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OFCM

OFFICE OF THE FEDERAL COORDINATOR FOR
METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

NATIONAL POST-STORM DATA ACQUISITION PLAN

FCM-P33-2003

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CHANGE AND REVIEW LOG

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FOREWORD

This publication is the 1st edition of the National Post-Storm Data Acquisition Plan (NPSDAP). It is a compilation of procedures and agreements reached through efforts of the Working Group for Natural Disaster Reduction and Post-Storm Data Acquisition (WG/NDR/PSDA). The WG/NDR/PSDA brings together the cognizant federal agencies on items of mutual interest and concern related to the acquisition and preservation of perishable environmental data following a significant storm, flood, tornado, or tsunami event.

The NPSDAP describes the mechanisms and procedures for coordinating the environmental data acquisition activities of participating federal agencies following a significant event. The intent of the NPSDAP is to provide a description of the types of data required or desired by the participating agencies and the means used to coordinate the various data acquisition activities. It is not the goal of the NPSDAP to prescribe the data acquisition activities of participating agencies, but instead to coordinate those agency activities already required by existing mission directives. The procedures outlined herein will no doubt be revised and refined as experience is gained in their application.

The effectiveness of the NPSDAP begins with the participation and dedication of the agency representatives assigned as members of the WG/NDR/PSDA. It is their willingness to accept personal responsibility to be available at what are typically stressful and inconvenient times and function as the primary liaison for their agency that permits that agency to perform its task most efficiently.

Samuel P. Williamson
Federal Coordinator for Meteorological
Services and Supporting Research

EXECUTIVE SUMMARY

The impetus for development of a national plan to coordinate the acquisition of post-storm data stemmed from a recognition by elements of several federal agencies that they were performing complementary and, in some cases, duplicate tasks while acquiring environmental data following significant storm events. These agencies desired to improve and leverage use of their individual resources by a collective response to the data acquisition task.

A series of informal meetings were held where the data acquisition capabilities and requirements of the interested agencies were identified, and a number of recommendations resulted. The National Post-Storm Data Acquisition Plan (NPSDAP) addresses one of the principal recommendations which was to document the types of data required, the acquisition processes, and the coordinating procedures to be used following a significant storm event. The Plan serves as a framework for the coordination of data acquisition activities of the participating agencies during a significant event, and the documentation and deposition of data and products following the event. Funding for the activities of the participating agencies is provided primarily by the individual agency's parent organization.

Environmental events addressed in the NPSDAP include landfalling tropical cyclones (hurricanes/typhoons and tropical storms), coastal extratropical storms (Nor'easters), severe convective outbreaks (tornadoes and windstorms), riverine and flash flooding, and tsunamis (tidal waves). The plan includes data requirements and acquisition capabilities of the participating agencies, event response initiation criteria, coordination procedures, agency points of contact, and data deposition procedures. An agency response to a particular event is the responsibility of the individual agency according to its mission requirements, data needs, and available resources.

The NPSDAP is a dynamic document. The contributors to its development anticipate and expect that the NPSDAP will be modified over time to reflect changes in the missions and resources of the interested agencies, the addition of types of hazards included in the plan, and the effects of evolving technologies.

As the body of data acquired by the participating agencies and associated event documentation grows, preparation of event and actuarial statistics becomes feasible. The responsibility and methodology for preparation of these statistics could become elements of future versions of the NPSDAP. Such statistics should prove useful to private sector institutions, such as the insurance industry, as well as other federal agencies.

NATIONAL POST-STORM DATA ACQUISITION PLAN

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CHAPTER 1

INTRODUCTION AND BACKGROUND

1.1 General. The impetus for the development of a national plan to coordinate the activities of federal agencies involved in post-event data acquisition grew from a charge by the president of the Coastal Engineering Research Board, United States (U.S.) Army Corps of Engineers (USACE), following the ad hoc coordination by several federal agencies in the aftermath of Hurricane Hugo of September 1989. The charge directed that means be explored and, if feasible, a plan be prepared and implemented that would establish procedures for coordinating the activities of federal agencies involved in post-storm data acquisition. In March 1992, the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM)'s Interdepartmental Committee for Meteorological Services and Supporting Research approved the formation of the Working Group for Post-Storm Data Acquisition, more recently renamed the Working Group for Natural Disaster Reduction and Post-Storm Data Acquisition (WG/NDR/PSDA). The first meeting of the working group was held in September 1992.

The motivation for development of a national plan was threefold. The first was to minimize or eliminate the duplication of effort by agencies performing post-event data acquisition. The minimization or elimination of duplicate efforts is directed toward best using the limited resources available to perform these surveys. The second was to assure these highly perishable data are indeed collected. It is generally acknowledged that the acquisition of these data is urgent; that the physical effects which depict the event are transient and can begin to change or be obliterated immediately after the event. The third was to define the coordination procedures of the agencies participating in the acquisition of post-storm environmental data.

1.2 Scope. The procedures outlined herein apply to the conterminous 48 states, Alaska, Hawaii, the Commonwealth of Puerto Rico, and the Virgin Islands, Guam, American Somoa, and the Confederation of Northern Marianna Islands. This plan defines the roles and coordinating procedures of the agencies participating in the acquisition of post-storm environmental data. When only a single agency is involved in a post-storm response, that agency should follow procedures specified in its internal documents, but those practices should be consistent with those contained herein to the extent possible. It is recognized that many federal missions are undertaken in the overall response and recovery process that follows a significant storm event. The intent of this plan is to address an important, though limited, aspect of this response process.

1.3 Examples of Past Responses.

1.3.1 Hurricane Hugo. Hurricane Hugo made landfall on the United States mainland near Charleston, South Carolina, late on 21 September 1989. The U. S. Geological Survey (USGS) District Chief approached the USACE to cooperate in an aerial photoreconnaissance effort of the affected reach of shoreline. The National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) performed an extensive review of its operations during the event. An informal agreement was reached whereby the USGS would assume responsibility for leveling water marks identified by both USACE and USGS field teams, and the USACE would assume responsibility for acquiring aerial photo reconnaissance in a format acceptable to both agencies.

Over 350 high-water marks were identified and leveled, and over 250 controlled aerial photos covering approximately 150 miles of coastline (from Little River Inlet to Edisto Island, South Carolina) were surveyed as a result of the ad hoc agreement between USACE and USGS. Subsequent to acquisition of these data, the Federal Emergency Management Agency (FEMA) partially reimbursed the USGS for its efforts. Both USGS and USACE published reports based upon the inundation data and aerial imagery. In an independent effort, the NWS performed an extensive review of its operations during the event and conducted a visual damage survey via aircraft.

1.3.2 Hurricane Andrew. Hurricane Andrew made first landfall on the continental United States near Homestead, Florida, early on the morning of 24 August 1992 and second landfall near Morgan City, Louisiana, on 26 August 1992. Three agencies were active in the Florida post-event survey--USACE, USGS, and the Florida Department of Natural Resources, a state agency.

As in Hugo, FEMA mission-assigned the USGS for the post-storm Andrew efforts. The USACE, primarily through the efforts of the Jacksonville District with assistance from the Waterways Experiment Station, performed extensive surveys of federal projects along the east and southwest coasts of Florida. The Florida Department of Natural Resources acquired low-level videotape imagery of the Florida east coast from Palm Beach to Key Biscayne and also performed some high-water surveys. All agencies published reports on their respective findings.

1.3.3 Goals. The goals of the National Post-Storm Data Acquisition Plan (NPSDAP) expand upon the objectives contained in the Terms of Reference document for the WG/NDR/PSDA and include:

a. identifying the requirements, resources, and capabilities of the participating agencies;

b. developing procedures for coordinating agency activities during and following storm events;

c. developing mechanisms for aggregating and sharing resources among the participating agencies; and

d. preparing summaries of event documentation and data acquired under the NPSDAP.

As experience is gained in responding to events and procedures become more refined and efficient, resources available outside the participating agencies should be identified and arrangements made to access these resources. Examples of such resources include aircraft for transport of personnel and for aerial photo-reconnaissance, expertise residing in academic institutions for field assessment and interpretation of storm effects and damage, and data acquired during scientific field experiments involving the same or similar storm events.

Post-storm data acquired or data products prepared by agencies associated with the working group should commonly be available via links on the OFCM Internet home page.

CHAPTER 2

AUTHORITY AND CAPABILITIES OF PARTICIPATING FEDERAL AGENCIES

2.1 General. The Department of Commerce through the OFCM assumes overall responsibility for the preparation and maintenance of the NPSDAP. The OFCM also assumes overall responsibility for post-event federal agency coordination. The role each agency assumes during the post-event period is determined by the individual agency's authority and mission requirements; see sections 2.2 and 2.3 for additional information on agency authorities and mission requirements. Specific agency authority and mission statements are contained in Appendix A.

2.2 Participating Agencies and Mission Requirements. The following federal departments are participants in the coordination plan, to include the individual agenices within the departments:

- Department of Defense (DOD) - U.S. Army Corps of Engineers (USACE), U.S. Air Force (USAF), Civil Air Patrol (CAP)-USAF Auxiliary.
- Department of Commerce (DOC) - National Oceanic and Atmospheric Administration (NOAA), National Institute of Standards and Technology (NIST).
- Department of Interior (DOI) - U.S. Geological Survey (USGS).
- Department of Agriculture (USDA) - Natural Resources Conservation Service (NRCS).
- Federal Emergency Management Agency (FEMA).

Mission statements of the participating agencies are founded in explicit directives contained in specific Public Law (e.g., PL 166 - 79th Congress, PL 71 - 84th Congress as applied to the USACE) or interpretation of more broadly worded agency mandates.

The Federal Highway Administration (FHWA) of the Department of Transportation (DOT), though not a current participant in the WG/NDR/PSDA, is expected to become more involved in the future. While they have no requirements to acquire environmental data following significant storm events, they work with state and local DOTs who are building the capabilities to do so. These sites, which monitor the highway system, could eventually be used in the port-storm data acquisition process.

