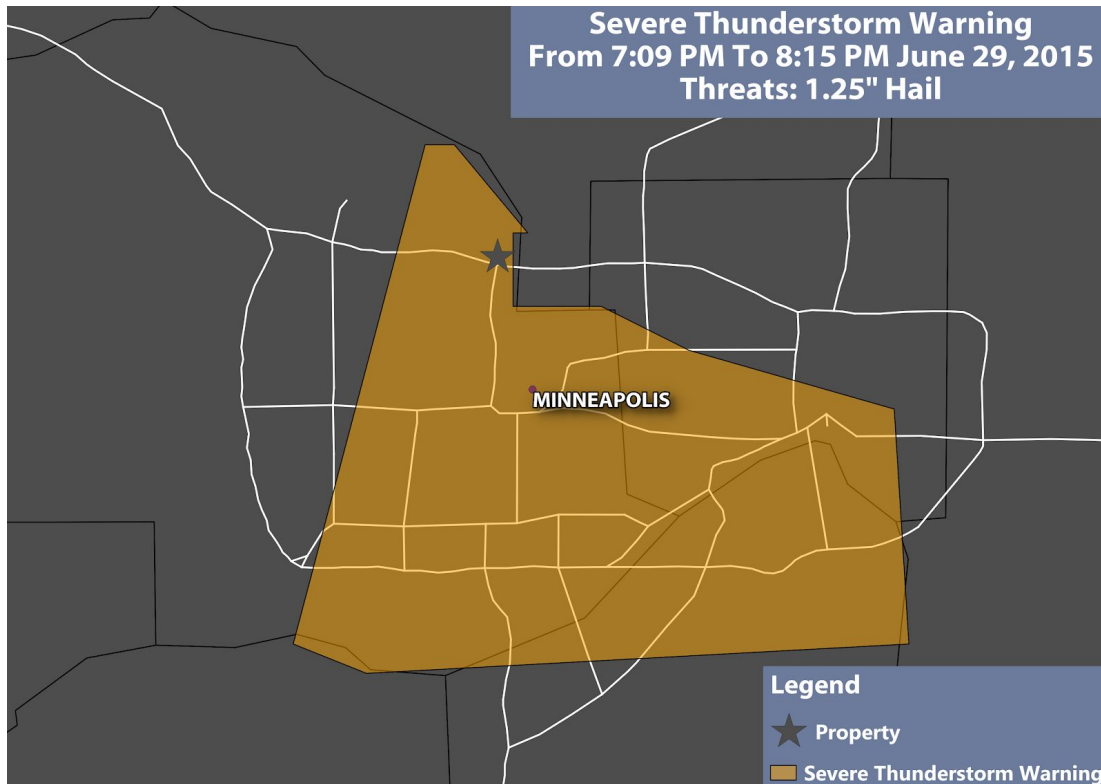
OTHER WATCH INFORMATION...CONTINUE...WW 369...

AVIATION...A FEW SEVERE THUNDERSTORMS WITH HAIL SURFACE AND ALOFT  
TO 1.5 INCHES. EXTREME TURBULENCE AND SURFACE WIND GUSTS TO 60  
KNOTS. A FEW CUMULONIMBI WITH MAXIMUM TOPS TO 500. MEAN STORM  
MOTION VECTOR 32030.

Figure 8. Severe Thunderstorm Watch issued on June 29, 2015 at 1:55 PM CDT. Source: Storm Prediction Center.

## FORENSIC ANALYSIS

**7:09 PM CDT on Monday, June 29, 2015:** The National Weather Service (NWS) in the Twin Cities issued a Severe Thunderstorm Warning until 8:15 PM CDT for Hennepin County (Figures 9 & 10). At the time of the warning, a severe thunderstorm was moving south at 25 mph toward the Property, capable of producing half-dollar size hail (1.25").



*Figure 9. Illustration of Severe Thunderstorm Warning issued on June 29, 2015 at 7:09 PM CDT which included the Property. Source: NWS Twin Cities.*

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BULLETIN - IMMEDIATE BROADCAST REQUESTED
SEVERE THUNDERSTORM WARNING
NATIONAL WEATHER SERVICE TWIN CITIES/CHANHASSEN MN
709 PM CDT MON JUN 29 2015

THE NATIONAL WEATHER SERVICE IN THE TWIN CITIES HAS ISSUED A

* SEVERE THUNDERSTORM WARNING FOR...
  NORTHWESTERN DAKOTA COUNTY IN EAST CENTRAL MINNESOTA...
  EASTERN HENNEPIN COUNTY IN EAST CENTRAL MINNESOTA...
  SOUTHERN RAMSEY COUNTY IN EAST CENTRAL MINNESOTA...

* UNTIL 815 PM CDT

* AT 709 PM CDT...A SEVERE THUNDERSTORM WAS LOCATED OVER FRIDLEY...OR
  9 MILES NORTH OF MINNEAPOLIS...MOVING SOUTH AT 25 MPH.

HAZARD...HALF DOLLAR SIZE HAIL.

SOURCE...RADAR INDICATED.

IMPACT...DAMAGE TO VEHICLES IS EXPECTED.

