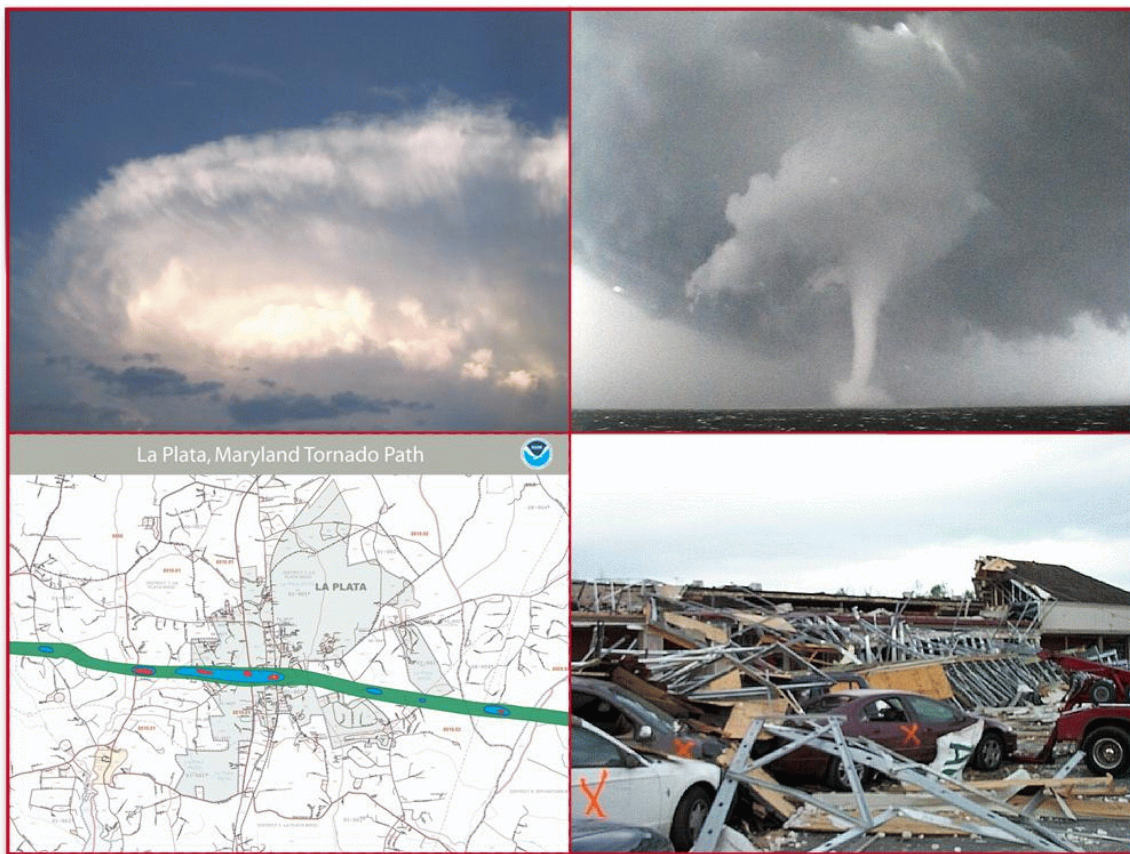




Service Assessment

La Plata, Maryland, Tornado Outbreak April 28, 2002



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service
Silver Spring, Maryland

Cover Photos:

Top left: April 28, 2002, La Plata supercell. (Courtesy of William Rison)

Top right: The La Plata tornado moving southeast across Chesapeake Bay as a waterspout. Photograph taken from Long Beach, Maryland, April 28, 2002. (Courtesy of Ted L. Dutcher)

Bottom left: La Plata, Maryland, tornado tracking map. (National Oceanic and Atmospheric Administration [NOAA])

Bottom right: CVS drugstore in La Plata, Maryland. (Courtesy of Dawn Glencer)



Service Assessment

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September 2002

U.S. DEPARTMENT OF COMMERCE
Donald L. Evans, Secretary

National Oceanic and Atmospheric Administration
Vice Admiral Conrad C. Lautenbacher, Jr.

National Weather Service
John J. Kelly, Jr., Assistant Administrator

Preface

A violent tornado, rated F4 on the Fujita Tornado Intensity Scale (see appendix A), moved across southern Maryland and devastated the town of La Plata. Tornadoes along the Atlantic coast are not common, and tornadoes of this magnitude are extremely rare. Only six F4 tornadoes have occurred farther north and east of the La Plata storm: Worcester, Massachusetts - 1953; New York/Massachusetts - 1973; Windsor Locks, Connecticut - 1979; five counties in New York - 1989; New Haven, Connecticut - 1989; North Egremont, Massachusetts - 1995. None were as close to the coast. The tornado traveled across the Chesapeake Bay almost to the Atlantic.

Due to the magnitude and rarity of this event in this part of the country, a service assessment team was formed to examine the warning and forecast services provided by the National Weather Service (NWS) to emergency managers, government agencies, and the public in southern Maryland. Service assessments provide a valuable contribution to our ongoing efforts to improve the quality and timeliness of our products and services for the protection of life and property. Findings and recommendations from this assessment will improve techniques, products, and services.

John J. Kelly, Jr.
Assistant Administrator
for Weather Services

September 2002

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Service Assessment Team

The service assessment team was activated on May 1, 2002. Team members visited the La Plata, Maryland, damage area, Charles and Calvert County emergency management, local radio and TV stations, and the Weather Forecast Office (WFO) Baltimore/Washington. In addition, telephone interviews were conducted with the Storm Prediction Center (SPC) and WFO Wakefield, Virginia. The team comprised the following individuals.

John Ogren	<i>Team Leader</i> , Meteorologist in Charge (MIC), WFO Indianapolis, Indiana
Richard Kane	Warning Coordination Meteorologist (WCM), WFO Pittsburgh, Pennsylvania
Steve Brueske	Science and Operations Officer (SOO), WFO Charleston, South Carolina
Michael Vescio	SOO, WFO Ft. Worth, Texas
John Leslie	Public Affairs Specialist, NWS Headquarters, Silver Spring, Maryland
Wayne Presnell	NWS Headquarters, Office of Climate, Water, and Weather Services (OCWWS), Silver Spring, Maryland
Tim Marshall	Consultant, Haag Engineering, Carrollton, Texas

Other valuable contributors include:

William Lerner	NWS Headquarters, OCWWS, Silver Spring, Maryland
Linda Kremkau	NWS Headquarters, OCWWS, Silver Spring, Maryland

Special thanks to:

Frank Lucia	Federal Communications Commission, Retired
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Acronyms

AWIPS	Advanced Weather Interactive Processing System
BPAT	Building Performance Assessment Team
CWA	County Warning Area
EAS	Emergency Alert System
EDT	Eastern Daylight Time
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
HMT	Hydrometeorological Technician
MIC	Meteorologist in Charge
NAWAS	National Warning System
NCF	Network Control Facility
NOAA	National Oceanic and Atmospheric Administration
NWR	NOAA Weather Radio
NWS	National Weather Service
OCWWS	Office of Climate, Water, and Weather Services
QRT	Quick Response Team
SAME	Specific Area Message Encoding
SOO	Science and Operations Officer
SPC	Storm Prediction Center
TVS	Tornado Vortex Signature
WCM	Warning Coordination Meteorologist
WDM	Warning Decision Making
WERC	Wind Engineering Research Council
WES	Weather Event Simulator
WFO	Weather Forecast Office
WSR-88D	Weather Surveillance Radar-1988 Doppler

Service Assessment Report

Introduction

On Sunday evening, April 28, 2002, a violent F4 tornado carved a 64-mile path across southeast Maryland. The La Plata, Maryland, tornado was part of a large severe weather outbreak that began in the mid-Mississippi Valley early on that day and spread across portions of the Ohio Valley and Mid-Atlantic States. In Maryland, 3 deaths and 122 injuries were a direct result of the storm (see appendix B). Property damage exceeded \$100 million. This is not the deadliest tornado to strike La Plata. In 1926, a tornado killed 14 children at a school.

An NWS service assessment team was formed to review the products and services provided by the Storm Prediction Center (SPC) and the Weather Forecast Offices (WFOs) Baltimore/Washington and Wakefield, Virginia. Emergency managers, people in the media, and local residents were interviewed to obtain feedback on NWS performance. The assessment team learned NWS customers and partners were satisfied with the information received before and during the La Plata tornado. Critical warnings reached the public despite the failure of one part of the dissemination system (see “Dissemination” section). NWS policy of using multiple dissemination methods worked during this event and remains a vital component of the NWS mission of protecting life and property.