2.3 Agency Capabilities and Data Requirements.

2.3.1 Department of Defense (DOD). The DOD is represented on the working group by elements of the U.S. Army and U.S. Air Force, primarily by the USACE and the Civil Air Patrol -- a civilian auxiliary of the U.S. Air Force. The CAP and the Air Force Reserve Command's 53rd Weather Reconnaissance Squadron (53 WRS) serve principally in a supporting role to the other participating agencies. The USACE has primary responsibility for construction and maintenance

of marine navigation in public waterways and coastal storm protection projects on public lands. The USACE post-event activities are coordinated through the Office, Chief of Engineers, and the Engineer Research and Development Center (ERDC).

a. **Capabilities**. The ERDC, in cooperation with participating USACE district offices, can provide data on nearshore wave conditions, beach profiles, damage assessment to marinas, coastal projects and navigation structures, morphological changes to beaches, and identification of high-water marks. The CAP provides, through a Memorandum of Understanding (between the CAP and the NWS), light aircraft, aircrews, and communications in support of post-storm overflights. The 53 WRS conducts aerial reconnaissance of tropical and extratropical cyclones to provide meteorological data on the geographic position of the storms; central sea-level pressure; vertical profiles of pressure, temperature, dew-point temperature, and wind speed and direction from the surface to flight level; geopotential heights of designated pressure surfaces; and other relevant data.

b. **Requirements**. Because they serve only in a supporting role, the CAP and 53 WRS have no individual requirements for data. The USACE requires environmental data to support the following missions:

- Coastal - shore protection, beach preservation and restoration
- Estuarine - navigation, environmental and water quality monitoring
- Riverine - inland navigation, flooding and streambank erosion control
- Reservoir control - reservoir level monitoring, catchment rate determination

In the broadest sense, any data which contribute to the performance of these missions are of value. Types of data include: tropical and extratropical storm-surge water levels, storm-generated coastal current and morphological changes, estuarine tidal inundation, precipitation-generated estuarine inflow, riverine flooding events, and reservoir overtopping.

2.3.2 Department of Commerce (DOC). Within the DOC, NOAA is the principal meteorological agency of the federal government. By law, NOAA is responsible for reporting the weather of the U.S., providing weather and flood warnings and forecasts to the general public, developing and furnishing applied weather services, and recording the climate of the U.S. This mission is carried out within NOAA by the NWS; the National Environmental Satellite, Data, and Information Service (NESDIS); the Office of Oceanic and Atmospheric Research; the National Ocean Service (NOS); and the NOAA Marine and Aviation Operations (NMAO).

2.3.2.1 National Weather Service (NWS). The NWS consists of a national headquarters in Silver Spring, MD; 6 regional headquarters across the continental U.S., Alaska and the Pacific; 122 weather forecast offices; and 13 river forecast centers which provide basin-specific forecast guidance on riverine and flash flooding. In addition, the agency's National Centers for Environmental Prediction (NCEP) include the following service centers: the Environmental Modeling Center, the Storm Prediction Center (SPC), NCEP Central Operations, the Hydrometeorological Prediction Center, the Ocean Prediction Center, the Tropical Prediction

Center, the Climate Prediction Center, the Aviation Weather Center, and the Space Environment Center. These service centers provide focused expertise and guidance, modeling, and numerical weather prediction for severe local storms, marine weather, tropical weather, climatic trends, aviation weather, and the space environment. This support provides basic information for NWS Weather Forecast Offices and the external community, including other federal agencies and emergency management officials.

Respondents in the event of tornadoes and other severe convective storms, flooding, and other weather-related natural disasters, represent all strata of the NWS, depending on the type of event. Warning Coordination Meteorologists (WCM) at each of the 122 weather forecast offices are the initial respondents to all major weather events, documenting apparent damage and causal effects as well as commentary from witnesses.

For all tornadoes suspected of producing greater than F3 damage, a special Quick Response Team (QRT) will be dispatched by the NWS. Internal NWS QRT operational procedures are included in Appendix B. The NWS QRT will enlist recognized wind damage expert(s) to determine the final F-Scale rating for these events. These experts include, but are not limited to: member(s) of the American Association for Wind Engineering (AAWE); other NWS personnel; members of the academic community; and, other private sector wind damage experts. These experts possess expertise in the areas of wind and associated wind-driven water loads on buildings and structures, societal impact of winds, hurricane and tornado risk assessment, cost-benefit analysis, codes and standards, dispersion of urban and industrial pollution, wind energy, urban aerodynamics, etc.

NWS will notify OFCM via phone if they plan to deploy a QRT following a significant wind event. OFCM will then notify via phone all appropriate agencies of the NPSDAP about the NWS QRT deployment, including AAWE. This notification should be followed up with coordination among all agencies of the NPSDAP, and with AAWE.

a. **Capabilities**. The NWS provides a continuous weather watch throughout the Americas and the Pacific, with lesser amounts of data collected globally. Data are gathered via remote sensing (satellite, radar, vertical sounders, and automatic surface observing systems) as well as manually (surface observations). Observational and computational information are processed through numerical weather prediction and river forecast computer models which are available to a wide variety of users globally.

b. **Requirements**. The NWS data requirements include obtaining all available records that define the impact, extent, timing, and intensity of significant natural hazard episodes such as floods, tropical cyclones, extratropical cyclones, tornadoes and other severe convective events, katabatic winds, and tsunamis.

2.3.2.2 National Institute of Standards and Technology (NIST). The mission of the Building and Fire Research Laboratory of NIST is to enhance the competitiveness of US industry

and safety of the public, through performance prediction and measurement technologies and technical advances that improve the life-cycle quality of constructed facilities.

a. **Background**. NIST, through the Structures Division, conducts laboratory, field, and analytical research in structural engineering, including the investigation of important structural failures, the characterization of building loads during construction and during their service life, and structural response analyses. Extreme events, such as hurricanes and tornadoes, are viewed as opportunities to evaluate the performance of structures subjected to wind loads that may approach or exceed the ultimate limit states of the structure. Beginning with Hurricane Camille in 1969, the Structures Division has conducted post-storm assessments on its own, or in collaboration with other federal agencies, universities, and building research centers.

The Structures Division has conducted post-storm investigation following notable events such as Hurricanes Alicia, Andrew, Bob, Camille, Elena, Frederic, and Hugo, as well as the Lubbock tornado outbreak of 1970. In recent years, the Structures Division has maintained an informal working relationship with the Research Division of the Atlantic Oceanographic and Meteorological Laboratory of NOAA to document near-surface wind speeds in hurricanes. The availability of reliable wind-speed estimates is crucial to the correct assessment of structural performance in extreme wind events.

b. **Capabilities**. A well-equipped structural testing laboratory and computer facilities for modeling loads and structural response are maintained by the Structures Division. The division's capabilities for predicting and assessing wind effects on buildings and other structures include computer codes for the simulation of extreme wind speeds in atmospheric boundary layers. The division also maintains special equipment and supplies needed for the rapid deployment of investigative teams following major wind and earthquake disasters, structural collapses, and building fires. NIST will notify OFCM via phone if they plan to deploy an investigative team following significant events. OFCM will then notify via phone all appropriate agencies of the NPSDAP about the NIST deployment. This notification should be followed up with coordination among all the agencies involved with PSDA activities.

The Process Measurement Division of the Chemical Science and Technology Laboratory within NIST maintains wind and water tunnels for fluid mechanics research. Of particular interest is the closed-return, low-speed, low-turbulence wind tunnel facility which serves as the U.S. primary standard for anemometer calibration. Interchangeable test sections allow calibrations at wind speeds of up to 67 m s^{-1} (149.87 mph). State-of-the-art flow visualization techniques, hot-wire anemometry, and laser-Doppler velocimetry are available in this laboratory.

c. **Requirements**. In wind-related disasters, all available records of wind speeds (from both ground stations and aircraft), barometric pressure measurements, and radar images from which to reconstruct the surface wind field are essential. In addition, aerial photographs of sufficient resolution to show damage and debris distribution and extent of storm-surge effects are of considerable value. In the case of damage to major structures, detailed site studies, followed by structural analyses, are performed.

2.3.3 Department of the Interior (DOI). Within DOI, the USGS is the principal Earth science agency responsible for collection, assessment, and dissemination of information, regarding the geology, topography, mineral resources, hydrology, and biology of the U.S. The USGS is a nationally recognized provider of accurate, unbiased water data and information for use by others to design, operate, manage, and regulate water resources, establish floodplain boundaries, issue flood warnings and river forecasts, and manage emergency operations. The Office of Management and Budget Memorandum M-92-01 designates DOI, through the USGS, as the lead agency for the Water Information Coordination Program (WICP) and provides that "all other federal organizations funding, collecting, or using water resources information should assist the USGS in ensuring the implementation of an effective WICP."

a. **Capabilities**. The principal data-collection activity of the USGS Water Resources Division (WRD) is the operation of 7,000 stream-gaging stations in cooperation with other federal, state, and local agencies. These stations are operated by USGS personnel in 48 districts (usually corresponding to state boundaries) in 160 offices dispersed throughout the Nation and strategically located near important rivers and streams. WRD personnel monitor the streams and make on-site measurements of depths, velocities, and flows. WRD personnel frequently make emergency measurements of discharge at the request of NWS forecasters, flood fighters, and emergency management personnel to aid in the management and assessment of the floods.

In addition to stream-gage operations, WRD investigates and documents floods, droughts, and mudflows. Historically, post-storm activities usually are not supported through annual Congressional appropriations but through a 50-50 cost share program between state and local agencies and the USGS, reimbursements from local, state, or federal agencies, and, occasionally, supplemental Congressional appropriations. Since federal fiscal year 2000, some Congressional appropriations have been provided for these activities although not enough to cover costs in a typical year.

Regarding post-storm data acquisition, WRD district (state) offices, in cooperation with other federal, state, and local agencies, can identify, document, and survey high-water marks, make discharge measurements, collect water-quality samples, and make post-storm estimates of peak-flow discharges by use of indirect measurements. The district offices also can furnish records of flood stage, flow, and occasionally rainfall at affected gaging stations and historic records of stage and discharge for comparison to floods of interest.

Through the Coastal and Marine Geology Program, the USGS Geologic Division (GD) investigates the geologic impacts of extreme storms and hurricanes on the physical coastal environment. A major objective of these investigations is to improve the capability to predict coastal erosion and other coastal changes caused by extreme storms. To conduct these investigations, GD personnel employ aerial photography and oceanographic techniques, emerging technologies like airborne scanning laser (e.g., LIDAR), recently available declassified instruments and data, and a USGS network of tide and environmental sensors. State-of-the art research vessels, Global Positioning System (GPS) satellites, and side-scan survey and velocity measurement equipment are used to collect post-storm data.

b. **Requirements.** The operational needs of the USGS during pre- and post-storm activities include access to forecasts, flood reports, and warning statements issued by NWS, and road and access reports issued by emergency management operation centers and law enforcement agencies. Potential data needs from other agencies include aerial photography, field support with small aircraft (fixed wing and helicopter), and analytical model results of storm surge and waves. Photographs of stream-gaging stations and bridge sites would be useful during and immediately after floods at which a survey and computation of discharge could be made after the flood.