* THIS SEVERE THUNDERSTORM WILL BE NEAR...
  BROOKLYN CENTER AND COLUMBIA HEIGHTS AROUND 715 PM CDT.
  MINNEAPOLIS AND ROSEVILLE AROUND 720 PM CDT.
  GOLDEN VALLEY AROUND 725 PM CDT.
  MINNETONKA AND ST. LOUIS PARK AROUND 730 PM CDT.
  EDINA AND HOPKINS AROUND 735 PM CDT.
  MSP INTERNATIONAL AIRPORT AROUND 740 PM CDT.
  BLOOMINGTON...EDEN PRAIRIE AND RICHFIELD AROUND 745 PM CDT.

OTHER LOCATIONS IMPACTED BY THIS SEVERE THUNDERSTORM INCLUDE FORT
SNELLING...NORTH MINNEAPOLIS...SOUTH ST PAUL AIRPORT...SOUTH ST
PAUL...COMO PARK...FORT SNELLING STATE PARK...MN STATE FAIR...
LILYDALE...UNIV OF MN MINNEAPOLIS CAMPUS AND SUNFISH LAKE.

THIS INCLUDES INTERSTATE 94 IN MINNESOTA BETWEEN MILE MARKERS 222 AND
246.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

FOR YOUR PROTECTION MOVE TO AN INTERIOR ROOM ON THE LOWEST FLOOR OF A
BUILDING.

&&

LAT...LON 4509 9327 4509 9328 4504 9328 4504 9322
      4501 9316 4497 9302 4481 9301 4479 9338
      4481 9343 4515 9334 4515 9332
TIME...NOT...LOC 0009Z 007DEG 22KT 4510 9324

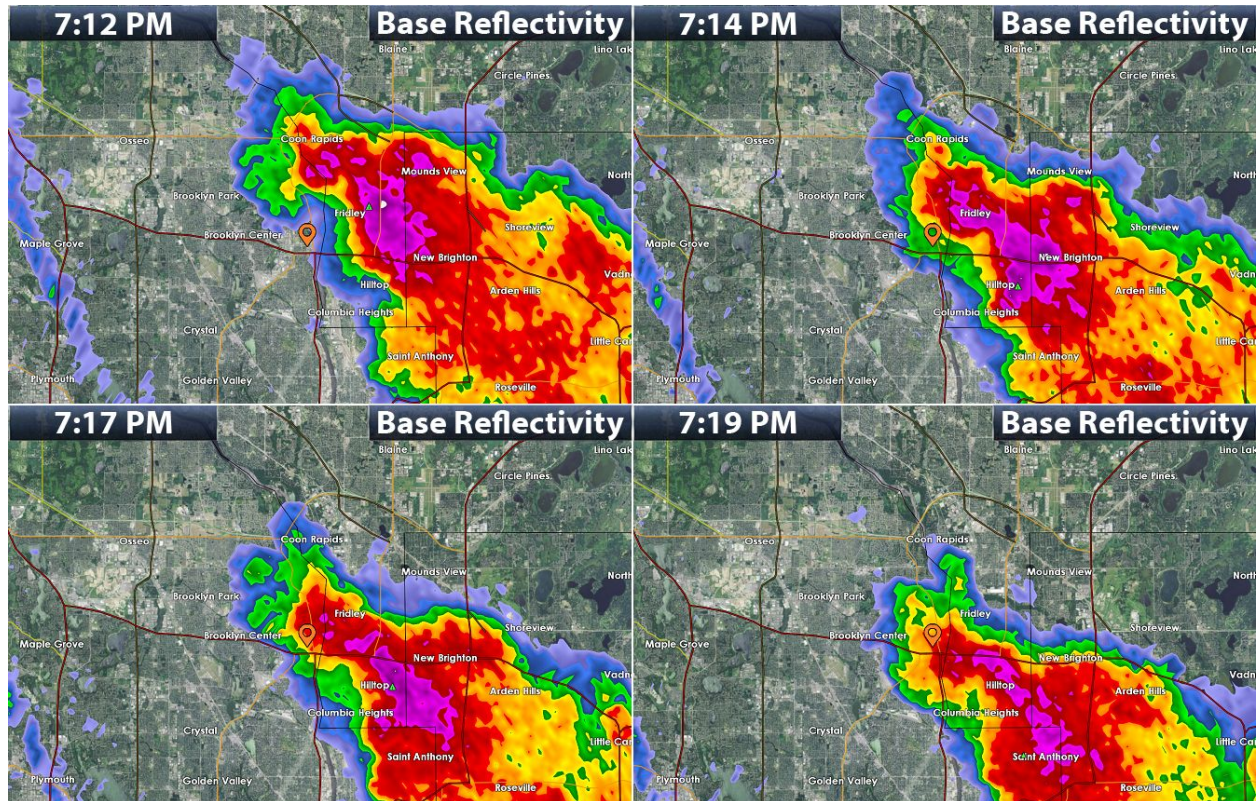
HAIL...1.25IN
WIND...<50MPH
  
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Figure 10. Severe Thunderstorm Warning issued on June 29, 2015 at 7:09 PM CDT. Source: NWS Twin Cities.