One purpose of service assessments is to identify issues and recommend improvements. In this case, the La Plata service assessment team identified three such issues: Emergency Alert System (EAS), WFO Baltimore/Washington warning decision process, and tornado intensity rating. These are discussed in detail in this report.

Overview

The weather system spawning the La Plata tornado contained the large-scale features typical of significant severe weather episodes (see figures 1a and 1b). A strong upper-level trough moved rapidly from the Ohio Valley to the Mid-Atlantic coast during the day. Jet stream winds greater than 90 mph were associated with the upper system and contributed to an atmosphere conducive to the development of supercell thunderstorms and tornadoes. Supercell thunderstorms are the most violent type of severe thunderstorm and produce large hail, damaging winds, and the majority of the tornadoes that occur across the United States. Supercell thunderstorms developed during the late morning over Ohio and Kentucky along a strong cold front and in association with the upper system. These storms raced eastward and crossed the

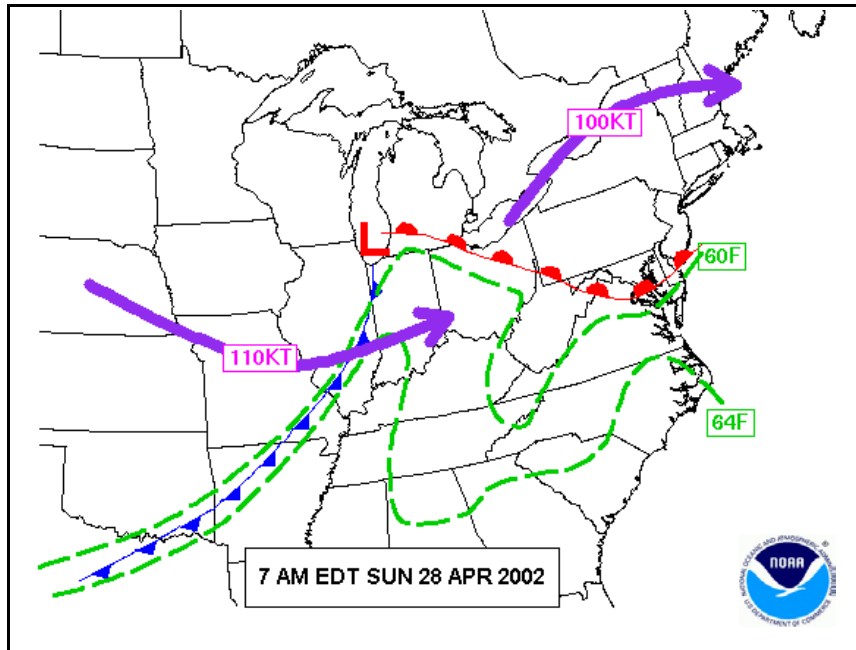


Figure 1a. Composite map from 7 a.m. EDT, Sunday, April 28, 2002, depicting the surface fronts, surface dew points (dashed lines) and upper level jet stream wind (solid lines). (NOAA)

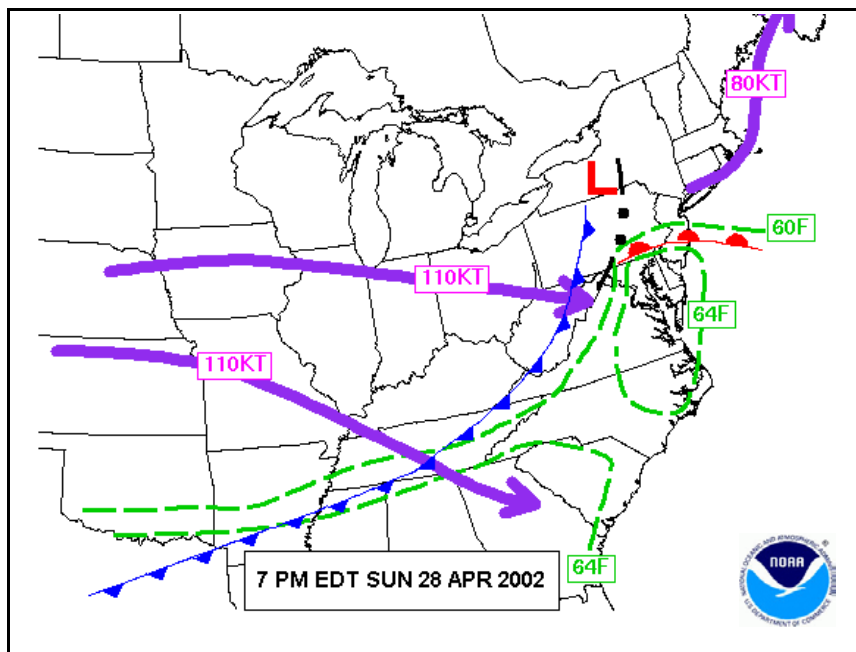


Figure 1b. Composite map from 7 p.m. EDT, Sunday, April 28, 2002, depicting the surface fronts, surface dew points (dashed lines) and upper level jet stream wind (solid lines). (NOAA)

Appalachian Mountains between 3 and 4 p.m. Eastern Daylight Time (EDT).¹ Many of the storms weakened as they crossed the high peaks of the Blue Ridge Mountains. However, the storm that struck La Plata remained a strong supercell as it moved from West Virginia through northern Virginia into southern Maryland.

In the La Plata area, a warm front was located just south of the town early Sunday morning (see figure 1a). Cool air reinforced by clouds and precipitation led to a stable air mass early in the day. However, the warm front moved north of the area by midday (see figure 1b), resulting in rapid air mass destabilization and provided ideal conditions for severe weather as the supercell moved into the area.

The La Plata tornado first touched down at 6:56 p.m., south of the town of Marbury in western Charles County, Maryland (see photo 1, aerial view of the tornado track; and figure 2, map of the entire tornado track and an inset of the tornado path through La Plata). Although initial damage was minimal, the tornado intensified as it approached the town of La Plata, and F3 damage occurred in two subdivisions west of town. Damage and eye witness accounts indicate a second weaker tornado formed a quarter of a mile south of the first tornado. Both tornadoes crossed the heart of La Plata between 7:02 p.m. and 7:07 p.m., causing widespread F2-F3 damage. Destruction in a one-square-block area on the east side of La Plata was most severe and rated F4 (see photo 2 of downtown La Plata F4 damage). The secondary tornado dissipated while the main tornado continued moving east through the rest of Charles County. Although much of the area east of La Plata was rural, 100 homes, 49 businesses, and numerous barns were destroyed. Acres of dense forest were leveled. At 7:30 p.m., the tornado crossed into Calvert County where it killed an elderly couple and destroyed an additional 10 homes and damaged another 125. It moved out onto the Chesapeake Bay just north of the Calvert Cliffs Nuclear Power Plant. A secondary vortex, a waterspout, formed for a few miles on the Bay. The primary tornado continued across Dorchester County again intensifying to F3 before dissipating as it approached Salisbury, Maryland.

WFO Baltimore/Washington has warning and forecast responsibility for a small part of the West Virginia Panhandle, extreme northern Virginia, and most of Maryland, including Charles and Calvert Counties. On the day of the tornado, the office issued all its routine products, a 13-county flood watch, a flash flood warning, 14 tornado warnings, 13 severe thunderstorm warnings, 4 special marine warnings, plus many special and severe weather statements. The Science and Operations Officer (SOO) stated that April 28 was *“the busiest day he had worked in the last 8 years.”*

The forecast office issued its first tornado warning for Shenandoah County, Virginia, at 4:37 p.m. for the thunderstorm that eventually spawned the La Plata tornado. The storm produced a tornado south of Mount Jackson at 4:55 p.m. Subsequent tornado warnings were

¹ All times listed in this service assessment are EDT.