2.3.4 Department of Agriculture (USDA). The National Resources Conservation Service (NRCS) provides technical and financial assistance through local conservation districts to land users, communities, watershed groups, federal and state agencies, American Indian tribes, and others at their request. The NRCS staff at the local level works alongside state and local conservation staff and volunteers in a partnership to care for natural resources on private lands. The NRCS develops comprehensive technical guidance for conservation planning and assistance.

The benefits of these activities include sustained and improved agricultural productivity; cleaner, safer, and more dependable water supplies; reduced damages caused by floods and other natural disasters; and an enhanced resource base to support continued economic and recreational project development.

The Rural Development Act of 1972, Public Law 92-419, Sec. 302, Title III (7 USC 1010a), August 30, 1972, authorized a land inventory and monitoring program, including studies and surveys of erosion, sediment damage, flood plain identification, and land-use changes and trends. The NRCS informs the USDA of the extent of short-duration natural phenomena that affect health, safety, and agricultural production. The reports will document impacts on resources of NRCS activities and describe the event in quantitative terms, including amount of precipitation and surface-wind speeds.

The Watershed Protection and Flood Prevention Act (PL 83-566, Statute 606) authorizes the Secretary of Agriculture to cooperate with state and local governments in planning and conducting improvements for soil conservation and other purposes. The NRCS can prepare reports on the impact of serious storms on the installed project measures.

2.3.5 Federal Emergency Management Agency (FEMA). FEMA is the federal coordinating agency that responds to major disasters or threats in the United States and its territories. FEMA provides response and recovery and hazard mitigation assistance, emergency management preparedness training, flood insurance, and funding for related studies and services. Headquartered in Washington, DC, FEMA has 10 regional offices, with field offices and special facilities located nationwide.

a. **Capabilities**. When a Presidentially declared disaster occurs, one or more Disaster Recovery Centers are established to coordinate federal disaster assistance for response and assistance. FEMA also employs a large contingent of temporary disaster assistance workers when necessary in addition to its authorized permanent staff. FEMA is organized along emergency

management functions and administers the Federal Insurance Administration and U.S. Fire Administration. Within FEMA's Mitigation Directorate, Flood Insurance Studies for the National Flood Insurance Program and Hurricane Evacuation Studies for the National Hurricane Program are prepared. FEMA's web-site address is www.fema.gov where the latest organization chart and articles on FEMA and Presidentially declared disasters may be viewed.

In addition, FEMA's Program Assessment and Outreach Division Federal Insurance and Mitigation Administration may elect to deploy a Building Performance Assessment Team (BPAT) following a disaster. The objectives of the BPAT are to inspect buildings and infrastructure, conduct forensic enginnering analyses to determine causes of structural failure and success, and recommend actions that state and local governments, the construction industry, and building code organizations can take to reduce future damages and protect lives and property in hazard areas. FEMA BPAT will notify OFCM via phone if they plan to deploy a field team following a disaster. OFCM will then notify via phone all appropriate agencies of the NPSDAP about the FEMA BPAT deployment. This notification should be followed up with coordination among all the agencies involved with PSDA activities.

b. **Requirements**. Perishable storm data are needed to support FEMA's mission. Data include principally high-water marks in riverine and coastal-flooded areas in addition to perishable wind-waterline data. The data are typically obtained by field survey teams within a few days or a week after the flooding event has occurred because high-water marks are quickly destroyed by response and recovery efforts. Along with FEMA, personnel from the NWS, USACE, USGS, NIST, NRCS, as well as private contractors comprise the perishable data collection teams in the field and assist in their analysis. The collected data are used to determine the extent and magnitude of the disaster, assess disaster damages, determine the range of mitigation alternatives, prepare benefit-cost analyses for federal recovery assistance and mitigation measures, and verify prediction models for natural hazards. For disaster response and recovery efforts, reconnaissance data are required during or within 12-24 hours after the event and are obtained by radar, reconnaissance flights, satellites, and water-level gauges that transmit their data.

Analyzed fields of maximum surface wind speeds caused by tornadoes, tropical storms, hurricanes, and winter storms also are required. The information in these fields is typically derived from surface observations and available Doppler radar data. Water-level, wind-speed and wind-waterline data have been used to prepare the Hazard Analysis section in Post-Storm Assessment reports following major hurricanes. Wind-waterline data, that is, the line that distinguishes damages caused by water damage versus wind damage, has immediate application for insurance claims. Water-level and wind-speed information from recent tropical storms and hurricanes have been used by the Storm-Surge Group at the Tropical Prediction Center/National Hurricane Center to verify their hurricane and winter-storm computer simulation and prediction models. These studies are sponsored by FEMA and are primarily used to verify the predicted maximum storm-surge heights derived from the NWS's Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model. The SLOSH model is used to make predictions of maximum storm-surge heights for classes of hurricanes striking a given coastal area. Information derived from SLOSH is used to identify the vulnerable population that must be evacuated and the critical facilities that need to be protected from

storm-surge flooding in coastal communities. These data will continue to be needed in future disasters to verify SLOSH model output and to support other FEMA mission requirements.

Perishable, storm-caused riverine and coastal-flooding data are used by the National Flood Insurance Program to calibrate and verify hydrologic and hydraulic models used in Flood Insurance Studies to establish the one-percent chance base-flood elevations shown on Flood Insurance Rate Maps (FIRM). Flooding information caused by tsunami events affecting the U.S. West Coast and Pacific islands is also needed to prepare tsunami hazard maps. Existing water-level data documenting such events are insufficient and are critically needed to verify computer models used for tsunami run-up predictions.

2.3.6 American Association for Wind Engineering (AAWE). AAWE is a national, nonprofit, technical society of engineers, meteorologists, architects, planners, public officials, social scientists, manufacturers and constructors. Included among AAWE members are researchers, practicing professionals, educators, government officials, and building code regulators.

a. **Capabilities.** AAWE was originally established as the Wind Engineering Research Council in 1966 to promote and disseminate technical information in the research community. In 1983 the name was changed to American Association for Wind Engineering and incorporated as a nonprofit professional organization. The multi-disciplinary field of wind engineering considers problems related to wind and associated water loads on buildings and structures, societal impact of winds, hurricane, and tornado risk assessment, cost-benefit analysis, codes and standards, dispersion of urban and industrial pollution, wind energy, and urban aerodynamics.

b. **Requirements.** AAWE affiliation with the NPSDAP is currently limited to coordination with the National Weather Service. For all tornadoes suspected of producing greater than F3 damage, a QRT will be dispatched by the NWS. NWS Headquarters, Office of Climate, Water, and Weather Services (OCWWS), will notify OFCM via phone of the QRT deployment. OFCM will then notify via phone, all appropriate members of the NPSDAP about the deployment, including AAWE. This notification should be followed up with coordination between AAWE and the NWS regarding any PSDA activities.

CHAPTER 3

GENERAL OPERATIONS AND PROCEDURES

3.1 General. An agency response to an event deemed to be under this plan shall be at the discretion and within the mission authority and resources of that agency. The OFCM serves as the WG/NDR/PSDA's executive agent to coordinate agency responses. The agencies participating in this effort typically have overlapping requirements for the event responses and data types. Agencies often acquire the same data type following an event but may use the data for substantially different purposes. For example, inundation data following a coastal storm may be used by one agency for flood hazard risk assessment purposes while another agency may use the same data for structural performance evaluation purposes. There are other events where one or two agencies may have little or no interest and no mission authority. An example would be a severe tornado outbreak. Unless the event directly affected a DOD installation, the DOD probably would have no justification for a response within the scope of this plan.

3.2 Concept of Operations. The plan of operations described herein is formulated to insure that agency responses to mutually examined events are adequate, while minimizing the expenditure of resources on events of interest to a single agency, or events of no common interest. Moreover, the plan has been organized to allow for changes in the scope of responses to particular types of events, and adoption or implementation of emerging technology, without requiring a revision of the entire plan.

3.2.1 Agency Structures. Agency coordination responsibility for a storm response does not necessarily reside within analogous elements of the agencies. Consequently, identification of the responsible agency element is not feasible by use of a generic organization chart. Moreover, in the present climate of active agency restructuring, such a chart could quickly become obsolete. Home pages of many federal agencies, which include links to current organization information, are posted on the World Wide Web. Appendix C contains Uniform Resource Locator (URL) information for the home page addresses of the participating federal agencies. Contact information for agency representation on the WG/NDR/PSDA are provided in Appendix D.

3.3 Initiation Criteria and Mechanisms. Initiation criteria for coordinating agency responses to a particular event depend upon the event. Events for which there is typically adequate warning, such as landfalling storms and inland floods, permit evaluation of the situation as it develops, and criteria are formulated accordingly. For other events, such as tsunamis and tornadoes, there may be little or no warning and little time to assess the initial effects of the event, if indeed an event occurs. A timely response therefore requires that initiation criteria be based upon the presumption of occurrence of a significant event. For reference purposes, the Saffir-Simpson Hurricane Scale and the Fujita Tornado Intensity Scale are provided in Appendices E and F, respectively.

3.3.1 Tropical Storms and Hurricanes/Typhoons. The response to a landfalling tropical storm or hurricane/typhoon shall be considered at least 48 hours prior to expected landfall if adequate forecast information is available. Otherwise, a response shall be considered as soon as

forecast information indicates the presence of a potential landfall situation. WG/NDR/PSDA members shall monitor storm development during the official hurricane season and contact the chairperson of the working group or, if unavailable, the Federal Coordinator designee when a landfalling storm or hurricane situation develops. The preferred manner of coordination among members of the working group is via telephone conference call. If impractical or unavailable, individual phone communication or electronic mail should be used.