## FORENSIC ANALYSIS

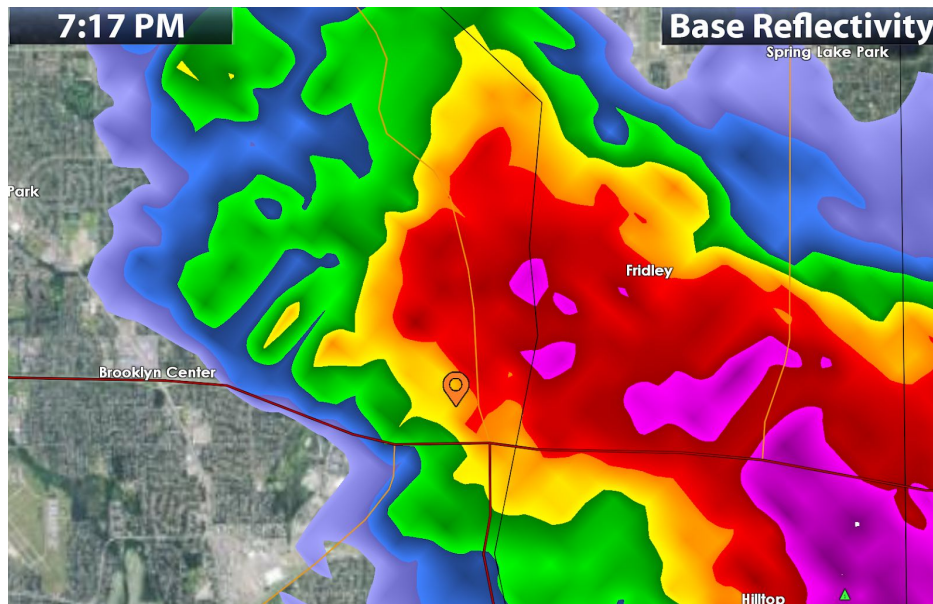
**Between 7:09 PM and 7:19 PM CDT on Monday, June 29, 2015:** Doppler radar showed the severe storm tracking through the area Monday evening (Figure 11). High reflectivity is noted in the red to fuchsia shades, which indicates the most intense part of the thunderstorm.



*Figure 11. Radar displaying a strong storm tracking through the Property on June 29, 2015 between 7:12 PM and 7:19 PM CDT. Source: KMPX.*

## FORENSIC ANALYSIS

At 7:17 PM, elevated reflectivity is displayed right over the Property as shown in Figure 12. These bright returns can also be seen over the Property on the 7:19 PM scan.

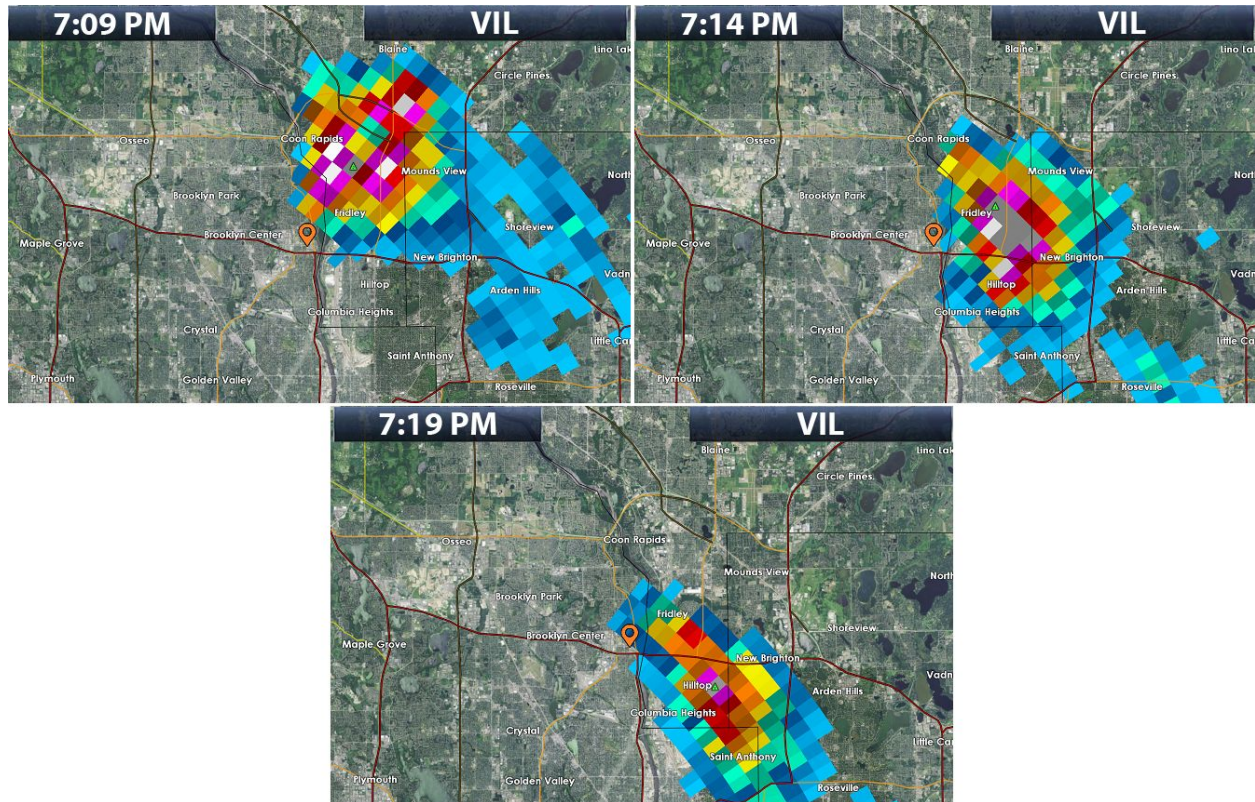


*Figure 12. Close-up of the reflectivity at the Property on June 29, 2015 at 7:17 PM CDT. Source: KMPX.*



## FORENSIC ANALYSIS

Doppler Radar showed elevated VIL values (Figure 13), indicating a severe hail core tracking near the Property that Monday evening between 7:09 PM and 7:19 PM.