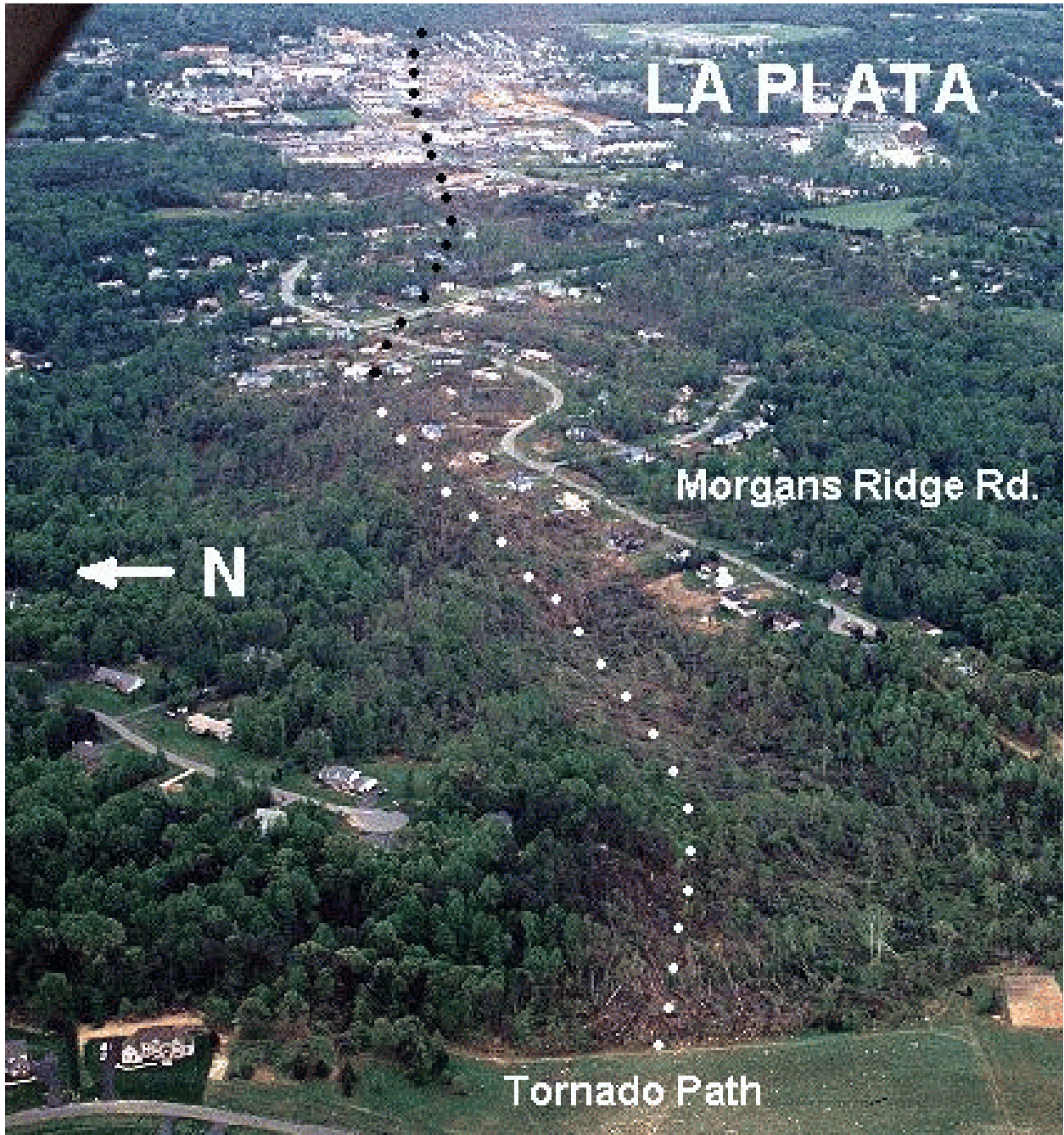


Photo 1. Aerial view of tornado path looking east toward La Plata, Maryland. Dots indicate the center of damage path. The tornado traveled through the Quailwood Subdivision in the foreground destroying several homes along Morgans Ridge Road. (Courtesy of Tim Marshall, Haag Engineering)

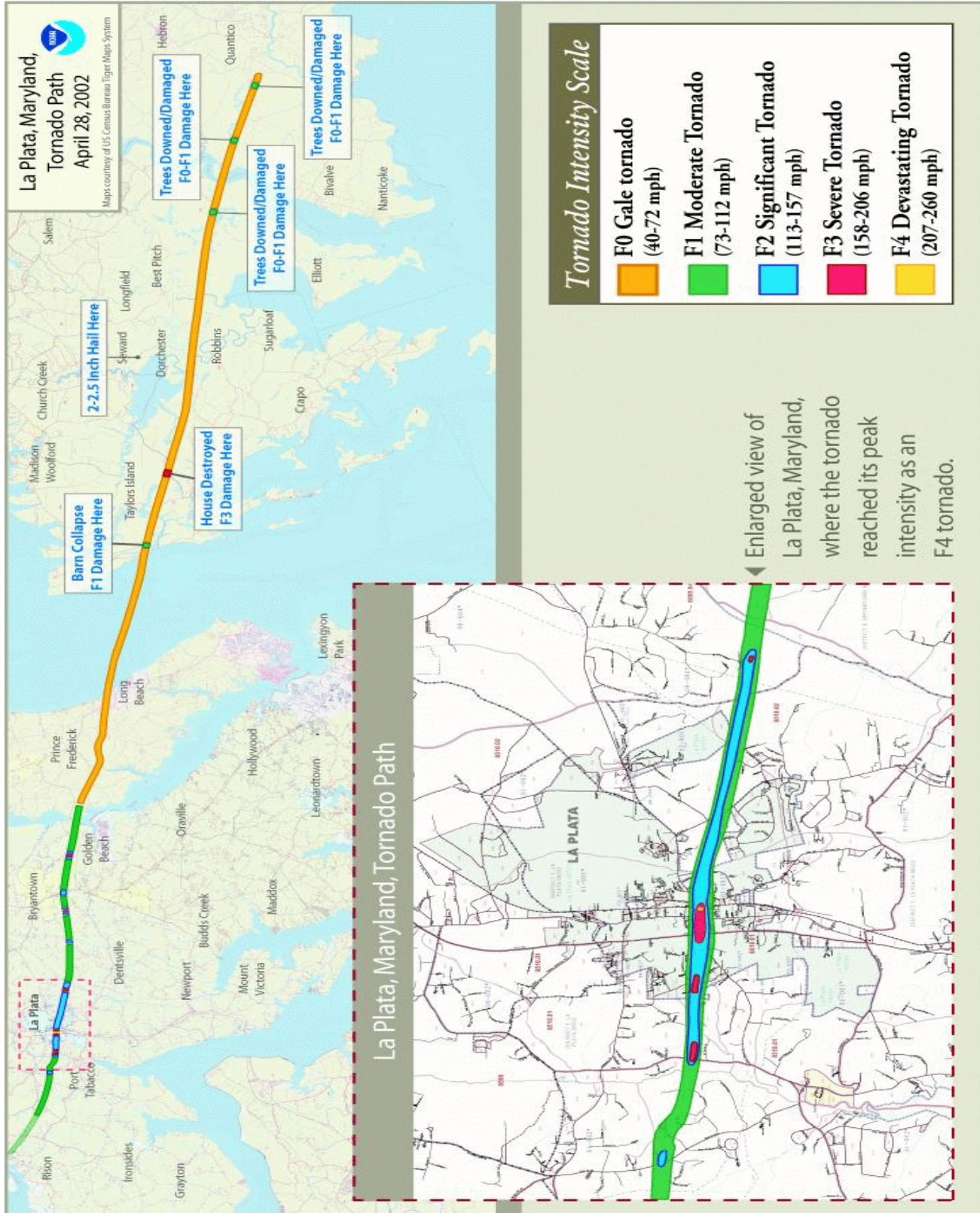


Figure 2. Map of the tornado track and an inset of the tornado track through LaPlata, MD. (NOAA)



Photo 2. Aerial view showing F4 damage to two homes in downtown La Plata, Maryland. These homes were downwind of a lumber yard and impacted by its debris. (Courtesy of Tim Marshall, Haag Engineering)

issued along the storm's path across northern Virginia through 6:45 p.m., but no additional tornadoes occurred. A severe thunderstorm warning was issued for northern Charles and Calvert Counties at 6:45 p.m. The call-to-action statement mentioned the possibility of tornadoes: "SEVERE THUNDERSTORMS CAN PRODUCE TORNADOES WITH LITTLE OR NO ADVANCE WARNING...." At 7:02 p.m., 6 minutes after the tornado touched down, the tornado warning was issued for Charles and Calvert Counties.