The NWS may deploy a special QRT and/or Service Assessment Team following significant tropical storms and hurricanes/typhoons. OFCM will be notified by NWS Headquarters, OCWWS, if a team(s) is being deployed. OFCM shall notify via phone, the appropriate members of the WG/NDR/PSDA that a NWS QRT and/or Service Assessment Team has been deployed. Subsequently, if other members of the WG/NDR/PSDA deploy a field survey team, they will notify OFCM via phone. OFCM will then notify via phone NWS Headquarters about the deployment.

3.3.2 Extratropical Storms. Responses to extratropical storms shall be considered on an individual basis. Most extratropical storms which affect the U.S. coastline occur between October and April. A typical season will produce three or four events along the northeast coast which warrant response consideration, with typically fewer events along the Gulf of Mexico and Pacific coastlines. Characteristics of extratropical events to be considered in initiating a response are:

a. an unusually high surge (in an historical context) at a particular coastal location;

b. an unusually prolonged period (e.g., several days) of elevated coastal water levels;

c. an extended reach (hundreds of miles) of affected coastline;

d. prolonged and/or unusually high surface wind speeds;

e. unusually long (> 16s) wind-generated wave periods along the Atlantic and Gulf of Mexico coasts; and/or

f. precipitation rates resulting in total rainfall that could cause potential flooding or flash-flooding; freezing and/or precipitation to the extent that accumulation of snow/ice on roadways/railways/airports/walkways is expected to cause such modes of transportation to become inoperative, or when the precipitation rate reduces visibility such that transportation is excessively hazardous, or when the accumulation of snow/ice on the built environment is expected to become a hazard due to structural failure.

Consideration of responses to extratropical events shall be coordinated among members of the working group in the same manner as for tropical storms and hurricanes.

3.3.3 Severe Convective Outbreaks. While conditions favorable for large-scale tornadic and other severe convective storms may be identified in advance, present forecast skill does not allow for definitive 12-h or longer forecasts of the number, specific location, and intensity of

individual tornadoes. The SPC should notify the working group when a major tornado outbreak is forecast, but frequently significant individual storms will occur without this prior notification. The NWS will conduct a PSDA survey following all severe convective storms in which wind damage occurs. The WCM at each of the 122 weather forecast offices are the initial respondents to major weather events, documenting apparent damage and causal effects, as well as commentary from witnesses.

The NWS will deploy a QRT for all tornadoes that are suspected of producing greater than F3 damage. An NWS Service Assessment Team may also be assembled for these events. In addition, the NWS may dispatch a QRT and/or Service Assessment Team for other significant severe convective wind events. The decision to deploy these teams will be made on a case-by-case basis.

OFCM will be notified of a NWS QRT and/or Service Assessment Team deployment by the NWS Headquarters, OCWWS. OFCM will notify via phone, all appropriate agencies of the WG/NDR/PSDA that a NWS team has been deployed. Subsequently, if other agencies of the WG/NDR/PSDA deploy field survey teams, they will notify OFCM via phone. OFCM will then notify NWS Headquarters about the deployment.

3.3.4 Tsunamis. Tsunami warnings are issued based upon seismic data indicating the occurrence of a sub-sea earthquake. The seismic data do not indicate the presence of a tsunami, only the possibility of one. Some oceanic regions where tsunamis are likely to be generated, such as the Aleutian Trench, are monitored for the passage of deep-ocean tsunamis. However, such monitoring networks are limited to a few regions worldwide. Because tsunamis travel very fast in the deep ocean with phase speeds of hundreds of kilometers per hour, there is typically only a few hours between the detection of a sub-sea earthquake and the tsunami's arrival. If the quake occurs near a coastline, the tsunami can arrive in a matter of minutes. Major tsunamis are principally generated by sub-sea earthquakes of magnitude greater than 6.5 (Richter scale) with focal depths less than 50 km.

Given the likely scenario that any generated tsunami already will have arrived by the time the WG/NDR/PSDA can be notified, the decision to be made will be the level of response. Those members of the working group participating in a response shall coordinate the response based upon reports assessing the damage in the affected area. The Federal Coordinator shall be informed of developments and apprised of the planned response.

3.3.5 Riverine Flooding. Responses to major riverine flood events shall be considered on an individual basis. Forecasts allow several days to weeks lead time to prepare for major flooding and to make decisions/preparations for post-storm data acquisition. Major floods can occur at any time of the year, although some areas of the country are at elevated risk for flooding during certain parts of year (e.g., West Coast, November - March; western mountains, March - June; Midwest, late winter - early spring; Southeast, late summer - early fall). Annual flood damages average near $3 billion, and many years experience several major floods.

Floods that are included in Presidentially declared disasters will be obvious candidates for flood documentation studies as well as floods of great magnitude or rarity. A flood rarer than that expected once every 200 years probably should be investigated. An estimate of flood magnitude and frequency can be formed based on available records of streamflow or FEMA FIRM maps.

Documentation of floods that provide information useful for making significant improvements in river forecast models should receive priority consideration. Unusual conditions include flash floods, dam failures, ice jams, floods of tributaries that were caused by backwater from a large stream, and floods that significantly exceed the maximum discharge covered by the stage-discharge relation at NWS forecast or model control points. Local NWS and USGS offices can verify that a flood exceeded the documented stage-discharge rating.

The NWS's Hydrologic Information Center and the USGS's WRD monitor flood conditions throughout the year, and each can notify the OFCM of potential major flood situations and will provide information during the flooding event.

3.4 Response Procedures. Coordination of agency responses to an event are desired where there are common activities in a common geographic area and common or overlapping data requirements. The specific agency responses following an event will depend to some extent on the nature and characteristics of the event.

3.4.1 Tropical Storms and Cyclones. NOAA/NWS shall have primary responsibility for providing forecast, warning, and near-real-time track and intensity data to the other agencies. The USACE and USGS shall have primary responsibility for providing resources for assessment of coastal and/or inland flooding and damages. NIST shall have primary responsibility for providing resources for assessment of structural damage. For declared disaster events, FEMA shall mission assign agencies to acquire data to satisfy FEMA mission requirements. USDA shall have primary responsibility for providing data (where available) on precipitation effects.

Upon the WG/NDR/PSDA's recommendation, the following activities will be initiated after landfall of a tropical storm or hurricane.

- USGS and USACE shall coordinate the deployment of field teams for the identification and recovery of high-water mark data. The teams shall be deployed in the affected area within 72 hours of landfall if possible. Leaders of field teams should secure lodging for themselves and team members prior to landfall. The lodging should be located close enough to the expected point of landfall to permit rapid deployment but distant enough to be substantially unaffected by the storm.

- NOAA shall coordinate the acquisition of satellite imagery and post-event aerial photography. Oblique hand-held video or aerial photography is useful for preliminary damage assessment, but controlled photography is required for quantitative determination of changes in shoreline morphology, assessment of other coastal processes, and identification of tornado tracks. Coordination of acquisition of controlled

photography shall include identification and securing of suitable aircraft platforms, selection of scale of aerial photography, specification track lines to be flown, and percentage of image overlap.

- NOAA/NWS will deploy field teams to assess the damage and performance of structures in the affected area. NIST may also deploy a team if the damage is sufficient enough to warrant this action. Team leaders should follow the same guidance for securing lodging as the high-water mark field teams.

- The NWS may deploy a QRT and/or Service Assessment Team following significant tropical storms and cyclones. OFCM will be notified of these deployments by the NWS Headquarters, OCWWS. OFCM will then notify via phone, all appropriate agencies of the WG/NDR/PSDA that a NWS team has been deployed. Subsequently, if other agencies of the WG/NDR/PSDA deploy a field survey team, they will notify OFCM via phone. OFCM will then notify NWS Headquarters about the deployment.

3.4.2 Extratropical Storms. The procedure for extratropical storms is essentially the same as for tropical storms and hurricanes. NOAA/NWS shall have primary responsibility for providing forecast, warning, and near-real-time track and intensity data to the other agencies. USACE and USGS shall have primary responsibility for providing resources for assessment of coastal and/or inland flooding and damages. NIST shall have primary responsibility for providing resources for assessment of structural damage. FEMA shall have primary responsibility for providing funds for reimbursement of tasks performed by other agencies which address FEMA mission requirements. For cases not addressed by FEMA mission requirements, the remaining agencies shall support acquisition of post-storm data at a level consistent with the resources available. USDA shall have primary responsibility for providing data (where available) on precipitation effects.

Upon the WG/NDR/PSDA's recommendation, the following activities will be initiated during or following an extratropical event which significantly impacts a coastal area:

- USGS and USACE shall coordinate the deployment of field teams for the identification and recovery of high-water mark data. If possible, the teams shall be deployed in the affected area within 72 hours of the occurrence of significant coastal flooding, erosion, or damage to coastal structures. Leaders of field teams should secure lodging for themselves and team members at locations substantially unaffected by the storm.

- NOAA shall coordinate the acquisition of satellite imagery and post-event aerial photography. Oblique hand-held video or aerial photography is useful for preliminary damage assessment, but controlled photography is required for quantitative determination of changes in shoreline morphology, and assessment of other coastal processes. Coordination of acquisition of controlled photography shall include identification and securing of suitable aircraft platforms, selection of scale of aerial photography, specification track lines to be flown, and percentage of image overlap.

- NOAA/NWS will deploy field teams to assess the damage and performance of structures in the affected area. NIST may also deploy a team if damage is sufficient enough to warrant this action. Team leaders should follow the same guidance for securing lodging as the high-water mark field teams.

3.4.3 Tornadoes and Other Severe Convective Storms. Upon the working group's recommendation, the following shall be initiated following a significant event:

- For all tornadoes producing potentially greater than F3 damage, the NWS will activate a QRT to photographically document storm damage intensity distribution by both aerial and ground surveys. Such a survey must be made within 24 hours of a event, so that salvage and clean-up efforts do not obscure the storm's true effects.

- NOAA/NWS shall coordinate the acquisition of satellite imagery and post-event aerial photography. Oblique hand-held video or aerial photography is useful for preliminary damage assessment. Coordinating acquisition of controlled photography shall include identifying and securing suitable aircraft platforms, selecting scale of aerial photography, specifying track lines to be flown, and percentage of image overlap. In addition, the local field WCM will ask the public to provide videotapes and other photographs of the storm.