*Figure 13. VIL highlighting a hail core near the Property on June 29, 2015 from 7:09 PM to 7:19 PM CDT. Source: KMPX.*



## FORENSIC ANALYSIS

The POSH and MEHS radar products also suggest that severe hail was being produced by this thunderstorm at 7:09 PM and 7:14 PM as it approached the Property (Figure 14). POSH showcased values of up to 100%. MEHS calculations support the potential of hailstones approximately 1" or larger occurring with the thunderstorm. The 7:14 PM and 7:19 PM scans show the hail core grazing the Property.

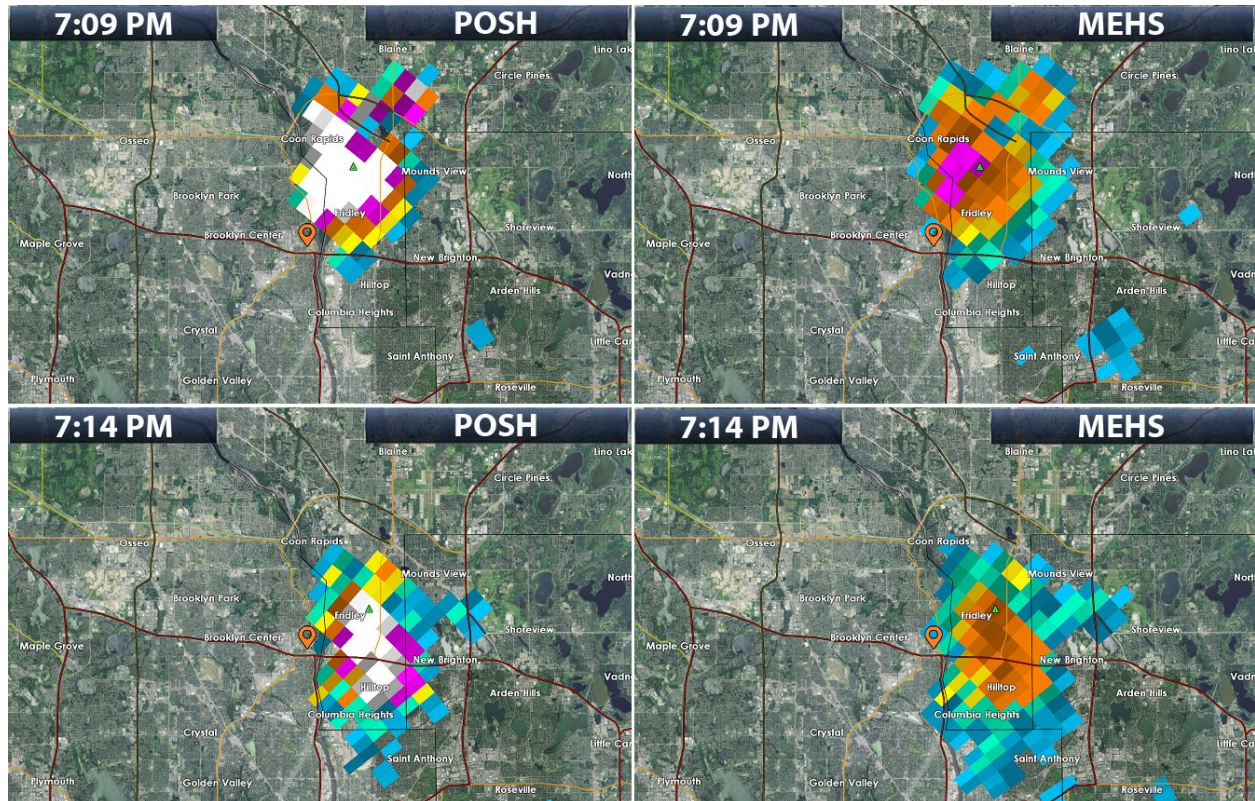
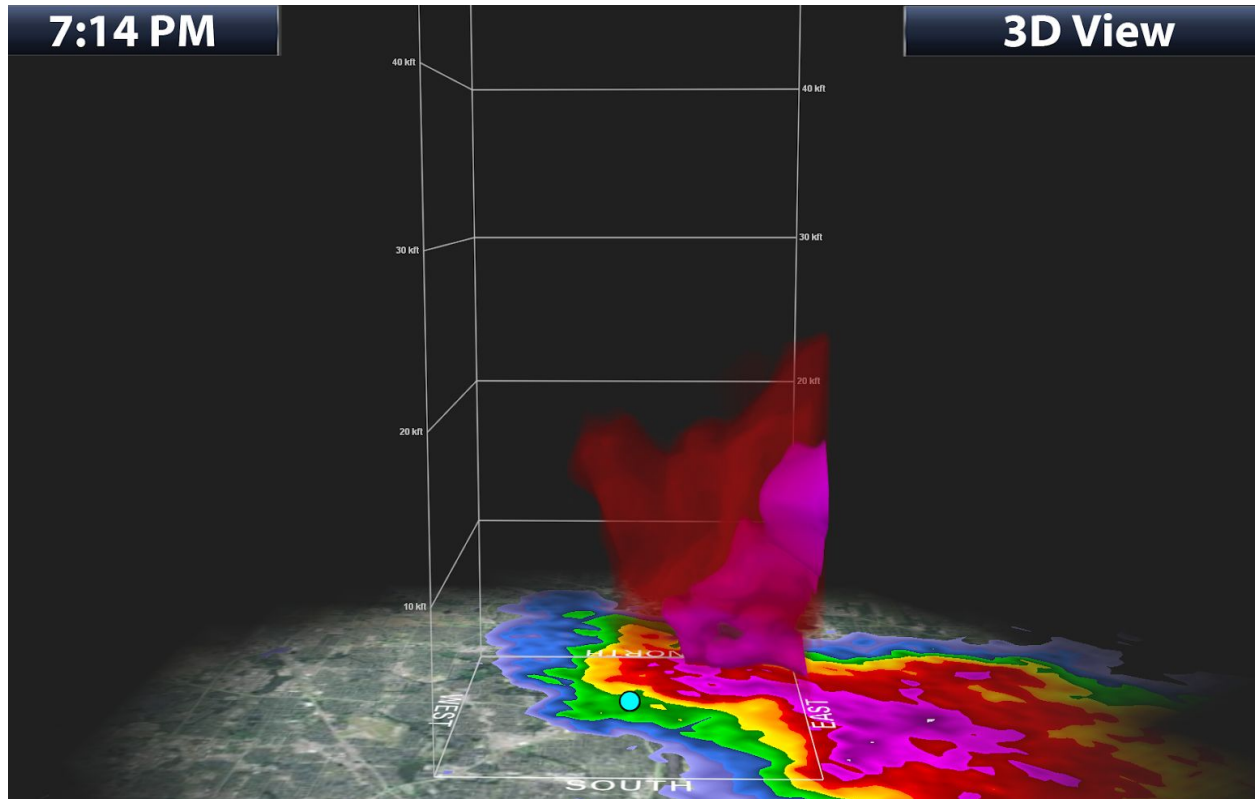