Warning and Forecast Services

WFO Baltimore/Washington

Before the Event

The Baltimore/Washington WFO preplanning was excellent. Awareness of the potential for severe weather prior to the onset of this event was extremely high. Planning began Saturday afternoon, April 27, the day before the tornado. People scheduled on the Sunday, April 28, evening shift were prepared to come in early should severe weather develop. The Network Control Facility (NCF) was notified at 8:30 a.m., Sunday morning, April 28, to put the Baltimore/Washington WFO in a critical weather watch for the Advanced Weather Interactive Processing System (AWIPS). The NCF serves as the AWIPS control center and identifies, diagnoses, and corrects system faults and outages; monitors site equipment operations; and alerts users at each site when malfunctions or degradations occur. During critical weather situations, the WFO may ask the NCF to keep a closer eye on AWIPS operations. Two additional forecasters arrived at the WFO by 2 p.m. and an additional Hydrometeorological Technician (HMT) arrived by 4 p.m. A short meeting was held at 3 p.m., Sunday, April 28, to determine staff responsibilities.

Several outlook and forecast products were issued for the severe weather threat over Virginia and Maryland. The first mention of possible severe weather was in the Baltimore/Washington WFO's Hazardous Weather Outlook issued at 5:25 a.m., Saturday, April 27. It stated, "SOME OF THESE STORMS MAY BE ON THE STRONG SIDE...WITH GUSTY WINDS THE PRIMARY THREAT." At 3:20 a.m., Sunday, April 28, another Hazardous Weather Outlook was headlined, "POSSIBLE SEVERE THUNDERSTORMS TODAY." The Outlook focused on damaging winds during the afternoon. The 10:30 a.m., Sunday, April 28, Hazardous Weather Outlook was the first to mention a tornado threat and gave the specific times: between 3 p.m. and 8 p.m. SPC issued a tornado watch at 3:30 p.m.

During the Event

The Baltimore/Washington WFO was staffed with eight people, including the Meteorologist in Charge (MIC), Warning Coordination Meteorologist (WCM), SOO, three lead forecasters, and two HMTs.

The WFO began issuing warnings when the La Plata supercell first entered its county warning area (CWA). Warning forecasters issued the first tornado warning for Shenandoah County, Virginia, at 4:37 p.m., and a tornado touched down south of Mount Jackson at 4:55 p.m. This F2 tornado destroyed 3 homes, 19 barns, and damaged 27 other residences. While the WFO received confirmation of the Shenandoah tornado, this confirmation was not passed to the warning forecasters during the event. Based on radar, the warning forecasters issued additional tornado warnings between 5 and 6:45 p.m. as the storm crossed Virginia. SKYWARN spotters and county warning points reported a funnel cloud, wind damage, and large hail associated with the storm, but no additional tornadoes. Without a confirmed tornado report, and believing the supercell's tornadic potential was decreasing, the warning forecasters issued a severe thunderstorm warning for Charles and Calvert Counties at 6:45 p.m. The call-to-action statement in the severe thunderstorm warning did state, "SEVERE THUNDERSTORMS CAN PRODUCE TORNADOES WITH LITTLE OR NO ADVANCE WARNING...."

Another forecaster working the severe weather episode called the Charles County 9-1-1 Operations Center between 6:10 and 6:20 p.m. to discuss the approaching storm. This forecaster stated, "*There is a tornadic thunderstorm headed your way.*" Charles County personnel informed the forecaster they were watching the storm on radar and knew they were in a tornado watch.

The thunderstorm crossed the Potomac River into Maryland where the La Plata tornado first touched down near Marbury at 6:56 p.m. At 7:02 p.m., 6 minutes after the tornado touched down, a tornado warning was issued for Charles and Calvert Counties. As the tornado warning was being issued, another forecaster called Charles County personnel in La Plata to warn them that radar indicated a tornado, but it took three attempts to get through because damage calls from Ripley and other locations west of La Plata were already clogging the telephone lines. The first fatality occurred 8 minutes later at 7:10 p.m. in La Plata. At 7:30 p.m., two more people died as the tornado entered Calvert County. See appendix C for WFO Baltimore/Washington chronological product highlights.

After the Event/Damage Assessment

Tornadoes are rated using the Fujita Tornado Intensity Scale or F-scale, which is named after Dr. T. Theodore Fujita, former professor of Meteorology, University of Chicago. The F-scale is a subjective visual interpretation used by the NWS to rate the worst building damage anywhere along the path from 0 to 5, with 5 being the most destructive (see appendix A). Empirically-derived wind speed ranges are also associated with the F-scale. An accurate F-scale rating is important for historical, statistical, and climatological reasons and allows the public to get a sense of the storm's destructive force.

WFOs assign an F-scale rating for tornadoes occurring in their CWAs except when a service assessment is undertaken. In those cases, the WFO rating is preliminary and the assessment team in coordination with the WFO assigns a final F-scale. WFO Baltimore/Washington surveyed the damage in La Plata, Monday, April 29. The WFO first rated the tornado an F4, but later raised the assessment to F5, based on building damage just east of downtown La Plata. This information was disseminated to the public and media through Public Information Statements and a news story prepared by the NWS Public Affairs Office without a “preliminary” indicator. Subsequent updates to the news story did contain the word “preliminary.” Current policy states “preliminary” should be used whenever a service assessment is possible. (Weather Service Operations Manual Chapter J-02, Significant Hydrometeorological Events, Post-storm Data Acquisition, and Service Assessments, section 6: *“If unsure whether a service assessment...is needed, the local office shall indicate that F-scale determinations are preliminary and subject to revision after further analysis.”*) The assessment team concluded the Baltimore/Washington WFO was unsure if a service assessment would be undertaken. Also, the assessment team questioned whether “preliminary” is a strong enough word to allow for any subsequent change to the rating. **(Finding 1)**

As mentioned above, Baltimore/Washington WFO personnel rated the worst damage F5. This preliminary F5 rating to a brick building in downtown La Plata (see photo 3) was lowered to F4 after the assessment team determined some of the damage was due to flying debris from a lumber company upwind. Damage to homes rated F5 by the WFO were lowered to F4 when the assessment team’s structural engineer, Tim Marshall, performed a detailed analysis of the construction. He determined these homes were not adequately anchored causing them to fail at a lesser wind force (see photos 4 and 5). In some cases, destroyed homes still had mailboxes and storage sheds left intact (see photo 6). WFO personnel who are trained in damage assessment receive it only once. In addition, violent F4 and F5 tornadoes are extremely rare, and there are few opportunities to view storm damage of this magnitude. **(Finding 2)**

The assessment team learned building damage surveys were being done by the Federal Emergency Management Agency’s (FEMA) Building Performance Assessment Team (BPAT) and Wind Engineering Research Council (WERC) at the same time the NWS was conducting their damage survey. **(Finding 3)**

After the tornado event on Sunday, April 28, Jim Travers, MIC, and Barbara Watson, WCM, WFO Baltimore/Washington, spent approximately 12 hours conducting interviews with national and local media. Most media reports were positive or neutral. A Public Affairs officer was present at the WFO Baltimore/Washington all day, Monday, April 29, and most of the next day. NOAA praised NWS Public Affairs staff for preparing news stories and updates.



Photo 5. Aerial view looking east of residential damage at end of Hawkins Gate Road, located just east of La Plata, Maryland. Split-level homes slid off their foundations into a ravine. The home had been anchor-bolted to its foundation but failed where the wall studs were straight nailed to the bottom plate. (Courtesy of Tim Marshall, Haag Engineering)



Photo 6. Poorly anchored home on Morgans Ridge Road was swept clean off its foundation while mailboxes remained undamaged. This example illustrates the difficulties in assigning an F-scale rating. (Courtesy of Tim Marshall, Haag Engineering)

WFO Performance

WFO Baltimore/Washington fulfilled its mission by issuing timely warnings, forecasts, and statements, and maintaining frequent contact with partners. Customers and partners were satisfied with the services provided. The team did note some areas where services could be improved.

The assessment team focused on why the warning forecasters decided to issue a severe thunderstorm warning rather than a tornado warning for Charles County and La Plata when tornado warnings had been issued for this storm in Virginia. Based on their responses, the assessment team identified four factors: warning forecasters did not receive a confirmed report of a tornado; radar indications of a weakening supercell; lack of a continuous weather watch on the supercell; and concern over false alarms. The combination of these four factors led to the decision to issue a severe thunderstorm warning. **(Finding 4)**

Warning forecasters did not receive a confirmed report of a tornado. As mentioned earlier, WFO staff received confirmation of a tornado in Shenandoah County, but this confirmation was not communicated to the warning forecasters. WFO Baltimore/Washington policy states when a person receives a severe weather report, this information is to be passed immediately to the warning team.