3.4.4 Tsunamis. Tsunamis may result from near- or far-field seismic events. The effects resulting from a near-field seismic event likely will be catastrophic. Such an event will undoubtedly have national attention focused upon it, and the WG/NDR/PSDA resources available to respond to inquiries and requests certainly will be strained. However, while the damage from a near-field tsunami likely will be severe, the affected area (or coastal reach) will be more confined than that resulting from a significant far-field tsunami. Obviously, there will be no advance warning in the case of a near-field tsunami event. The most efficient response will involve an aerial reconnaissance to delimit the affected area, perform a preliminary assessment of the damage extent, and aid in directing ground crews into the area via the most efficient routes. Aircraft to perform this function would be obtained by the same means as for post-tornado assessment.

A far-field tsunamigenic event may present some advance warning, perhaps as much as a half day for some locations. Also, tsunamis transiting some Pacific Ocean areas may be detected and confirmed while still at sea. Such detection and confirmation will provide an estimate of the likely impact area and severity upon which to gauge an appropriate response level. Upon arrival, a far-field tsunami event would be preliminarily assessed similar to a near-field event.

Presumably there will be little or no meteorological effects involved in tsunami events; therefore, NOAA resources that might otherwise be directed toward wind-field studies could be used to supplement other agency efforts in the determination of hydrodynamic effects.

3.4.5 Riverine Flooding. The procedure for riverine flooding is essentially the same as for tropical storms and hurricanes. NWS shall have primary responsibility for providing forecast,

warning, and near-real-time track and intensity data to other agencies. The USACE and the USGS shall have primary responsibility for providing resources for assessment of coastal and/or inland flooding and damages, and for documenting stream stages and discharges. NIST shall have primary responsibility for providing resources for assessment of structural damage. FEMA shall have primary responsibility for providing funds for reimbursement of tasks performed by other agencies which address FEMA mission requirements. For cases not addressed by FEMA mission requirements, the remaining agencies shall support acquisition of post-storm data at a level consistent with the resources available. USDA shall have primary responsibility for providing data (where available) on precipitation effects.

Upon the WG/NDR/PSDA's recommendation, the following activities will be initiated during or following extensive riverine flooding:

- USGS and USACE shall coordinate the deployment of hydrologic-data field teams for the identification and recovery of high-water mark data and for the determination of discharge measurements. To the extent practical, high priority sites will be identified in advance of the event by USGS in consultation with USACE and NWS. When possible, the teams shall be deployed in the affected areas within 72 hours of the occurrence of significant flooding, erosion, or damage to structures. Leaders of field teams should secure lodging for themselves and team members at locations substantially unaffected by storm damage.

- NOAA shall coordinate the acquisition of satellite imagery and post-event photography. Oblique hand-held video or aerial photography is useful for preliminary damage assessment, but controlled photography is required for quantitative determination of changes in river morphology, extent of inundation and assessment of other erosion processes, including levee breaks and damage to other control structures. Coordination of acquisition of controlled photography shall include identification of and securing of suitable aircraft platforms, selection of scale of aerial photography, specification of track lines to be flown, and percentage of image overlap.

- NOAA/NWS will deploy field teams to assess the damage and performance of structures in the affected area. NIST may also deploy a team if damage is sufficient enough to warrant this action. Team leaders should follow the same guidance for securing lodging as the high-water mark field teams.

3.5 <u>Data Acquisition Procedures</u>. Because all events specified in the WG/NDR/PSDA Terms of Reference share some common characteristics, the data acquisition procedures share some similarities. Sections 3.5.1 through 3.5.4 provide general guidance on procedures, type, and quantity of data. Appendix G contains an example of detailed procedures to be used for high-water mark identification and recovery used by USGS.

3.5.1 Tropical Cyclones.

- NOAA shall assemble and analyze available wind data, and provide anemometer records and synoptic depictions of near-surface wind fields. Available barographs shall be assembled; satellite and radar imagery data and other information which might aid to determine the point of landfall shall be assembled. Synoptic depictions of near-surface wind fields shall be prepared at 6-h intervals for the 48-h period prior to landfall and, if feasible, at 3-h intervals for the 12-h period prior to landfall. Time-dependent central pressure and maximum-wind radii data shall be assembled, tabulated, and plotted.

- The appropriate USACE District office shall be contacted as to the availability of field teams to identify, preserve, and level high-water marks in the affected area. The teams will coordinate their activities through the Federal Coordinator and field directors of USGS, FEMA, NIST, and NOAA/NWS, but shall remain under the control of the USACE. In the event NOAA-provided controlled aerial photography is unavailable or beyond the resources of the participating agencies, USACE shall explore use of a commercial service through existing USACE contracts. Where substantial or significant coastal morphological changes or damage to navigation structures have occurred, USACE may perform assessments.

- The appropriate USGS district office shall be contacted as to availability of field teams to identify, preserve, and level high-water marks in the affected area. The teams will coordinate their activities through the Federal Coordinator and field directors of USACE, FEMA, NIST, and NOAA, but shall remain under the control of USGS. Where available, USGS shall provide data, imagery, or information on pre-existing conditions of the affected area.

- FEMA shall provide resources as available to the other participating agencies along with guidance on FEMA's specific data requirements for the particular event.

- USDA shall provide available precipitation, soil erosion, and agricultural damage data.

- NIST and NOAA shall provide field teams to assess the storm-induced structural damage. Where possible, charts depicting estimates of the surface wind speeds inferred from structural effects shall be prepared.

- The NWS may deploy a QRT and/or Service Assessment Team following significant tropical cyclones. OFCM will be notified of these deployments by the NWS Headquarters, OCWWS. OFCM will then notify via phone, all appropriate agencies of the WG/NDR/PSDA that a NWS team is being deployed. Subsequently, if other agencies of the WG/NDR/PSDA deploy a field survey team, they will notify OFCM via phone. OFCM will then notify NWS Headquarters about the deployment.

3.5.2 **Extratropical Storms**.

- NOAA shall assemble and analyze available wind data, and provide anemometer records and synoptic depictions of near-surface wind fields. Available barographs shall be assembled; satellite and radar imagery data and other information which might aid to determine the extent and evolution of the system shall be assembled. Synoptic depictions of near-surface wind fields at six-hour intervals shall be prepared. Available buoy and Coastal-Marine Automated Network station wave, wind, and pressure data shall be assembled.

- USACE responsibilities shall be the same as for tropical storms and hurricanes.

- USGS responsibilities shall be the same as for tropical storms and hurricanes.

- FEMA responsibilities shall be the same as for tropical storms and hurricanes.

- USDA responsibilities shall be the same as for tropical storms and hurricanes.

- NIST responsibilities shall be the same as for tropical storms and hurricanes.

3.5.3 Tornadoes and Other Severe Convective Storms. NOAA/NWS shall assemble and analyze damage survey findings, satellite and radar imagery, videotapes, and other information while determining the structure and organization of the tornadic storm(s). These data will become part of a national database to be used in evaluating the geographic distribution of tornado risk.

3.5.4 Tsunamis. The data-acquisition procedures for tsunamis shall parallel the procedures for acquisition of hydrodynamic and structural effects data following a tropical storm or hurricane. In addition, available hydrographs acquired at open ocean and affected coastal locations shall be assembled. Estimates of the net sub-sea bottom displacement are desirable, and if not otherwise available, consideration should be given to using WG/NDR/PSDA resources to develop such estimates.

3.5.5 Riverine Flooding. The NOAA shall assemble and analyze satellite and radar imagery data and other information which might aid in determining areas of greatest precipitation. When possible, post-storm surveys documenting extreme conditions (precipitation and streamflow) will be conducted by the most efficient means possible. The NWS will provide forecasts of impending precipitation along with issuing flood watches and warnings. If possible, local NOAA offices will discuss impending flooding with local USACE and USGS offices to aid in targeting the field deployment of personnel from these agencies. Similar coordination will occur at the national headquarters level between the NWS, FEMA, USACE, and USGS.

The USACE and USGS responsibilities shall be the same as for tropical storms and hurricanes with the addition of providing field teams and equipment to make discharge and current velocity measurements where such teams are available.

The FEMA, USDA, and NIST responsibilities shall be the same as for tropical storms and hurricanes.

CHAPTER 4

STORM DATA REQUIREMENTS AND DEPOSITION

4.1 General. Data requirements of the participating agencies for the events identified in the Terms of Reference were developed by the WG/NDR/PSDA members and represents data routinely acquired or which may be acquired within the existing operational capabilities of the participating agencies. Sections 4.2, 4.3, and 4.4 address data deposition. In general, the raw data will reside with the acquiring agency.

4.2 Atmospheric Data. The primary source of atmospheric data accompanying a tropical or extratropical storm is NOAA. In principle, all agency data requirements are usually met by NOAA. USDA may provide additional surface-wind data should the storm system affect an area where USDA instrumentation is resident.

4.3 Hydrodynamic Data. Examples of hydrodynamic data include coastal wave climate and water levels, coastal surface and bottom currents, beach wave runup and uprush, and breaking wave and overtopping of coastal structures. Surface and bottom current, and remotely sensed offshore and near-coast wave data are very useful to describe the hydrodynamic environment during coastal storms but usually are not acquired. The technology to acquire remotely sensed wave data from aircraft exists but requires modification of the fuselage of the supporting aircraft to accommodate the radar antenna -- a requirement likely to reduce the number of candidate aircraft.

Surface current data during coastal storm events feasibly may be acquired by use of a Bragg-scatter radar (e.g., Ocean Surface Current Acquisition Radar). The logistic difficulty of deploying such a radar at a suitable site in advance of a land-falling storm will be considerable, as will the risk of damage or loss. While the acquisition of bottom current data is entirely within the capability of present in situ technology, the logistic difficulties of instrument deployment prior to and recovery after the event are formidable.

Given the difficulty and presumed accompanying expense of acquiring remotely sensed wave data and current data (both surface and bottom), efforts to acquire these data should be undertaken with specific needs and applications in mind.

In the most general sense, acquisition of hydrodynamic data serves to support the USACE's broad missions of shore protection and restoration, navigation, and characterization of estuarine circulation and water quality properties. Acquistion of all hydrodynamic data that support these missions is desirable.

4.3.1 Riverine Flooding Data. Hydrodynamic data required to assess riverine flooding, but usually not acquired, include streamflow discharge and current velocities. The USGS and some USACE districts maintain field crews capable of making the necessary measurements. During floods, these teams are routinely deployed at stream gages and occasionally at major engineering structures in order to measure streamflow, but they are relatively few in number and provide only

sparse coverage of many rivers and communities subject to flooding. Closer coordination between the USGS and USACE and improved communication with NOAA flood forecasting operations can enable efficient national deployment of these limited resources to enhance forecasts and document riverine flow magnitudes, which are among the most perishable data.