Figure 14. POSH and MEHS indicating the potential of severe hail between 7:09 PM and 7:14 PM CDT on June 29, 2015. Source: KMPX.

## FORENSIC ANALYSIS

In Figure 15 (shown below), we provide a 3-D scan of the thunderstorm that impacted the Property. Radar, when shown in 3-D, can also show the development of a hail core within the severe storm. By filtering the reflectivity on the scans we can track a well-defined hail core near the Property at 7:14 PM.



*Figure 15. 3-D scan of Doppler Radar showing a prominent hail core approaching the Property at 7:14 PM CDT on June 29, 2015. Source: KMPX.*

Based on the Doppler radar data, it is evident that the largest hail associated with the severe thunderstorm occurred mainly north and east of the Property. However, large hail still would have been possible, given the wind field surrounding the severe thunderstorm and the proximity of the hail core. Elevated reflectivity values between 7:14 PM and 7:19 PM support that possibility. In this case, one would have to weigh nearby storm reports and eyewitness reports from the Property. We discuss this in greater detail coming up.

### Summary:

The storm, which prompted the issuance of a Severe Thunderstorm Warning at 7:09 PM, impacted the Property between 7:09 PM and 7:19 PM (Monday, June 29, 2015). In addition to the evidence of severe hail on Doppler radar, there were still several hail reports in the area that confirmed the presence of large, severe hail being produced by the thunderstorm (Figure 16). This hail was confirmed by trained weather spotters in the area. A number of quarter size (1" diameter) hail events were reported nearby in Fridley, Columbia Heights, New Brighton and Brooklyn Park.