The NWS offers a 4-day Warning Decision Making (WDM) Workshop. One of the subjects is *“Strategies for Optimizing Severe Weather Performance.”* A key topic covered is the importance of effective communication within the office: *“Do everything you can to ensure critical information is relayed to those who need it as quickly as possible and that open communication is encouraged.”*

Radar indications of a weakening supercell. Based on radar indications, the warning forecasters thought the storm was weakening and losing its potential to produce a tornado. Assessment team members reviewed the archived data from the Weather Surveillance Radar-1988 Doppler (WSR-88D) and found the significant hook echo, or pendant, evident on the lowest radar scans from 6:10 to 6:20 p.m. on the southwest side of the storm, had dissipated by the 6:30 to 6:40 p.m. scans. Hook echos at low levels are frequently indicative of rotating storms and often indicate tornadoes, but are only one of the several signatures available to identify severe storms. In addition, at 6:20 p.m., the WSR-88D’s algorithms did not indicate a mesocyclone (a deep, symmetrical, rotating vortex) or a Tornado Vortex Signature (TVS) previously identified in the storm. Cycles of weakening and regeneration are common in long-lived supercell thunderstorms.

Despite the loss of the hook echo signature, at 6:35 p.m. the radar’s Tornado Vortex Detection algorithm indicated a TVS that extended from the lowest level observed by the radar (1,800 feet above ground at the particular storm’s location) to over 10,000 feet. The detection of this signature automatically triggered an alarm on the AWIPS that the warning forecasters noticed. In addition, the radar’s mesocyclone detection algorithm identified a mesocyclone within the storm that extended from 9,200 feet to 20,500 feet within the storm. From 6:35 p.m. (21 minutes before tornado touchdown) until the storm reached the Patuxent River over an hour later, the WSR-88D’s algorithms continuously identified both the mesocyclone and TVS. This final TVS was the first signature associated with a tornado since the Shenandoah storm.

The WDM Workshop provides guidelines on optimizing procedures for efficient analysis of severe weather. The guidelines recommend “*Be very slow to downgrade from a Tornado Warning to a Severe Thunderstorm Warning.*” Eastern Region’s Severe Weather Best Practices Web site states, “*It is a good rule of thumb to continue tornado warnings for a few volume scans following the dissipation of the radar-observed vortex signature.*”

Lack of a continuous weather watch on the supercell. Two forecasters combined their efforts to issue warnings for the entire CWA. When the La Plata tornado first touched down, the warning forecasters were issuing a severe thunderstorm warning for Anne Arundel, Howard, and Montgomery Counties in Maryland at 6:58 p.m. This practice prevented a full weather watch by the warning team on more than one part of the CWA at any given time.

The May 3, 1999, Oklahoma/Southern Kansas Tornado Outbreak Service Assessment recommends as a best practice “*Sectorization of Warning Operations.*” The Performance Strategies section of the WDM Workshop recommends use of a team-centered approach of sectorized operations using multiple workstations.

Concern over false alarms. In recent years, the NWS has emphasized improving products and services. The warning forecasters believed the emphasis was on verification scores and that perception led to false alarm concerns. In this case, several tornado warnings issued for Virginia had not verified.

Eastern Region’s Severe Weather Best Practices Web site states, “*When supercells are possible and/or indicated by radar, it is important to err on the side of safety and issue a tornado warning,*” and “*Since supercells are relatively rare, we are not increasing the FAR [False Alarm Rate] much if a given supercell...doesn’t produce a tornado.*” In November 2000, the Director, Eastern Region, discussed the importance of performance rather than focusing on statistical measures of performance, including false alarm rates, with the WFO Baltimore/Washington staff.

WFO Wakefield, Virginia

The WFO in Wakefield, Virginia, provided good warning and forecast services for the La Plata tornado as it moved through Dorchester and Wicomico Counties. WFO Wakefield's CWA was located on the southeastern fringe of the severe weather area that occurred on Sunday, April 28. SPC outlooks indicated Wakefield's CWA had a slight risk of severe weather and WFO Wakefield's public products blended well with these outlooks.

The La Plata tornado crossed the Chesapeake Bay, moved across Dorchester County with maximum F3 intensity, and dissipated in Wicomico County. Tornado warnings were issued for both counties. Lead time was 11 minutes for Dorchester County, and 7 minutes for Wicomico County. There were no fatalities or injuries, all systems performed adequately, and staffing was sufficient for the event.

Storm Prediction Center

The SPC, part of the National Centers for Environmental Prediction, provided good outlook and watch services for the April 28 severe weather outbreak.

The SPC put much of the Mid-Atlantic region in a slight risk of severe weather in the Day 2 Outlook issued at 3 a.m., Saturday, April 27. The Outlook stated the primary risk was for damaging winds. However, the Outlook stated, "THE TORNADO/HAIL THREAT IS CONDITIONAL BASED ON THE DEGREE OF DESTABILIZATION. IF CONFIDENCE INCREASES...AN INCREASE TO MODERATE RISK MAY BE NECESSARY."

The Day 1 Outlook, issued at 2 a.m., Sunday, April 28, forecast a moderate risk of severe weather for the central Appalachians and the Mid-Atlantic States. The Outlook stated the primary threat was for widespread damaging winds. An update was issued at 9 a.m., stating, "ISOLATED TO SCATTERED SEVERE STORMS...POSSIBLY SUPERCELLS...CANNOT BE RULED OUT FROM THE D.C. AREA ACROSS VA. DURING THE EVENING." SPC issued a tornado watch at 3:05 p.m., valid from 3:30 p.m. until 9 p.m., for Washington, DC; Maryland; and western and central Virginia.

Partner and Customer Coordination and Response

The effectiveness of the weather warning system is dependent on close coordination, cooperation, and a clear consistent message among the various agencies responsible for public safety. This includes the NWS, the media, and state and local governments. Customers said they were satisfied with the warning, forecast, and other services provided before, during, and after the event.

Emergency Management

There is excellent communication between WFO Baltimore/Washington and state and local emergency management. When asked, Charles County Emergency Management Director, Don McGuire, stated, *“We have a very good working relationship with the Baltimore/Washington NWS office. We routinely call the office for weather updates.”* This sentiment was echoed by Calvert County Emergency Management Director, Don Hall. A review of the past 2 years of emergency management contacts show numerous meetings where issues were discussed.

Mr. McGuire said he was very pleased with the speed at which the WFO Baltimore/Washington conducted the preliminary investigation the day immediately after the storm. By mid-week, the potential for more severe weather threatened recovery and cleanup operations. The NWS provided frequent and timely weather briefings to the Emergency Operations Center throughout the afternoon of Thursday, May 2. The Charles County emergency management director was very grateful for the additional weather support by the NWS.

Media

Overall, the Washington, DC, area television weathercasters complimented the WFO Baltimore/Washington on the quality of service. None of the TV weathercasters mentioned problems receiving the warnings and forecasts from the Baltimore/Washington WFO. For example, Tony Pann, weekend meteorologist at the CBS affiliate WUSA-TV (Channel 9), said the services and products from WFO Baltimore/Washington during the April 28 tornado event were *“outstanding, excellent, timely, and the duration of the warnings was very good.”* Topper Shutt, chief meteorologist at the station said, *“[WFO] Sterling could have been a little ahead of the game with the Charles County tornado warning, but I am very happy with their services during this event.”*

Doug Hill, the chief meteorologist at the ABC affiliate WJLA-TV (Channel 7), said, *“Jim Travers runs a great shop.”* However, he added the NWS should look into installing a separate telephone line only for local TV weathercasters to access a forecaster. The Baltimore/Washington WFO, as do many forecast offices, has a media line. During major events like this, these phone lines are in heavy use and often busy. Based on the collective expertise and experience of the assessment team, it concluded additional phone lines will not improve this situation.

Two local radio stations noted they did not receive EAS activation notification. Dave Garner, WTOP radio, Washington, DC, said, *“...not receiving the alert [EAS codes] from Sterling was unusual. Usually we receive more than we need, an overload.”* WTOP radio monitors the Manassas, Virginia, NOAA Weather Radio (NWR) transmitter and is the state EAS relay point for the Washington, DC, metropolitan area. Mike Friedman, WJFK radio, echoed Mr. Garner’s comments noting flood products from the WFO were received during the morning, but no watches or warnings were received during the afternoon. More detail on this subject is contained in the “Dissemination” section.

