

March 1, 2007

Mr. Dick Kotapish, GIS Director
Lake County GIS Department
105 Main Street
Painesville, OH 44077

RE: July 27-28, 2006 rainstorm
AccuWeather File Number: 120618

Dear Mr. Kotapish:

As you requested, we have investigated the weather conditions across Lake County, Ohio from July 26, 2006 through July 28, 2006, with particular attention to rainfall timing and intensity. The results of our investigation are presented in the following paragraphs. This report is designed to accompany digital rainfall data, covering portions of the same time period, which is being provided to you by AccuWeather.

Our research shows that soil moisture conditions in Lake County were unusually moist throughout July 2006. The weekly value of the Palmer Drought Severity Index for Lake County on July 22, 2006 was "very moist". During the period from July 23, 2006 through July 25, 2006, there was no significant rainfall in Lake County. High temperatures were in the 70s on the 23rd and in the 80s the next two days. The relative humidity was lower than average on the 23rd and 24th and then the atmosphere became more humid on the 25th.

On July 26, 2006, the sky over Lake County was mostly clear before sunrise and mostly sunny throughout the daylight hours. The temperature ranged from an early morning low near to 70 degrees to an afternoon high well up in the 80s and the air was moderately humid. Meanwhile, a slow-moving cold front was drifting southeastward across Michigan on the 26th. In advance of this front, there was an increase in cloudiness in the sky over Lake County during the evening hours of July 26, 2006 and some showers along with isolated thundershowers moved across the county from west to east between 10:20 p.m.¹ and 11:30 p.m. Rainfall totals during the passage of these showers were less than 0.10 of an inch county-wide.

Rainfall activity increased in portions of Lake County during the predawn hours of July 27, 2006. Between 12:15 a.m. and 1:20 a.m., a band of eastward-moving showers and thunderstorms moved in off Lake Erie and across the northeastern part of the county, affecting North Perry and the northern part of Madison Township. Highest rainfall totals of approximately 0.80 of an inch fell with this activity in North Perry and small areas in the northwestern and northeastern corners of Madison Township.

¹ This and all other time references in this report are expressed in Eastern Daylight Time (EDT).

Separately, a batch of showers and thunderstorms moved from west to east across the county farther south between 1:00 a.m. and 2:20 a.m. on the 27th. The heaviest rainfall with these convective cells was 0.30 to 0.35 of an inch in the vicinity of Mentor-on-the-Lake, although many locations received over 0.10 of an inch from Timberlake and the northern part of Mentor eastward to Leroy Township. Another cluster of showers and thunderstorms moved from west to east across a similar area between 2:35 a.m. and 3:35 a.m., dropping generally between 0.10 and 0.25 of an inch of rain. Slightly more rain fell in a small area in eastern Concord Township.

One final batch of predawn showers and thunderstorms crossed Lake County from west to east between 4:30 a.m. and 5:35 a.m. on July 27, 2006. Rainfall with this activity ranged generally from 0.10 to 0.30 of an inch across most of the county with the exception of Kirtland, southern Leroy Township and the northeastern part of the county north of Perry and Madison where only a little rain fell.

Between 5:35 a.m. and about 11:00 a.m. on the 27th, there was no significant rainfall in Lake County. The sky became partly sunny for a portion of this time and the temperature climbed to the 80-degree mark. The air was much more humid than on previous days and the soil across the county was quite wet due to the early morning rainfall.

During the remainder of July 27, 2006, several clusters of thunderstorms containing heavy downpours moved generally from west-southwest to east-northeast across northeastern Ohio and southern Lake Erie. The first group of thunderstorms brought torrential downpours between 11:00 a.m. and 1:00 p.m. While approximately 1.10 inches of rain fell during this time in a small area of extreme southern Mentor, between 1.00 and 2.00 inches fell along and near the Lake Erie shoreline from Fairport Harbor northeastward to northern Madison Township. The remainder of the county received less than 1.00 inch of rain from this thunderstorm cluster.

A larger portion of the county was impacted by the next batch of drenching thunderstorms between 2:00 p.m. and 3:30 p.m. More than an inch of rain fell over all portions of the county except the extreme southwest and most of Madison Township. Peak rainfall amounts during this 90-minute period reached 1.50 inches in eastern Mentor, northern Concord Township and southern Leroy Township.

Another batch of thunderstorms containing very heavy rain affected the northern part of Lake County between 3:45 p.m. and 5:00 p.m. The greatest rainfall on land during this time was close to 2.00 inches in the vicinity of Fairport Harbor with more than 1.00 inch of rain eastward from there to Madison Township.