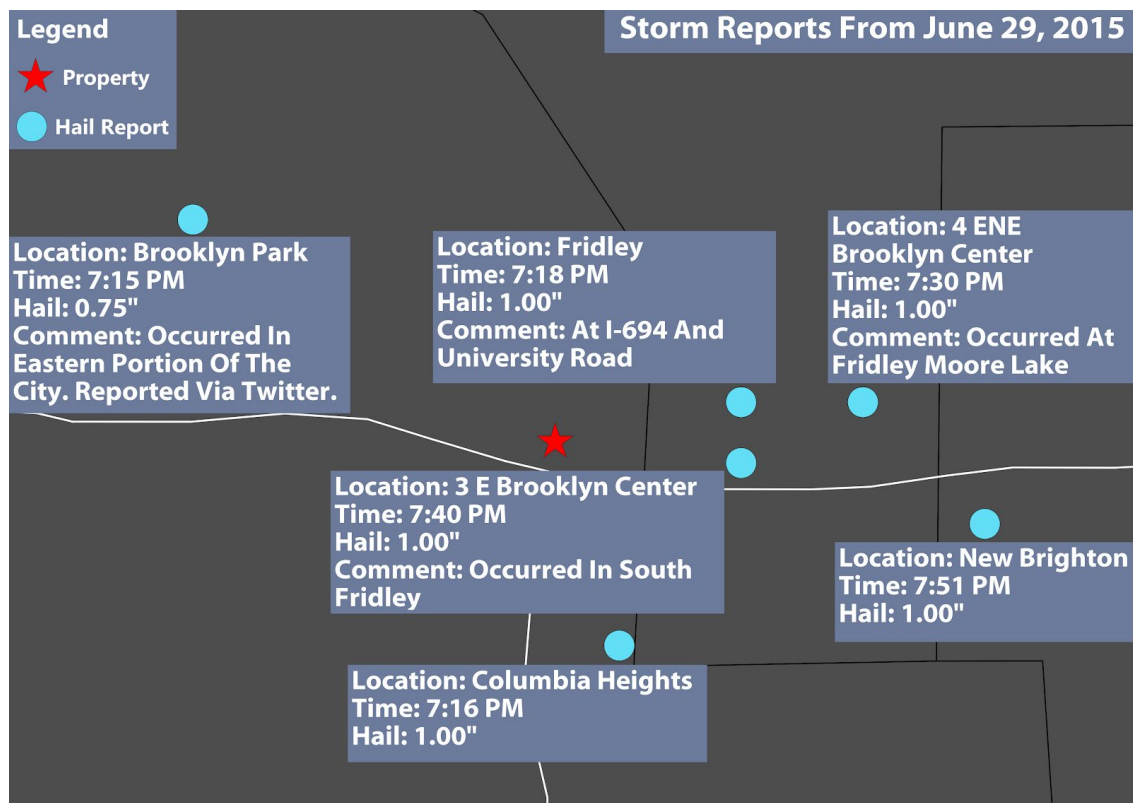


Figure 16. Summary of storm reports in and around the property on June 29, 2015. Source: NWS Twin Cities.



## FORENSIC ANALYSIS

The hail reported in eastern Brooklyn Park, specifically, is particularly of interest. This hail would have likely been just due north of the Property by a few miles near the Mississippi River. We reach this conclusion by factoring in the radar analysis of this storm, as this is where the periphery of the hail core would have been. As the storm tracked southward at 25 mph (as per the Severe Warning text on Page 10), that same southern edge of the hail core would have moved over the Property.

Images of the severe hail that occurred in neighboring Brooklyn Park are available on Twitter (Figures 17 and 18). The images confirm  $\frac{3}{4}$ " to 1" diameter hail.



*Figure 17. Hail photographed in Brooklyn Park on the evening of June 29, 2015.  
Source: Twitter (@Janmandy)*



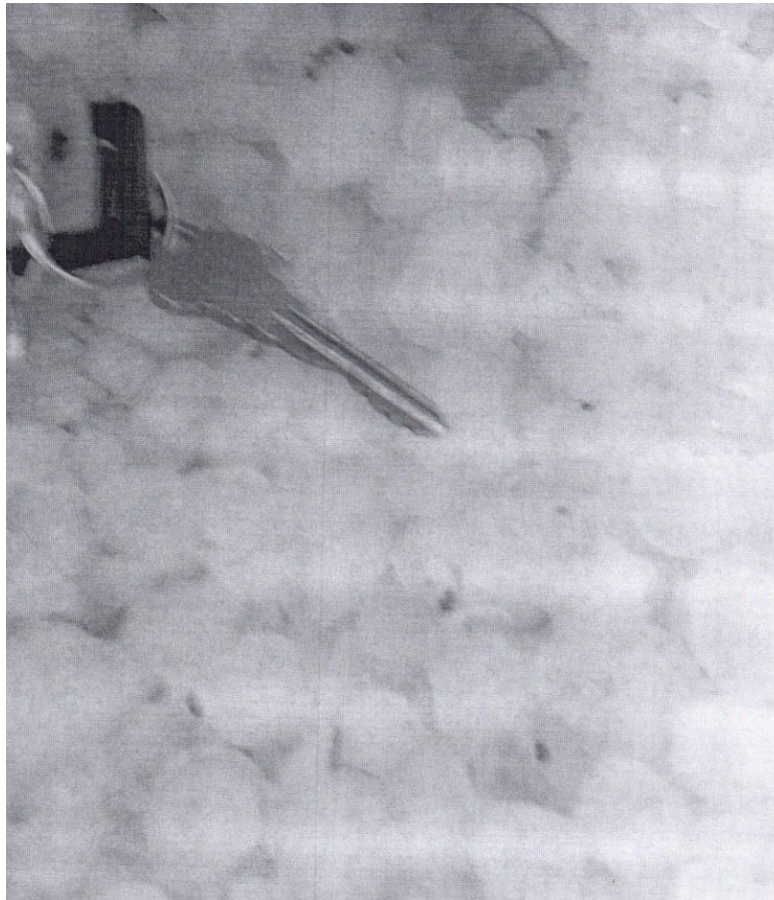
Figure 18. Hail photographed in Brooklyn Park on the evening of June 29, 2015.  
Source: Twitter (@Janmandy)

## FORENSIC ANALYSIS

The most compelling evidence is eyewitness photographs of the hail taken at the Property. The photos in Figures 19 and 20 were taken after the June 29th, 2015 storm, according to a witness report provided by Sample PLLC. Figure 19, in particular, clearly confirms 1-inch diameter hail, the threshold for “severe” designation by The National Weather Service.



*Figure 19. Large, severe hail photographed at the Property after the June 29, 2015 storm. Source: Witness Report (Sample PLLC)*



*Figure 20. Hail photographed at the Property after the June 29, 2015 storm. Source: Witness Report (Sample PLLC)*

Eyewitness commentary noted the large size of the hail that fell with this thunderstorm at the Property with one stating that he placed a piece of carpet over the windshield of his truck to protect the windshield and that the “speed and size of the hailstones were clearly capable of damaging aluminum siding, ...” As stated in the Sample Engineering Report, there are no substitutes for “site-specific observations” (Sample, Page 4).