Radio station WSMD in Mechanicsville, Maryland, serves the southern Maryland listening area. The station was off the air during the time the tornado warning was issued due to a power failure. When power was restored, the station received the warning from a TV station and rebroadcast it. Station spokeswoman, Heather Kincaid, said she was pleased with WFO Baltimore/Washington's services during the event.

News articles generally discussed the tornado watch and warnings being issued well in advance and being widely received. An April 29, 2002, Washington Post article stated, "*despite tornado alerts that the NWS began issuing, many people said they had known nothing about the impending danger.*" An April 29, 2002, New York Times article quoted Charles County spokeswoman, Nina W. Voehl, "*the National Weather Service issued a tornado warning (watch) [sic] four hours before La Plata was hit. But residents said they became aware of one only when they saw the tornado and heard it.*" This was confirmed in interviews where most people said they were not paying close attention to the media on a Sunday afternoon.

Public

La Plata area residents interviewed by the assessment team knew severe weather was possible that afternoon. Most heard watches over The Weather Channel and local TV or radio stations. When warnings were issued, some mentioned local TV stations' crawlers only contained information pertaining to the type of warning and county affected. One Calvert County resident whose home was just missed by the tornado said, "*I saw the tornado warning on Channel 9, then I didn't see a thing outside because I ran to my basement!*"

Even though a tornado watch was issued well in advance and a severe thunderstorm warning was in effect 11 minutes before the tornado touched down, people not tuned to a media source did not believe there was a threat. Most of these people took action based on seeing the tornado or being told by neighbors. Many La Plata residents did follow the correct safety procedures by taking shelter from the tornado.

Dissemination

Weather warnings are disseminated by various voice and text methods. The NWS broadcasts over NWR, National Warning System (NAWAS), telephone, and amateur radio networks. Text dissemination methods include NOAA Weather Wire Service, Family of Services, Internet, and Emergency Management Weather Information Network.

Emergency Alert System

There was a problem with the EAS activation process. EAS is a Federal Communications Commission (FCC) program for TV and radio stations to relay emergency alerts, including tornado watches and warnings, to the public. EAS receivers are certified by the FCC. NWS activates EAS with text messages through government and private vendors' dissemination systems and audio messages through NWR. TV stations broadcasting in the La Plata listening area had no problem receiving severe weather warning information during this event. Radio stations use NWR which activates EAS when warnings containing digital Specific Area Message Encoding (SAME) are broadcast. Problems with EAS activation were limited to radio stations.

Radio station WTOP in Washington, DC, is the Local Primary 1 (LP1) EAS station. It distributes information to, and is monitored by, 25 radio stations throughout the Washington, DC, region. Radio station WJFK in Manassas, Virginia, is the Local Primary 2 (LP2) EAS station and serves as a backup to WTOP. Other stations voluntarily monitor NWR as an additional backup to WTOP/WJFK. Team members interviewed the chief engineer at WTOP. He stated the radio station did not receive the NWR SAME alerts for tornado watches and warnings issued on Sunday, April 28, and the EAS was not activated for the La Plata tornado. The WTOP engineer also said, *"We received flash flood watches earlier in the day but did not receive any watches or warnings during the afternoon."* Fifty-three percent of radio stations broadcasting into the La Plata listening area experienced similar problems.

Frank Lucia (a retired FCC employee and EAS expert) and team members contacted 16 radio stations whose broadcast areas include La Plata. Of the 16, 7 radio stations received all watches and warnings broadcast via NWR on April 28. The 9 stations that did not, all use FCC-certified equipment manufactured by the same company. Eight of these radio stations received watch and warning information from alternate sources and rebroadcast it to the public.

A test was conducted using the identical NWR SAME location codes as were used on April 28. The 9 receivers failed again. In discussions with the company, Mr. Lucia learned when more than 28 NWR SAME location codes are transmitted to a receiver manufactured in 1996/1997, and the station's NWR is plugged into Channel 3 or higher, the system fails. The only WFOs in the NWS that transmit more than 28 NWR SAME location codes on a single transmitter are WFOs Baltimore/Washington and Blacksburg, Virginia. The receiver manufacturer and the radio stations are working to rectify the problem. **(Finding 5)**

NOAA Weather Radio

NWR is the NWS's direct method of disseminating weather warnings to the public. Several NWS employees received warnings through NWR. However, there is limited knowledge of NWR among La Plata area residents.

- There was no NWR receiver in the Charles County Sheriff's office which is the 9-1-1 Operations Center and contact point for the NWS.
- One law enforcement officer mentioned when he sees a warning on TV, he usually tunes to the main radio station in the area, WSMD. However, the station lost power and was off the air. This same officer was asked if he owned an NWR receiver. He did not know about NWR but when it was described to him, he said, *"No, but I'm going to get one now!"*
- Of the 40 residents interviewed, only one Charles County resident knew about NWR but heard the warning from a TV station.

WFO Baltimore/Washington has conducted numerous NWR outreach activities. In June 2002, Maryland Gov. Parris N. Glendening distributed NWR receivers to all schools in Maryland. This project began well before the La Plata tornado.

NAWAS

NAWAS is a FEMA communications "hotline" used by NWS and state and local emergency management to communicate critical weather information. Maryland's county emergency management community relies heavily on the NAWAS circuit for the exchange of severe weather information between individual counties and the NWS. Maryland is one of the few states with an NAWAS drop in each of its counties. However, Charles and Calvert Counties are unable to monitor the exchange of severe weather information between Virginia and the NWS.

The Charles County emergency management director stated he needs more advance notice and would like a "heads up" when severe weather is over Virginia and before warnings are issued for southern Maryland. The assessment team found the WFO communicated directly with Charles County several times before and during the event. This included notification of the tornado watch and the severe thunderstorm and tornado warnings, as well as a "heads-up" call indicating the potential for tornadic storms about 40 minutes before tornado touchdown. **(Finding 6)**

Facts

Introduction

FACT: On Sunday evening, April 28, 2002, a violent F4 tornado carved a 64-mile path across southeast Maryland.

FACT: The assessment team learned NWS customers and partners were satisfied with the information received before and during the La Plata tornado.

Overview

FACT: Destruction in a one-square-block area on the east side of La Plata was most severe and rated F4.

Warning and Forecast Services

WFO Baltimore/Washington

Before the Event

FACT: The Baltimore/Washington WFO preplanning was excellent.

During the Event

FACT: Without a confirmed tornado report, and believing the supercell's tornadic potential was decreasing, the warning forecasters issued a severe thunderstorm warning for Charles and Calvert Counties at 6:45 pm.

FACT: At 7:02 p.m., 6 minutes after the tornado touched down, the tornado warning was issued for Charles and Calvert Counties.

After the Event/Damage Assessment

FACT: Baltimore/Washington WFO personnel rated the worst damage F5.

WFO Performance

FACT: The assessment team focused on why the warning forecasters decided to issue a severe thunderstorm warning rather than a tornado warning for Charles County and La Plata and identified four factors: warning forecasters did not receive a confirmed report of a tornado; radar indications of a weakening supercell; lack of a continuous weather watch on the supercell; and concern over false alarms.

Partner and Customer Coordination and Response

Emergency Management

FACT: Charles County Emergency Management Director, Don McGuire, stated, *“We have a very good working relationship with the Baltimore/Washington NWS office. We routinely call the office for weather updates.”*

Media

FACT: Topper Shutt, chief meteorologist at the station said, *“[WFO] Sterling could have been a little ahead of the game with the Charles County tornado warning, but I am very happy with their services during this event.”*

Dissemination

Emergency Alert System

FACT: There was a problem with the EAS activation process. Fifty-three percent of the radio stations broadcasting into the La Plata listening area experienced problems.

Findings and Recommendations

Warning and Forecast Services

WFO Baltimore/Washington

After the Event/Damage Assessment

Finding 1: The WFO first rated the tornado an F4, but later raised the assessment to F5. This information was disseminated to the public and media without a “preliminary” indicator. Current policy states “preliminary” should be used whenever a service assessment is possible.

Recommendation 1a: The Office of Climate, Water, and Weather Services (OCWWS) should create a national Quick Response Team (QRT) to determine the final rating for all tornadoes suspected to be F4 or F5.