New technologies, such as the acoustic Doppler current profiler can increase the level of measurement detail and speed data collection, but they are expensive to deploy. Therefore, early consultations among WG/NDR/PSDA members, especially USGS and USACE representatives, should include consideration of detailing such equipment and crews for their operation from USGS and USACE districts in other areas of the Nation. However, such details are also expensive, disrupt normal operations, and require expenditure of scarce internal funds or reimbursement from interested agencies, such as FEMA.

4.4 Morphological Data. Morphological data include shoreline changes both above and below the high-tide contour. In principle, at least one of the participating agencies usually acquires needed morphological data except for pre-event shoreline topography. Acquisition of pre-event shoreline topography is probably feasible only by means of aerial photogrammetry, and only then under favorable conditions (i.e., daylight and minimal cloud cover).

An alternative to aerial photogrammetry for rapid mapping of the pre-/post-event shoreline and nearshore bathymetry is the Scanning Hydrographic Observational Airborne Laser System operated by the USACE Mobile District and flown aboard NOAA Aircraft Operations Center aircraft. The system uses a aircraft-mounted down-looking laser to acquire bathymetric data in shallow water environments and is coupled to a high accuracy GPS-based positioning system which permits mapping of the adjoining super-aqueous sections of coastline. The system is rapid enough that kilometers of shoreline can be mapped in minutes.

As with the acquisition of surface and bottom current data, acquisition of pre-event shoreline topography data should be undertaken only with specific needs and applications in mind. Changes in flood plains need to be documented to ensure accurate river forecasts. Delineation of changes in river channels and levee breaches can be made using some combination of field surveys, aerial photography, and interpretation of satellite information.

CHAPTER 5

EVENT SUMMARIES

5.1 General. Event summaries are completed as needed or directed by the acquiring agency. These summaries will embody a concise description of the event, interpretive information, and supporting data. Examples include the NWS Service Assessment of the La Plata, Maryland, Tornado Outbreak of April 28, 2002, FEMA BPAT reports, data gathered by the USACE, and a report of water levels associated with hurricanes and tropical storms from NOS's Center for Operational Oceanic Products and Services (CO-OPS). The interpretive information and supporting data will be directed at satisfying the requirements and needs of secondary users. These include those whose requirements are met by processed data and/or composite images. Users requiring access to unprocessed data (e.g., magnetic media data files) will be directed to the acquiring agency. Many or most of these summaries can be found by accessing the agency's URL listed in Appendix C.

5.2 Content Outline. It is recommended the following sections be included in an event summary report:

a. executive summary;

b. event description and its impact;

c. event analysis;

d. description of agency responses;

e. description of data acquired, availability, and deposition status;

f. supporting documentation (e.g., eyewitness accounts); and

g. conclusions, findings, and/or recommendations, if appropriate.

APPENDIX A

AGENCY AUTHORITY AND MISSION STATEMENTS

Federal Emergency Management Agency

Contained in the agency charter as "... providing the leadership and support to reduce the loss of life and property and protect our institutions from all types of hazards through a comprehensive, risk-based, all hazards emergency program of mitigation, preparedness, response, and recovery."

National Institute of Standards and Technology

Contained in the National Bureau of Standards Authorizing Act of 1986: "The National Bureau of Standards, on its own initiative, ... may initiate and conduct investigations to determine the causes of structural failures in structures which are used or occupied by the general public."

National Resources Conservation Service

Contained in the Rural Development Act of 1972, Public Law 92-419, Sec. 302, Title III (7 USC 1010a) August 30, 1972, which authorizes a land inventory and monitoring program, including studies and surveys of erosion, sediment damage, flood plain identification, and land use changes and trends.

National Weather Service

The National Weather Service (NWS) provides weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas, for the protection of life and property and the enhancement of the national economy. NWS data and products form a national information database and infrastructure which can be used by other governmental agencies, the private sector, the public, and the global community.

US Army Corps of Engineers

Public Law 71 (Coastal and Tidal Areas - Survey - Damages), 84th Congress, 1955.

US Air Force

Memorandum of Agreement between the USAF Reserve and NOAA dated May 4, 1992.

Civil Air Patrol

The Civil Air Patrol (CAP) is chartered under 36 U.S.C. 201 et. seq. and is a civilian auxillary of the USAF. The USAF is authorized under 10 U.S.C. 9441 to use the services of the CAP to fulfill its non-combat missions. Memorandum of Understanding between the CAP, NWS, and the CAP-USAF, 22 Aug 97.

US Geological Survey

The Water Resources Division of the USGS is responsible for the coordination of the water-data acquisition activities of all federal agencies as mandated by Office of Management and Budget Memorandum No. M-92.01.

APPENDIX B

INTERNAL NATIONAL WEATHER SERVICE QUICK RESPONSE TEAM (QRT) OPERATIONAL PROCEDURES

1. Event occurs

2. Per individual Region notification guidelines, local WFO immediately notifies their Regional Headquarters that a significant event has occurred.

3. Regional Headquarters immediately notifies the NWS Watch Office of the significant event(s) with potentially greater than F3 damage. The Watch Office will contact the National WCM Program Manager, the Director of OCWWS, the Performance and Awareness Division Chief, and other senior NWS officials including the AA for Weather Services, as appropriate. The AA for Weather Services will, at their discretion, contact the NOAA Administrator or other senior NOAA officials.

4. Regional Headquarters should notify the NWS Watch Office through the following:
   a) Sending an email message to "nws.metwatch@noaa.gov" (preferred) or
   b) Leaving a message on the Watch Office hotline at (301) 713-0090 x123

   These are the first actions that should be taken and apply to both business and non-business hours.
   Regional office personnel should provide their name, phone number, and a brief message for a return call. Either email messages or phone calls should activate Watch Office pagers. If a call is not received in a reasonable time (within 15 minutes), contact one of the persons listed below.

Designate WSH (OS) Watch Office Personnel

OS Duty Officers	**Office**
Bob McLeod	(301) 713-1704
Donna Franklin	(301) 713-0090 x 141
Mary Newton	(301) 713-0090 x 103
Steve Kuhl	(301) 713-0090 x 175
Mike Gerber	(301) 713-0090 x 116

5. Local WFO Post-Storm Data Acquisition (PSDA) Team immediately deploys to the damage site and determines that greater than F-3 damage may have occurred. If necessary, the local WFO may request PSDA ***"mutual aid"*** support from an adjacent office for the purpose of conducting the survey. The local PSDA Team will reach a consensus to define the potential of greater than F3 damage. The local PSDA Team shall continue the survey effort independent of the F3 damage determination to ensure acquisition of valuable survey information.

6. Local WFO shall provide the following statement to emergency management and media: ***"damage is potentially greater than F3,"*** as outlined in NWS Directive 10-1604, until the QRT Wind Damage Expert(s) provide(s) input to the WFO for the final F-scale determination.

7. The National WCM Program Manager, or their designee, will contact the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) to notify them that the NWS is activating QRT procedures, and advise that NWS Regional or National Headquarters may be contacting them to request Civil Air Patrol (CAP) support. OCWWS personnel on the PSDA Working Group includes the National WCM Program Manager and National WCM Program Assistant.

8. Local WFO will coordinate with Regional and National Headquarters to arrange a timely aerial survey of the damage area. Aerial surveys can be arranged via the CAP or other sources (e.g., National Guard, TV/Sheriff Office Helicopters, etc.)

9. If it is determined that a QRT is needed, Regional Headquarters personnel will call **one** of the Wind Damage Experts listed in Appendix BB, to see if they are available to perform a post-storm wind damage survey. Regional Headquarters will provide the Wind Damage Expert with logistical information about the local WFO (i.e., MIC and WCM contacts, office address, phone number, etc). If the first expert called is not available, another person listed in Appendix BB should be called. For widespread and/or multiple events, additional Wind Damage Expert(s) may be required.

   NOTE: Other NWS personnel not listed in Appendix BB can be considered as Wind Damage Experts and serve on a QRT, if they demonstrate extensive PSDA experience and are recommended as a National Authority by their Regional Office.

10. Wind Damage Experts will have pre-draft blanket Travel Orders from NWS Headquarters (W/OS5) to expedite their travel. During normal business hours (9:00 a.m. to 5:00 p.m. eastern time) the Wind Damage Experts should call SATO Travel in Silver Spring, MD to obtain their plane tickets at: **(301) 713-2407.** During non-business hours SATO Travel 24 Hour Emergency Services Desk should be called at: **(800) 827-7777**. *Note: SATO's Silver Spring Office pseudo city code is 01S0 (this code is used to reserve airline tickets via the 24 hour emergency number).*

11. QRT Wind Damage Expert must travel to the local WFO within 18-24 hours of the event.

12. Local WFO will arrange for the transportation, lodging, etc of the Wind Damage Expert. If necessary, the local WFO may request logistical support from adjacent offices or the appropriate Regional Headquarters.

13. The Wind Damage Expert(s) will accompany the local WFO PSDA Team to the damage site and provide their expertise for the determination of the F-Scale rating. The local WFO PSDA Team will provide the official F-Scale rating to the public.

14. Wind Damage Expert returns home and submits travel expense receipts to NWS Headquarters (W/OS5) for reimbursement to the following address:

NWS Headquarters
1325 East-West Highway
SSMC2, Rm 14442, W/OS5
Silver Spring, MD 20910-3283
Attn: Steve Kuhl/Debbie Greeley

Appendix BB
NWS Quick Response Team
Wind Damage Assessment Experts

Editors Note: Please contact Mr. Stephan Kuhl, National Weather Service, for further information. He can be reached at (301) 713-0090 ext. 175, or at Stephan.Kuhl@noaa.gov .