Due to atmospheric parameters favoring the potential for large hail, Doppler radar, official National Weather Service storm spotter reports of hail, social media, and eyewitness photographs it is our professional opinion that large hail impacted the Property on the evening of June 29, 2015.



### CONCLUSION

After exhaustive analysis of credible, industry-standard meteorological databases, including archived Doppler radar reports, professional storm spotter summaries, social media and eyewitness photographs, we have concluded that the thunderstorm that passed over the Property in question the evening of June 29, 2015 was severe, with hail large enough to trigger potential structural damage.

Doppler radar data and social media reports (Figure 17-18) confirm the development of quarter size associated with the severe storm that passed over the Property. It's worth noting that the National Weather Service classifies any storm with quarter size hail (1.00") or larger and/or 58 mph wind gusts as "severe," capable of property damage.

NOAA issued a Severe Thunderstorm Watch for the Twin Cities metro area, including the Property, the evening in question, confirming that the atmosphere was ripe, locked and loaded for a severe thunderstorm outbreak. A subsequent Severe Thunderstorm Warning confirmed that Doppler and storm spotter reports were sufficient to warn on this cell, a storm capable of significant structural damage. That is precisely what was observed in the aftermath of this extreme storm, confirmed by numerous storm reports.

After analyzing all available credible meteorological data and social media reports I can confirm, with a reasonable degree of meteorological certainty, that the thunderstorm grazing the Property in Brooklyn Center on June 29, 2015 was, in fact, severe and capable of material damage. I adamantly agree with the Sample Engineering report in that there is no substitute for site-specific observations. What ultimately increases our confidence level are eyewitness photographs taken at the Property, in combination with other multiple threads of forensic evidence (Doppler radar, storm spotter observations and social media reports). This conclusion doesn't rest on one slender thread of meteorological evidence.

It is my professional opinion that our analysis confirms a damage swath from the severe storms that tracked across the northern metro area of the Twin Cities the evening of June 29, 2015, leaving behind a well-documented trail of damage, one recorded by NWS Doppler radar scans, trained National Weather Service storm spotters and social media reports. The storms were severe on Doppler radar, but we also have the supporting "ground truth" to confirm that these thunderstorms did, in fact, leave behind a trail of hail-related damage, which, in all probability, applied to the Property in question.

The evidence is considerable and, in my judgement, convincing.

Paul Douglas, Certified Broadcast Meteorologist, Founder and Senior Meteorologist, Praedictix

## FORENSIC ANALYSIS



Paul Douglas is Minnesota's first AMS-Certified Broadcast Meteorologist, with a 40 year career in television and radio. He is Founder and President of Media Logic Group, with offices in Minneapolis. His company provides weather data, graphics and mobile API's via AerisWeather, ag weather and advanced forecasts for utilities and construction companies with Smart Energy, automated severe storm alerts and extreme weather briefings with Alerts Broadcaster, and daily video forecasts for new and legacy media from Broadcast Weather. In 2011 Broadcast Weather helped launch WeatherNation TV, a new 24/7 national weather channel dedicated to meteorology and storm coverage across the USA. His firm specializes in custom weather solutions to aid productivity, efficiency and safety for the corporate world, including forensic meteorological consulting.

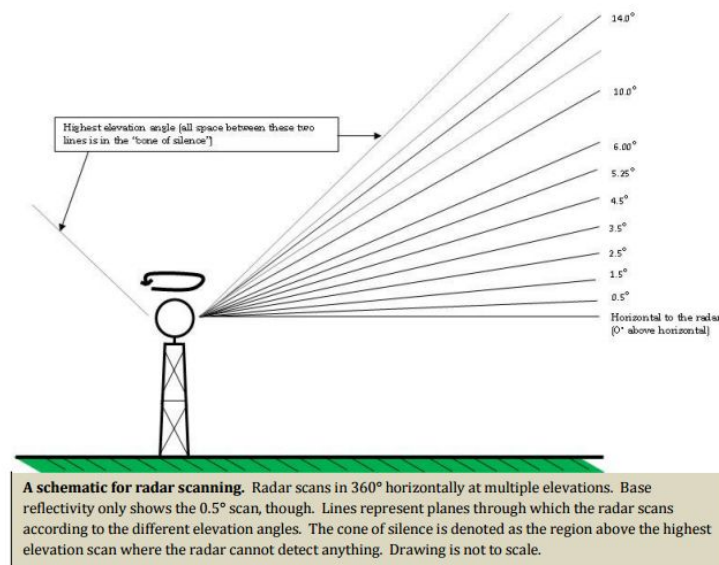
Douglas has a meteorology degree from Penn State, where he sits on the Meteorology Advisory Board. In his television career he appeared on the CBS Evening News, Nightline, MSNBC and CNN. His broadcast meteorology positions took him from the New York City area and Chicago to the Twin Cities, his current home. In 2004 he wrote a book about extreme weather, "Restless Skies", for Barnes and Noble.

Previous companies include "EarthWatch Communication," which invented 3-D weather graphics licensed to television stations worldwide – and featured in Steve Spielberg's movies "Jurassic Park" and "Twister". His last venture was "Digital Cyclone", the first company in the world to put an app on a cellular phone in 2001. He sold that company to Garmin in 2007 to focus on his latest ventures.