Recommendation 1b: OCWWS should modify appropriate directives and require WFOs to use “potentially greater than F3” whenever tornado damage of F4 or F5 intensity is suspected and until the QRT makes its final determination.

Finding 2: WFO personnel who are trained in damage assessment receive it only once. In addition, violent F4 and F5 tornadoes are extremely rare, and there are few opportunities to view storm damage of this magnitude.

Recommendation 2: OCWWS should provide WFOs with a standardized damage assessment guide.

Finding 3: The assessment team learned building damage surveys were being done by the Federal Emergency Management Agency’s (FEMA) Building Performance Assessment Team (BPAT) and Wind Engineering Research Council (WERC) at the same time the NWS was conducting their damage survey.

Recommendation 3: OCWWS should work to establish Memoranda of Understanding with FEMA and WERC to create a notification process when assessment teams are deployed.

WFO Performance

Finding 4: Warning forecasters decided to issue a severe thunderstorm warning rather than a tornado warning for Charles County and La Plata because: warning forecasters did not receive a confirmed report of a tornado; radar indications of a weakening supercell; lack of a continuous weather watch on the supercell; and concern over false alarms.

Recommendation 4a: OCWWS, in cooperation with Regional Scientific Services Divisions, should summarize practices for severe weather operations contained in the WDM Workshop and in service assessment/regional best practices, and provide material to all WFOs. Internal office communication, radar analysis, sectoring of warning operations, and performance principles should be included.

Recommendation 4b: Regions should ensure WFOs review the severe weather operations summary material through station drills and a demonstration of proficiency prior to each severe weather season.

Dissemination

Emergency Alert System

Finding 5: The 9 radio stations that did not receive NWR SAME messages all have FCC-certified EAS equipment manufactured by the same company. The receiver manufacturer and the radio stations are working to rectify the problem.

Recommendation: 5: OCWWS should monitor actions by the receiver company.

NAWAS

Finding 6: The Charles County emergency management director stated he needs more advance notice and would like a “heads up” when severe weather is over Virginia and before warnings are issued for southern Maryland.

Recommendation 6: WFO Baltimore/Washington and the Charles County emergency management director should make mutually acceptable modifications to the communication process to ensure “heads up” when severe weather is over Virginia.

Best Practices

1. Preplanning

Awareness of the potential for severe weather prior to the onset of this event was extremely high. Planning began Saturday afternoon, April 27, the day before the tornado. People scheduled on the Sunday, April 28, evening shift were prepared to come in early should severe weather develop. The NCF was notified at 8:30 a.m., Sunday morning, April 28, to put the Baltimore/Washington WFO in a critical weather watch for AWIPS. Two additional forecasters arrived by 2 p.m. and an additional HMT by 4 p.m. A short meeting was held at 3 p.m., Sunday, April 28, to determine staff responsibilities. The WFO Baltimore/Washington was well staffed with eight people for this event, including the MIC, WCM, SOO, three lead forecasters, and two HMTs.

2. Public Affairs Assistance

After the tornado event on Sunday, April 28, Jim Travers, MIC, WFO Baltimore/Washington, called the NWS Public Affairs director to request support Monday morning, April 29, to handle the anticipated barrage of media calls. A Public Affairs officer was present at WFO Baltimore/Washington all day, Monday, April 29, and most of the next day. NOAA praised NWS Public Affairs staff for preparing news stories and updates after the event. As a result, the national media received the latest information directly from the official source.

3. Additional Weather Support

The Charles County emergency management director stated he was very pleased with the speed at which the Baltimore/Washington WFO conducted the preliminary investigation the day immediately after the storm. By mid-week, the potential for severe weather threatened recovery and cleanup operations. The NWS provided frequent and timely weather briefings to the Emergency Operations Center throughout the afternoon of Thursday, May 2. The Charles County emergency management director was very grateful for the additional weather support by the NWS.

Appendix A

Fujita Tornado Intensity Scale²

The Fujita Tornado Intensity Scale is a scale of wind damage intensity which wind *speeds* are inferred from an analysis of wind *damage*.

<u>Category</u>	<u>Definition and Effect</u>
F0	<u>Gale tornado (40-72 mph): Light damage.</u> Some damage to chimneys; break branches off trees; push over shallow-rooted trees; damage sign boards.
F1	<u>Moderate tornado (73-112 mph): Moderate damage.</u> The lower limit is the beginning of hurricane wind speed; peel surface off roofs; mobile home pushed off foundations or overturned; moving autos pushed off the roads.
F2	<u>Significant tornado (113-157 mph): Considerable damage.</u> Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated.
F3	<u>Severe tornado (158-206 mph): Severe damage.</u> Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off ground and thrown.
F4	<u>Devastating tornado (207-260 mph): Devastating damage.</u> Well-constructed houses leveled; structure with weak foundation blown off some distance; cars thrown and large missiles generated.
F5	<u>Incredible tornado (261-318 mph): Incredible damage.</u> Strong frame houses lifted off foundations and carried considerable distance to disintegrate; automobile-sized missiles fly through the air in excess of 100 yards; trees debarked; steel-reinforced structures badly damaged; incredible phenomena will occur.

² From *J. Atmos. Sci.*, August 1981, p. 1517-1519.

Appendix B

Maryland Tornado Fatalities

Charles County, Maryland

<i>Date</i>	<i>Cause</i>	<i>Age</i>	<i>Gender</i>	<i>Circumstances</i>
04/28/02	Tornado	51	Male	Permanent Home

Calvert County, Maryland

<i>Date</i>	<i>Cause</i>	<i>Age</i>	<i>Gender</i>	<i>Circumstances</i>
04/28/02	Tornado	68	Male	Permanent Home
04/28/02	Tornado	65	Female	Permanent Home

Appendix C

Maryland Tornado Outbreak of April 28, 2002

WFO Baltimore/Washington Chronological Product Highlights

Note: Format of following paragraphs will be as follows:
Valid time (EDT) Product issued or Severe Report Area/Counties Affected
Remarks

Valid Time (EDT)	Product Issued/ Severe Report	Area/Counties Affected
FRIDAY		
1445 4/26/02	AFD	Entire LWX CWA
<i>Thunderstorms possible during daylight hours Sunday.</i>		
SATURDAY		
0242 4/27/02	AFD	WFO LWX CWA
<i>Late day thunderstorms and rain showers reasonable Sunday.</i>		
0333	SWODY2	All of Maryland and Northern and Western Virginia
<i>Slight risk of severe weather on Day 2 (28 0800 EDT to 29 0800 EDT).</i>		
0525	OPU (Hazardous Weather Outlook)	WFO LWX CWA
<i>Scattered thunderstorms possible late in the day Sunday. Some of these may be on the strong side...with gusty winds the primary threat.</i>		
1025	AFD	Entire LWX CWA
<i>Late day thunderstorms and rain showers reasonable Sunday.</i>		

1030 OPU (Hazardous Weather Outlook) WFO LWX CWA
Scattered thunderstorms possible late in the day Sunday. Some of these may be on the strong side...with gusty winds the primary threat.

1255 SWODY2 All of Maryland and Northern and Western Virginia
Slight risk of severe weather on Day 2 (28th 0800 EDT to 29th 0800 EDT).

1500 AFD WFO LWX CWA
Looks good tomorrow (Sunday) for some strong to severe storms during mid afternoon to early evening. Main threat, damaging winds.

1530 ZFP WFO LWX CWA
"Some thunderstorms may contain strong gusty winds."

2053 ZFP WFO LWX CWA
"Some thunderstorms may contain strong gusty winds."

2135 AFD WFO LWX CWA
"Mid-Atlantic is outlooked slight risk of severe...thunderstorms with strong winds look to be main threat."

SUNDAY

0156 SWODY1 All of Maryland and most of Northern and Western Virginia
Moderate risk of severe weather on Day 1 (28th 0800 EDT to 29th 0800 EDT).

0248 4/28/02 AFD WFO LWX CWA
"Best chance for thunderstorms here will be this afternoon. Strong winds will be the primary threat."

0320 OPU (Hazardous Weather Outlook) WFO LWX CWA
Headline "...POSSIBLE SEVERE THUNDERSTORMS TODAY..." Primary threat will be strong and potentially damaging winds. The peak time of the threat will be this afternoon.