APPENDIX C

UNIFORM RESOURCE LOCATOR (URL) ADDRESSES FOR PARTICIPATING FEDERAL AGENCIES AND GROUPS

American Association for Wind Engineering	www.aawe.org
Federal Emergency Management Agency	www.fema.gov
Building Performance Assessment Team	www.fema.gov/mit/bpat/bp_faqs.htm
National Institute of Standards and Technology	www.nist.gov
National Oceanic and Atmospheric Administration	www.noaa.gov
National Weather Service	www.nws.noaa.gov
National Ocean Service	www.nos.noaa.gov
Center for Operational Oceanic Products and Services	www.co-ops.nos.noaa.gov
Office of the Federal Coordinator for Meteorological Services and Supporting Research	www.ofcm.gov
National Resources Conservation Service	www.nrcs.usda.gov
US Air Force	www.af.mil www.hurricanehunters.com
US Army Corps of Engineers	www.usace.army.mil
US Department of Agriculture	www.usda.gov
US Department of Transportation	www.dot.gov
Federal Highway Administration	www.fhwa.dot.gov
US Geological Survey	www.usgs.gov

APPENDIX D

WORKING GROUP FOR NATURAL DISASTER REDUCTION AND POST-STORM DATA ACQUISITION

MEMBERSHIP LIST

NAME & ADDRESS	STATUS	TELEPHONE/FAX/EMAIL
Dr. Andrew W. Garcia U.S. Army Corps of Engineers ATTN: CEERD-HC-S 3909 Halls Ferry Road Vicksburg, MS 39180-6199	CH	PH: 601-634-3555 FAX: 601-634-3151 DSN: 637-3555 EMAIL: garciaa@wes.army.mil
Ms. Mary M. Cairns Office of the Federal Coordinator 8455 Colesville Road, Suite 1500 Silver Spring, MD 20910	ES	PH: 301-427-2002 FAX: 301-427-2007 DSN: 851-1460 EMAIL: mary.cairns@noaa.gov
Mr. Stephan Kuhl National Weather Service 1325 East-West Highway Room 14442, W/OS51 Silver Spring, MD 20910	M	PH: 301-713-0090, ext 175 FAX: 301-713-1598 EMAIL: stephan.kuhl@noaa.gov
Mr. Jon Werner Natural Resources Conservation Service Conservation Engineering Division U.S. Department of Agriculture 1400 Independence Ave, SW Rm.6136-S Washington, DC 20250	M	PH: 202-720-0772 FAX: 202-720-0428 EMAIL: jon.werner@usda.gov
Mr. John Gambel Hurricane Preparedness Program Federal Emergency Management Agency Federal Center Plaza 500 C Street, SW Washington, DC 20472	M	PH: 202-646-2724 FAX: 202-646-4596 EMAIL: john.gambel@fema.gov

Status Codes: *CH=Chairperson* *ES=Executive Secretary* *M=Member* *A=Alternate Member* *P=Participant* *O=Observer* *T=Technical Adviser* *CC=Info Copy*

NAME & ADDRESS	STATUS	TELEPHONE/FAX/EMAIL
Mr. Kernell Ries U.S. Geological Survey, WRD 12201 Sunrise Valley Dr., MS415 Reston, VA 20192	M	PH: 703-648-5307 FAX: 703-648-5722 EMAIL: kries@usgs.gov
Dr. Michael A. Riley Materials & Construction Research Div, NIST 100 Bureau Drive, Stop 8611 Gaithersburg, MD 20899	M	PH: 301-975-6065 FAX: EMAIL: michael.riley@nist.gov
Dr. Wilson A. Shaffer National Weather Service 1325 East-West Highway Room 10426, W/OSD22 Silver Spring, MD 20910	A	PH: 301-713-1613 FAX: 301-713-0003 EMAIL: wilson.shaffer@noaa.gov
Mr. William Massey FEMA Region IV 3003 Chamblee Tucker Road Atlanta, GA 30341	A	PH: 770-220-5430 FAX: EMAIL: Bill.Massey@fema.gov
Mr. Charles B. Chesnutt US Army Corps of Engineers, HQ 441 G Street, NW Washington, DC 20314	A	PH: 202-761-0523 FAX: 202-761-1972 EMAIL: charles.b.chesnutt@hq02.usace.army.mil
Ms. Emily Hirsch Hazard Study Branch, FEMA Federal Center Plaza 500 C Street, SW Washington, DC 20472	A	PH: 202-646-2585 FAX: 202-646-4596 EMAIL: Emily.Hirsch@fema.gov
Dr. Michael P. Gaus American Association for Wind Engineering 3283 Deerfield Ct Williamsburg, VA 23185-8401	T	PH: 757-258-1273 FAX: EMAIL: aawe@aawe.org mgaus@gausassoc.com

Status Codes: *CH=Chairperson* *M=Member* *O=Observer*
ES=Executive Secretary *A=Alternate Member* *T=Technical Adviser*
P=Participant *CC=Info Copy*

NAME & ADDRESS	STATUS	TELEPHONE/FAX/EMAIL
Mr. Paul Tertell Program Assessment and Outreach Div FEMA BPAT 500 C St., S.W. Washington, DC 20472	T	PH: 202-646-3935 FAX: 202-646-2577 EMAIL: Paul.Tertell@fema.gov
Mr. Paul Pisano Federal Highway Administration Department of Transportation 400 Seventh St., SW Washington, DC 20590	O	PH: 202-366-1301 FAX: 202-366-8712 EMAIL: Paul.Pisano@fhwa.dot.gov
Office of Oceanographer of the Navy CNO-NO96 (N963C) U.S. Naval Observatory, Bldg. 1 3450 Massachusetts Avenue, NW Washington, DC 20392-5421	CC	PH: 202-653-1604 FAX: 202-653-1435 DSN: 294-1604 EMAIL:

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APPENDIX E

SAFFIR-SIMPSON HURRICANE SCALE

CATEGORY ONE HURRICANE -- WEAK

Winds: 75-95 mph (65-82 kt) at standard anemometer elevations. Damage is primarily to shrubbery, trees, foliage, and unanchored mobile homes. No real damage occurs to building structures. Some damage to poorly constructed signs.

Storm surge: Nominally is 4-5 ft (1.2-1.5 m) above normal. Low-lying coastal roads are inundated; minor pier damage occurs; some small craft in exposed anchorages break moorings.

CATEGORY TWO HURRICANE -- MODERATE

Winds: 96-110 mph (83-95 kt) at standard anemometer elevations. Considerable damage is done to shrubbery and tree foliage, some trees are blown down. Major structural damage occurs to exposed mobile homes. Extensive damage to poorly constructed signs. Some damage is done to roofing material, windows, and doors; no major damage to building structures.

Storm surge: Nominally is 6-8 ft (1.8-2.4 m) above normal. Coastal roads and low-lying escape routes inland are cut by rising water 2-4 hours before arrival of center. Considerable pier damage occurs; marinas are flooded. Small craft in unprotected anchorages break moorings. Evacuation of some shoreline residences and low-lying island areas is required.

CATEGORY THREE HURRICANE -- STRONG

Winds: 111-130 mph (96-113 kt) at standard anemometer elevations. Damage occurs to shrubbery and trees: foliage is blown off trees; large trees are blown down. Practically all poorly constructed signs are blown dow; some roofing material damage occurs; some window and door damage occurs; and some structural damage occurs to small residences and utility buildings. Mobile homes are destroyed. There is a minor amount of curtainwall failure.

Storm Surge: Nominally is 9-12 ft (2.7-3.7 m) above normal. Serious flooding occurs at the coast with many smaller structures near the coast destroyed. Larger structures are damaged by battering of floating debris. Low-lying escape routes inland are cut by rising water 3-5 hours before the center arrives. Terrain continuously lower than 5 ft (1.5 m) above sea level may be flooded inland 8 mi (12.9 km) or more. Evacuation of low lying residences within several blocks of the shoreline may be required.

CATEGORY FOUR HURRICANE -- VERY STRONG

Winds: 131-155 mph (114-135 kt) at standard anemometer elevations. Shrubs and trees are blown down; all signs are down. Extensive roofing material damage occurs; extensive window and door damage occurs; complete failure of roof structures occurs on man y small residences; and complete destruction of mobile homes occurs. Some curtainwalls experience failure.

Storm Surge: Nominally is 13-18 ft (3.9-5.5 m) above normal. Terrain continuously lower than 10 ft (3 m) above sea level may be flooded inland as far as 6 mi (9.7 km). Major damage occurs to lower floors of structures near the shore due to flooding and battering action. Low-lying escape routes inland may be cut by rising water 3-5 hours before the storm center arrives. Major erosion of beach areas occurs. Massive evacuation of all residences within 500 yds (457 m) of the shoreline may be required and of single-story residences within 2 mi (3.2 km) of the shoreline.

CATEGORY FIVE HURRICANE -- DEVASTATING

Winds: Greater than 155 mph (135 kt) at standard anemometer elevations. Shrubs and trees are down; roofing damage is considerable; all signs are down. Very severe and extensive window and door damage occurs. Complete failure of roof structures occurs on many residences and industrial buildings. Extensive glass failures occur; some complete buildings fail; small buildings are overturned and blown over or away; and complete destruction of mobile homes occurs.

Storm Surge: Height is nominally greater than 18 ft (5.5 m) above normal. Major damage occurs to lower floors of all structures located less than 15 ft (4.6m) above sea level and within 500 yd (457 m) of the shoreline. Low-lying escape routes inland are cut by rising water 3-5 hours before the storm center arrives. Massive evacuations of residential areas situated on low ground within 5-10 mi (8-16 km) of the shoreline may be required.

APPENDIX F

FUJITA TORNADO INTENSITY SCALE

Category **Definition -- Effects**

(F0)
Gale tornado (Approximate wind speeds 40-72 mph): Light damage. Some damage to chimneys; break branches off trees; push over shallow rooted trees; damage sign boards.

(F1)
Moderate tornado (Approximate wind speeds 73-112 mph): Moderate damage. The lower limit is the beginning of hurricane wind speed; peel surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads.

(F2)
Significant tornado (Approximate wind speeds 113-157 mph): Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated.

(F3)
Severe tornado (Approximate wind speeds 158-206 mph): Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off ground and thrown.

(F4)
Devastating tornado (Approximate wind speeds 207-260 mph): Devastating damage. Well constructed houses leveled; structures with weak foundation blown off some distance; cars thrown and large missiles generated.

(F5)
Incredible tornado (Approximate wind speeds 261-318 mph): Incredible damage. 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; incredible phenomena will occur.