The next group of heavy thunderstorms moved across the southern portion of the county between 4:30 p.m. and 6:00 p.m., dropping generally between 0.50 and 1.00 inch in most places. A small area in Eastlake received about 1.20 inches of rain from this feature. Rainfall from this group of storms tracked south of the area covered by the previous batch of thunderstorms.

A small but very intense thunderstorm moved from west to east across the southwestern part of the county between 6:00 p.m. and 7:00 p.m., bringing very heavy rain to Wickliffe, Willoughby Hills, Waite Hill and Kirtland. During this hour, peak rainfall totals reached 1.50 to 1.70 inches in northeastern Willoughby Hills.

After a brief lull, additional showers and thunderstorms moved across the southern half of Lake County between 8:30 p.m. and 10:15 p.m., bringing generally between 0.50 and 1.00 of rainfall. As much as 1.20 inches fell in southern Kirtland during this time.

By 10:15 p.m. on July 27, 2006, the amount of rainfall across the county since 11:00 a.m. was between 4.00 and 7.00 inches in most places. Rainfall totals reached nearly 3.50 inches in Painesville by 4:30 p.m. and 6.50 inches in Mentor by 9:00 p.m. Widespread flooding resulted countywide, with rapid rises in areas streams and rivers. The Painesville area was especially hard hit by flooding. In Mentor, over 120 children were evacuated from a day care center around 4:00 p.m. as flood waters began to enter the building. During the evening of the 27th, water reached a depth of four feet on some county streets and there were hundreds of reports of basement flooding. A fire station in Willoughby Hills was damaged in the flooding.

The final round of intense rains struck Lake County between 11:00 p.m. on July 27, 2006 and approximately 2:30 a.m. on July 28, 2006. Several groups of thunderstorms with torrential downpours moved from west to east across the county during this time. While less than 1.0 inch of rain fell in the extreme southwestern part of the county and not much more than 1.00 inch fell in the extreme northeast, particularly heavy rain tracked across the central portion of the county where many spots had in excess of 3.00 inches.

While the heaviest rain had departed before 3:00 a.m., additional rainfall between 3:00 a.m. and 5:30 a.m. brought another 0.25 to 0.65 of an inch across the county. There was no additional significant rainfall after 5:30 a.m. on the 28th, although spotty light showers persisted until about 9:00 a.m.

The National Weather Service office in Cleveland prepared the following summary of the impacts of the excessive rainfall in Lake County on July 27 and 28, 2006. The rainfall total given for Mentor appears to be too high.

After a brief lull, heavy thunderstorm rains resumed just after midnight and devastating flash flood quickly developed. As much as three inches of rain fell between 12:30 and 2:30 a.m. By daybreak on the 28th, as much of 10 inches of rain had fallen on portions of Lake County since the first thunderstorms developed during the afternoon hours of the 27th. Rainfall totals included: 9.70 inches in Mentor; 7.95 inches in Concord; 6.89 inches in Kirtland; 6.30 inches just south of Painesville and 5.50 inches in Madison. Nearly every community in Lake County was hard hit by flooding. A 51 year old man disappeared around 2 a.m. while trying to move vehicles from flood waters at an Eastlake marina. He was later found deceased along a beach in

Mentor. Thousands of homes were damaged and hundreds of people had to be evacuated. Widespread evacuations began in Painesville and Madison between 3 and 4 a.m. In Painesville, the Grand River rose from a stage of 2 feet on the morning of the 27th to 17.36 feet around 5 a.m. on the 28th establishing a new record stage. The old record stage was 13.1 feet set in 1979. Damage along the river was catastrophic and homes along Main Street, Millstone Drive, Gristmill Drive, Steele Avenue and Grand River Avenue were devastated. A total of 81 homes were destroyed on these streets with dozens more heavily damaged. Around 600 people had to be evacuated from homes along the Grand River and approximately 25 people had to be rescued by boat from rooftops after flood waters climbed into the second floors of their homes. Several other people had to be rescued by helicopter because the flood waters were flowing too fast to allow boat rescues. In Madison Township, around 1200 people were evacuated from a mobile home park as flood waters began to encroach their neighborhood. Dozens of homes and business in the area sustained damaged, much of it caused by flooding from the Grand River. State Route 84 was washed out by a creek near the Perry and Madison Township border. Up to 70 boats and large sections of piers were torn loose along the Grand River and washed into Lake Erie. Many of these boats were later deposited on beaches between Fairport Harbor and Madison. A floating restaurant near the mouth of the Grand River broke free during the flooding and sustained considerable damage. Homes along the mouth of the river in Fairport Harbor were littered with debris from damaged homes and businesses upstream. The Chagrin River in Eastlake rose from a stage around 4 feet on the morning of July 27th to 14.77 feet at 4:30 a.m. on the 28th. Widespread damage was reported in both Eastlake and Willoughby from the resulting flooding. Significant damage was also reported in portions of Mentor, Kirtland and Concord Township. During this event emergency personnel conducted 41 separate rescue operations involving around 200 people. Around 3,600 families in Lake County applied for flood assistance. Approximately 100 homes were destroyed in the county with another 800 significantly damaged. Almost all of these homes were in Painesville, Eastlake, Madison, Fairport Harbor or Concord Township. Nearly 200 businesses were affected by flooding. Five bridges were destroyed by flooding and at least eight roads were washed out. Several bridges and many other roads were also damaged. Two sewer plants sustained significant damage. Damage to roads, bridges and other public infrastructure has been conservatively estimated to be around \$15 million. Damage in Lake County during this event was unprecedented.