0406 ZFP
Forecast mentions scattered showers and thunderstorms, with some thunderstorms containing strong gusty winds.

0412 SPS (Severe Weather Outlook) WFO LWX CWA
Headline "...POSSIBLE SEVERE THUNDERSTORMS TODAY..." Primary threat strong and potentially damaging winds. The peak time of threat will be this afternoon.

1315 Conference call

Conference call between SPC, LWX and surrounding offices to coordinate tornado watch #168. LWX counties not included in Tornado watch as was coordinated with LWX SOO and SPC forecaster.

1321 SPCSEL8

Tornado watch #168 issued for most of West Virginia and Western Maryland panhandle. Valid until 1700 EDT.

1442 NOW Portions of West Virginia and Maryland

“Thunderstorms with wind gusts in excess of 35 mph, heavy rain, and small hail.”

1500 AFD WFO LWX CWA

“Main focus this afternoon and early evening is potential for severe weather.” Also states, “Severe weather parameters indicating potential for tornado threat this afternoon.”

1500

Conference call between SPC, LWX and surrounding offices to coordinate tornado watch #172. Tornado watch includes parts of northern Virginia and most of Maryland.

1505 SPCSEL2

Tornado watch #172 issued for most of western Virginia and most of Maryland. Valid until 2100 EDT. “Tornadoes...hail to 2 inches in diameter...thunderstorm wind gusts to 70 mph...and dangerous lightning are possible in these areas.”

1529 SLS Portions of Virginia and Maryland

Redefining Statement for Tornado Watch Number 172.

1535 NOW Portions of West Virginia

Headlined “...Tornado Watch in Effect until 9 PM...” Also states “Thunderstorms with heavy rain, small hail, and wind gusts to 40 mph.”

1545 ZFP WFO LWX CWA

States “some storms may contain damaging winds and large hail.”

1603 SWODY1 Western half of Maryland and most of northern and western Virginia

Moderate risk area for severe weather.

1603 SVR Grant and Hardy Counties in eastern West Virginia

“Radar indicated a severe thunderstorm with a history of producing nickel-sized hail.” Also, “Severe thunderstorms can produce tornadoes with little or no advance warning.”

1616 SVS Grant and Hardy Counties

Headlined "...Severe thunderstorm warning continues...." Also includes "Remember...severe thunderstorms can and occasionally do produce tornadoes with little or no warning."

1637 TOR Shenandoah and Northern Rockingham Counties in Virginia

First tornado warning of the event issued. "RADAR indicated a tornado."

1647 SVS Northern Rockingham and Shenandoah Counties

Headlined "...Tornado warning continues...."

1658 SVR Page, Rappahannock, and Shenandoah Counties in Northwest Virginia

"Radar indicated a severe thunderstorm. Severe thunderstorms can and occasionally do produce tornadoes."

1715 NOWLWX Portions of Virginia and Maryland

Headlined "...Tornado Watch in Effect until 9 PM...." Also, "Thunderstorms with wind gusts to 45 mph and small hail."

1717 SVR Grant, Hardy Counties in eastern West Virginia

"Radar indicated a severe thunderstorm." Also, "Severe thunderstorms can and occasionally do produce tornadoes."

1723 SVS Shenandoah, Page, and Rappahannock Counties

Headlined "...Severe thunderstorm warning continues...." Also "Severe thunderstorms can produce tornadoes with little or no advance warning."

1737 SVS Grant and Hardy Counties

Headlined "...Severe thunderstorm warning continues...." Also "Severe thunderstorms can produce tornadoes with little or no advance warning."

1743 LSR

Reports of wind damage and 0.75 inch hail.

1748 TOR Northern Culpeper, Fauquier, and eastern Rappahannock Counties in Virginia

"RADAR indicated a tornado."

1748 LSR

Reports of tornado damage in Shenandoah County, Virginia, at 1645.

1755

Conference call between SPC, LWX, and surrounding offices to coordinate tornado watch #177. Tornado watch includes eastern portions of Virginia and portions of southern Maryland.

1757 SPCSEL7

Eastern Virginia and portions of Southern Maryland

Tornado watch #177. Valid from until 2200 EDT. States "Tornadoes...hail to 2 inches in diameter...thunderstorm wind gusts to 70 mph...and dangerous lightning are possible in these areas."

1802 SMW

Tidal Potomac from Key Bridge to Indian Head Maryland

"Mariners can expect wind gusts over 35 kt...large hail...locally high waves...dangerous lightning...and heavy downpours."

1806 MWS

Tidal Potomac from Key Bridge to Indian Head Maryland

Headlined "...Special Marine Warning..." and "...Tornado Watch in effect until 9 PM for entire tidal Potomac and Maryland portion of Chesapeake Bay...."

1810 SPS

Headlined "...Severe thunderstorm warning for Hardy County expired..." and "...Tornado watch remains in effect until 900 pm...."

1810 SLS

Portions of Maryland

Note: See 1830L issuance for additional VA locations. Redefining Statement for Tornado Watch Number 177

1810-1820

Forecaster called Charles County, MD, 911 center and briefs them that a severe thunderstorm in Virginia is headed their way.

1812 TOR

City of Manassas, southern Fairfax, eastern Fauquier, and Prince William Counties in Virginia

"RADAR indicated a tornado."

1825 SVS

Fauquier County

Headlines state "...Tornado warning for Fauquier County has been cancelled..." and "...A tornado warning continues for Manassas...Southern Fairfax County and Prince William County in Northern Virginia until 645 pm...."

- 1830** **SLS** **Portions of Virginia and Maryland**
Redefining Statement for Tornado Watch Number 177.
- 1845** **SVR** **Extreme southern Anne Arundel, Prince George's, Calvert and northern Charles Counties in Maryland and southern Fairfax and eastern Prince William Counties in Virginia**
"Radar indicated a severe thunderstorm." Also, "Severe thunderstorms can produce tornadoes with little or no advance warning."
- 1853** **LSR**
Reports of additional wind damage and 1.75 inch hail.
- 1858** **SVR** **Northern Anne Arundel, Howard, and eastern Montgomery Counties in Maryland**
"Radar indicated a severe thunderstorm." Also, "Severe thunderstorms can produce tornadoes with little or no advance warning."
- 1858** **LSR**
Reports of additional 1.75 inch hail.
- 1900-1903**
Forecaster calls Charles County, MD, 911 center and warns them of a tornado. The forecaster received immediate feedback from 911 operator of a tornado in La Plata at the time.
- 1902** **TOR** **Southern Prince George's, Calvert, Charles, extreme northern St. Mary's Counties in Maryland**
"RADAR indicated a tornado."
- 1905** **SMW** **Chesapeake Bay**
"Tornado reported in La Plata." Also states "Storms will move into Chesapeake Bay between 7:30 and 8 pm."
- 1911** **SVS** **Prince William, Fairfax, Anne Arundel, Charles, Prince George's, Calvert, St. Mary's Counties**
Headlines, "...Severe thunderstorm warning cancelled for..." and "...Tornado warning continues for..." as well as "...A tornado watch continues..." Also stated later in the product is "At 702 pm...emergency officials reported a tornado on the ground over La Plata in Charles County moving east. This is a dangerous storm. Seek shelter immediately!"

1912 LSR

Additional reports of tornado and 1.75 inch hail in La Plata at 1903.

1924 SVS

**Prince George's, Calvert, Charles,
St. Mary's Counties**

Headlined "...TORNADO WARNING CONTINUES UNTIL..." and "...A TORNADO WATCH CONTINUES..." Also stated later in the product is "At 715 pm...emergency officials reported a tornado on the ground at Route 6...the tornado has caused extensive damage in La Plata. This is an extremely dangerous storm! Seek shelter immediately if you are in the path of this storm."

1925 LSR

Additional tornado information. 1 dead, several structures demolished in La Plata at 1910.

1933 SVS

**Anne Arundel, Howard, Montgomery
Counties**

Headlined "...Severe thunderstorm warning has been cancelled..."

1944 TOR

Calvert County, Maryland

"RADAR indicated a tornado."

1954 SVS

Calvert County

"...Tornado warning has been cancelled..."

2042 LSR

Reports of funnel cloud sighted near Key Bridge. Tornado reported at Bowens in Calvert County at 1940. House collapse, numerous houses damaged.

2115 NOW

Portions of Maryland

"Heavy rain, small hail, and wind gusts in excess of 35 mph."

2155 LSR

"Tornado reported at Benedict in Calvert County at 1940. 1 dead."