APPENDIX G

UNITED STATES GEOLOGICAL SURVEY
HURRICANE RESPONSE PLAN

I. OFFICE ORGANIZATION

A. Office Responsibilities

1. District Chief

a. Hurricane event attendance policy - In the event of a hurricane moving in the general vicinity of the office, the District Chief should set a policy for attendance. In general, employees should report to work when the threat of the hurricane has passed and personal circumstances permit. The attendance policy and any other plans should be announced at a general meeting prior to the storm.

b. Survey contacts - Apprise Region and Area staff as to conditions in the District.

c. Cooperators - Make contact with the Federal Emergency Management Agency to initialize a storm-surge study. Make other cooperator contacts as necessary.

2. Administrative Officer

a. Office status - Check on physical structure, electricity, and phone service at office. Start repair procedures in motion. If a mobile phone is available, the phone number should be distributed to employees prior to the storm event. If there is a power outage, the office phones will not work, even though phone service is still functioning. The mobile phone could be used for employees to contact the office, and vice-versa. Also, generators could be used to power some essential equipment or lights.

b. Personnel - Attempt to determine status of employees and notify employees as to office status and attendance policy.

3. Data Section Chief

a. Monitor network - Determine status of satellite link and data collection platforms. Determine status of other gaging stations in affected area.

b. Flood measurement - Determine if flooding has occurred and oversee the organization of field crews and technicians to make flood measurements on streams impacted by heavy precipitation if needed.

4. Studies Section Chief

a. Storm surge - Organize studies section personnel for the collection of high-water marks in the impacted area. Assign someone the duty of project chief and authorize to direct other personnel as needed.

b. Survey contacts - Determine the need for additional personnel and make appropriate contacts to temporarily obtain personnel from other Districts.

c. Other contacts - Notify appropriate agencies as per the decisions of the OFCM Post-Storm Data Acquisitions Working Group.

5. All Other Employees - All employees are responsible for conforming to the predetermined attendance policy. In general, employees are required to report to work when the threat of the hurricane has passed and personal circumstances permit.

II. STORM-SURGE DOCUMENTATION

A. Advance Planning

1. Maps - Several sets of quad maps of coastal areas could be obtained and kept on hand in case of a hurricane event.

2. Transects - Coastal transacts can be defined prior to a hurricane event.

3. Bench marks - Information for bench marks located in coastal counties can be obtained prior to the hurricane event. Sources include the National Geodetic Survey and county engineers.

4. Other agencies - Information about other agencies that would be involved in a hurricane event could be compiled prior to a hurricane event. This would include local agencies such as levee districts and county engineers.

B. Equipment

1. Transportation and lodging - At least one vehicle is needed for each field crew. Personnel on loan from neighboring Districts should be encouraged to bring a vehicle if needed. Boats may be needed to reach remote areas. Lodging in the impacted are may be difficult to obtain due to the influx of insurance adjusters, utility repairmen, etc. Reservations for a lodging as close as possible to the impacted area should be made immediately after the storm.

2. Maps, transacts, and bench marks - Each field crew should be given a set of quad maps for their assigned area. If available, maps and information about bench marks in their area should also be given to each crew.

3. Surveying equipment - Each field crew should have at least one field notebook, level, tripod, rod, 50-ft. steel tape, and folding engineers rule for surveying. They should also have an adequate supply of spray paint, chalk, magic markers, flagging, stakes, nails, cold chisel, and a hammer for flagging and surveying the high-water marks. A carpenters level is also handy for carrying marks around comers.

4. Cameras - Each field crew should have a camera. The disposable cameras work well, but each photograph should be documented in the field book. Polaroid cameras, that give you the photo on the spot, also work well because you can put information directly on the photo. However, getting reprints of these can be costly.

5. Mobile phones - Mobile phones can be useful to field crews. The field crews need to make daily contact with the project chief, at least in the initial stages of the investigation, and the impacted areas have often lost phone services.

6. Global Positioning Systems - The portable "Pathfinder" units work extremely well for documenting high-water mark locations. Elevation measurements made using the larger GPS systems may not produce the level of accuracy required for the study.

7. Other - Field crews may need rubber boots, rain gear, insect repellent, shovels, and machetes. In addition, field crews may need documents or permits from appropriate agencies authorizing passage through road blocks into stricken areas.

C. High-water Mark Data Collection

1. Project Chief

   a. Assignment of duties - The project chief is responsible for the assignment of areas or transacts to the field crews and the designation of a leader for each crew. The project chief is also responsible for providing the field crews with bench-mark information and necessary maps.

   b. Data checks - The project chief is responsible for collecting and checking field data from the crews as it becomes available. Make copies of field notes as they become available. Transfer data from field maps to a master set and check for completeness of coverage and cohesiveness of adjacent high-water mark elevations. The project chief is also responsible for collecting all field notebooks, maps, and film at the end of the surveying phase of the project.

   c. Field perspective - The project chief should spend most of his time in the field collecting data so that he becomes completely familiar with the situation, and can be in constant contact with the other field crews.

   d. Local agencies - The project chief should meet with local, State, and federal agencies with common interests in storm-surge documentation and compare notes and ideas.

2. Field crews

   a. Equipment - Field crews should be responsible for obtaining and maintaining the necessary vehicles and equipment.

   b. Lodging - Field crews should make the necessary lodging arrangements as soon as possible after they receive their assignments.

   c. Documentation - Each crew is responsible for the full and complete documentation of the storm-surge in their assigned area.

3. Flagging high-water marks

a. Locating marks - Talking to locals in the area is the best way to find out about the storm-surge in an area. Stop and ask when you see someone outside of their house or business. Once you've identified one high-water mark it is not too difficult to track it along the transect. Try to locate a mark every mile inland along the transect until the marks end. The best marks are found inside closed structures, or other places that are sheltered from wave action. Always try to find other marks nearby that will corroborate with the one you found.

b. Documenting marks

(1) Location - Note the mark's location on the map and in the field notes. Identify the transect, quad map, street address, and latitude and longitude, if available, in the field notes. Notes should be taken of the location of the mark in or on the structure, and a sketch should be made. Detailed descriptions should be made so that another person could find the mark using the notes. An identifying mark should be made with chalk, magic marker, paint, flagging, etc. in case the actual mark is destroyed by cleaning or rain. The mark should also be assigned a number which is noted at the site, in the notes, and on the map. Preliminary measurements from the floor or ground to the mark should be made using a steel tape or engineer's rule.

(2) Classification - The mark should be classified by line type, such as debris, seed, stain, wash, drift, etc. The quality of the line should also be noted: Excellent, Good +/- 0.1 ft., Fair +/- 0.25 ft., Poor > 0.25 ft. The notes should also indicate whether the mark is inside or outside of a structure.

(3) Photographs - At least one photo should be taken of each high-water mark. Because the lines defining high-water marks can often be faint, the line should be pointed to or otherwise marked for ease in identification in the photo. A photo of the structure should also be taken to facilitate finding it again at a later date. Keep a log of photos taken.

(4) Other - For each high-water mark, identify the members of the flagging crew, the day, and the time of day.

4. Surveying high-water marks

a. Peg test - Conduct a 2-peg test once a week. Note the serial number of the level, the type of rod used, the persons conducting the test, and the date.

b. Survey procedures - Run a survey loop from a bench mark to each high-water mark using standard surveying rules for accuracy. Make at least one ground shot for a representative ground elevation and one water-surface shot for a representative water-surface elevation (if possible). Also survey the tops of levees or roads and ground surfaces on each side. Note the bench-mark identification, high-water mark number, transect, surveying crew, date, and time of day. Keep standard surveying notes.

c. Sketches - Make a detailed sketch or sketches showing location of bench mark, high-water mark, and approximate surveying route.

d. Maps - Transfer the high-water mark elevations to maps and note similarity to elevations of nearby marks. If elevations differ significantly, try to find out why.

III. WATER QUALITY DATA COLLECTION

A. Manpower - The District QW specialist is responsible for organizing the collection of water quality data from areas impacted by the storm. Crews should be made up of two persons each, one to drive the boat, and another to collect samples and conduct measurements. The number of crews used will depend on the size of the impacted area, the sampling coverage desired, and funding.

B. Equipment - Each crew will require a vehicle, boat, sample bottles, Hydrolab, maps, and field notebook. A camera should also be used to record significant effects of the storm, such as damaged trees and fishkills.

C. Sampling Parameters - Dissolved oxygen and biochemical oxygen demand are the important parameters to measure immediately after the storm's passage, especially in wetlands. Nutrient information is also desirable to further document the effects of the storm. Chloride concentration, or specific conductance, are good indicators of the extent of salt-water intrusion into freshwater areas.

D. Sampling frequency - The number of sites sampled is dependent on the availability of funds, the size of the area covered, and the level of coverage desired. The sites should be resampled at a rate sufficient to determine the storm's impact on water quality and the recovery of water quality to normal conditions. The resampling rate will often be higher during the first weeks after the storm, then slow down later as recovery rates are determined.

APPENDIX H

ABBREVIATIONS AND ACRONYMS

-A-

AAWE	American Association for Wind Engineering

-B-

BPAT	Building Performance Assessment Team

-C-

CAP	Civil Air Patrol
CO-OPS	Center for Operational Oceanic Products and Services

-D-

DOC	Department of Commerce
DOD	Department of Defense
DOI	Department of Interior
DOT	Department of Transportation

-E-

ERDC	Engineering Research and Development Center

-F-

FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Maps

-G-

GD	Geologic Division
GPS	Global Positioning System

-N-

NCEP	National Centers for Environmental Prediction
NESDIS	National Environmental Satellite, Data, and Information Service
NIST	National Instititue of Standards and Technology
NMAO	NOAA Marine and Aviation Operations
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NPSDAP	National Post-Storm Data Acquisition Plan
NRCS	Natural Resources Conservation Service
NWS	National Weather Service

-O-

OCWWS	Office of Climate, Water, and Weather Services
OFCM	Office of the Federal Coordinator for Meteorological Services and Supporting Research

-P-

PSDA	Post-Storm Data Acquisition

-Q-

QRT	Quick Response Team

-S-

SLOSH	Sea, Lake, and Overland Surges from Hurricanes model
SPC	Storm Prediction Center

-U-

URL	Uniform Resource Locator
US	United States
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USDA	United States Department of Agriculture
USGS	United States Geological Survey

-W-

WCM	Warning Coordination Meteorologist
WG/NDR/PSDA	Working Group for Natural Disaster Reduction and Post-Storm Data Acquisition
WICP	Water Information Coordination Program
WRD	Water Resources Division
WRS	Weather Reconnaissance Squadron

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