During the entire event between 10:00 p.m. on July 26, 2006 and 9:00 a.m. on July 28, 2006, the total amount of rainfall across Lake County ranged from a minimum of about 4.25 inches in the southeastern corner of Kirtland to a maximum of approximately 9.25 inches in the vicinity of Fairport Harbor. A large portion of the county received at least 6.00 inches of rain in this

unusual storm. Rainfall amounts were generally less in the counties surrounding Lake County. The CD that accompanies this report displays hourly rainfall maps covering the entire event as well as a map showing the total rainfall.

Meteorologists use the "return period", also sometimes called the "return interval" or "recurrence interval" to describe the rarity of a particular event. For example, a return period of 50 years means that, based on historical records, a particular event can be expected to occur at the given location, on average, once every 50 years. Due to the inherent variability of the atmosphere, the actual time between such events can vary widely.

A map showing the return period of the July 26-28, 2006 rainfall event across Lake County is also included on the CD that accompanies this report. Return periods exceeded 100 years over nearly the entire county except for small portions that include Wickliffe, southern Willoughby Hills, southern Kirtland, southeastern Leroy Township and parts of Madison and southeastern Madison Township. Return periods exceeding 1000 years appear along and near the lakeshore from northern Mentor to North Perry as well as scattered locations in Kirtland Hills and southern Mentor.

To accurately and usefully prepare the rainfall information that we have provided in this report and on the accompanying CD, we began by obtaining gauge-adjusted rainfall data from the National Weather Service Doppler radar. This adjustment was made using a proprietary process developed by OneRain, Inc. The process merges actual ground-truth rainfall data from a collection of rain gauges, in this case the Ohio EMA ALERT gauge network, with rainfall estimates from the Doppler radar. The result is a gauge-adjusted radar rainfall data set that combines the spatial distribution of the radar images with the scaling information from the gauges. The result is a more accurate picture of the amount and distribution of rainfall than can be obtained from simply rain gauges or Doppler radar alone. The rainfall data was generated for each hour during the storm in question as well as for the storm as a whole. The gauge-adjusted radar rainfall estimates were lower than those provided by radar alone.

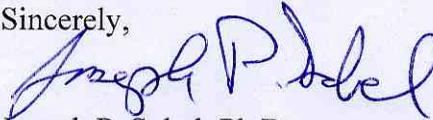
The data we obtained from the OneRain process described above was further adjusted to a format that would be most useful for the Lake County GIS Department. Hourly and storm total rainfall provided by OneRain was first converted to point locations by finding the center of each grid cell. This point distribution was then interpolated to a continuous grid by finding a best fit surface of the rainfall data. This interpolation also improved the resolution of this data from 0.5 of a mile to 100 meters, which helps in visualizing the localized distribution of rainfall throughout the county and surrounding areas. Each enhanced surface was then contoured at specific intervals of rainfall depth to provide an overview of trends across the study area.

Return period information for the entire rainfall event was calculated for each pixel on the map utilizing the National Oceanic and Atmospheric Administration's Precipitation Frequency Atlas 14, Volume 2.

The information in this report has been determined from the best sources of weather information available to us at this time and is the result of interpretation by our staff of professional meteorologists and represents our opinions to a reasonable degree of scientific certainty.

We trust that this information is useful to you. If you should have any additional questions or need additional information, please do not hesitate to contact us.

Sincerely,



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