Douglas writes a daily print and online column for the Star Tribune and the St. Cloud Times. He contributes to the CSRRT, The Climate Science Rapid Response Team, and he's a member of the board of EEN, the Evangelical Environmental Network. TV meteorologist, author and teacher, Douglas speaks to corporations about severe weather and climate trends - and his entrepreneurial ride launching 4 start-up companies. He is active in Boy Scouts and SAVE, Suicide Awareness, Voices of Education. Married to a professional architect for 30 years, Douglas has two sons: a digital media specialist in the Twin Cities, and a Naval Academy graduate and helicopter pilot, currently based in San Diego.

## APPENDIX

- <sup>1</sup>: "Why One Inch Hail Criterion?" National Weather Service. Accessed 11 October 2016.  
<http://www.nws.noaa.gov/oneinchhail/>
- <sup>2</sup>: "GRLevel 3 Basics Knowledge Sheet." TheWxPage.com. Accessed 11 October 2016.  
<http://webpages.charter.net/gcara/files/Download/GRLevel3%20Info.pdf>
- <sup>3</sup>: "GRLevel 3 2.00 User Guide." GR Level X. Accessed 11 October 2016.  
[http://www.grlevelx.com/manuals/grlevel3\\_2/](http://www.grlevelx.com/manuals/grlevel3_2/)
- <sup>4</sup>: "What is VIL (Vertically Integrated Liquid)?" Jeff Haby. Accessed 11 October 2016.  
<http://www.theweatherprediction.com/habyhints/249/>
- <sup>5</sup>: "How to use and interpret Doppler weather radar." Wolfram Science. Accessed 11 October 2016.  
<https://www.wolframscience.com/summerschool/2014/alumni/files/Howtoreadandinterpretweatherradar.pdf>





## FORENSIC ANALYSIS

**National Weather Service (NWS) Twin Cities:** Local National Weather Service office responsible for issuing forecasts and warnings for the claim location.

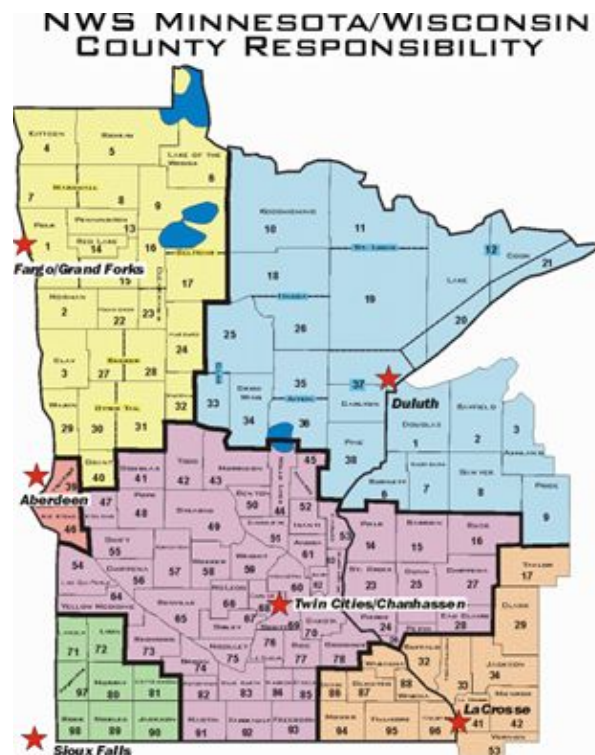


Figure A1. National Weather Service county responsibility map. Source: <http://www.crh.noaa.gov/mpx/office.php>

## FORENSIC ANALYSIS

Date	Time	Temperature	Dewpoint
6/29/2015	6:53 PM	82	63
6/29/2015	7:53 PM	69	63
6/29/2015	8:53 PM	69	64
6/29/2015	9:53 PM	67	63
6/29/2015	10:53 PM	65	62
6/29/2015	11:53 PM	65	62
6/30/2015	12:53 AM	64	61
6/30/2015	1:53 AM	64	61
6/30/2015	2:53 AM	63	60
6/30/2015	3:53 AM	64	60
6/30/2015	4:53 AM	64	59
6/30/2015	5:53 AM	63	59
6/30/2015	6:53 AM	64	59
6/30/2015	7:53 AM	65	60
6/30/2015	8:53 AM	69	60
6/30/2015	9:53 AM	70	60
6/30/2015	10:53 AM	71	60
6/30/2015	11:53 AM	72	60
6/30/2015	12:53 PM	73	58

Figure A2. Temperatures and dewpoints reported at the Crystal Airport between 6:53 PM June 29, 2015 and 12:53 PM June 30, 2015. Source: NWS/IEM

### Other Links

#### Severe Watch & Warnings

- Watch issued for the Twin Cities metro (including Brooklyn Center) on June 29, 2015:  
<http://www.spc.noaa.gov/products/watch/2015/ww0370.html>
- Warning issued for Brooklyn Center at 7:09 PM CDT on June 29, 2015:  
<https://mesonet.agron.iastate.edu/vtec/#2015-O-NEW-KMPX-SV-W-0057/USCOMP-N0Q-201506300010>

#### Storm Reports

- June 29, 2015:  
<http://mesonet.agron.iastate.edu/lsr/#MPX/201506290500/201506300459/0100>

#### Social Media

- Photos of hail event in nearby Fridley taken on June 29, 2015:
  - <https://twitter.com/Janmandy/status/615738871930847233>
  - <https://twitter.com/Janmandy/status/615695738446684161>