1 Introduction

1.1 PURPOSE

This report presents the findings of the Building Performance Assessment Team (BPAT) regarding building successes and failures during Hurricane Opal and recommends mitigation measures that will enhance the performance of buildings in future storms. The Appendix lists the BPAT members.

Typical construction types are defined for structures built prior to and after the affected communities' adoption of the floodplain management ordinance required for participation in the National Flood Insurance Program (NFIP). Because the ordinance is based on flood hazard information shown on the Flood Insurance Rate Map (FIRM) issued for each community, these structures are referred to as "pre-FIRM" and "post-FIRM," respectively. The BPAT's observations regarding flood and wind damage caused by the storm are described in detail, and recommendations are presented regarding design and construction of new structures and substantial improvements to existing structures; permitting, plan review, and inspection; construction materials; and repair and retrofit of damaged structures.

1.2 BACKGROUND

Hurricane Opal made landfall on Santa Rosa Island, in Santa Rosa County, Florida, near Navarre Beach, at approximately 6:00 p.m. c.d.t. (central daylight time) on Wednesday, October 4, 1995. Fifteen counties in the Florida Panhandle were declared Federal disaster areas (see Figure 1-1). Most of the damage was concentrated in six counties: Escambia, Santa Rosa, Okaloosa, Walton, Bay, and Gulf. Lee County, along the gulf coast in southwest Florida, was declared a Federal disaster area because of rainfall-induced flooding associated with the same storm system.

The most severe damage caused by Opal was concentrated along a 200-mile stretch of Florida's Gulf of Mexico shoreline, between Pensacola Beach (Escambia County) and St. Joseph Spit (Gulf County). This is the area where the BPAT conducted its field inspections (see Figure 1-1). The results of these inspections and the BPAT's review of post-storm video taken by the Florida Department of Environmental Protection (FDEP), Bureau of Beaches and Coastal Systems, led to the conclusion that most of the structural damage associated with the storm was caused by coastal flood forces — storm surge, wind-generated waves, storm-induced erosion, and floodborne debris. Flood damage also occurred along the shorelines of Santa Rosa Sound, Choctawhatchee Bay, and other inland waters.

Wind damage along the coast was confined largely to roof damage, sign damage, tree damage, and similar impacts and was judged by the BPAT to be less severe and less extensive than the flood damage. However, wind damage extended throughout the affected counties. Newspaper accounts indicated that approximately 18,000 dwelling units (e.g., homes, apartments, hotel/motel units) in 10 panhandle counties were rendered uninhabitable by Hurricane Opal and approximately one-fifth of these units were destroyed (*Panama City News Herald* 1995). The BPAT was unable to confirm these estimates.

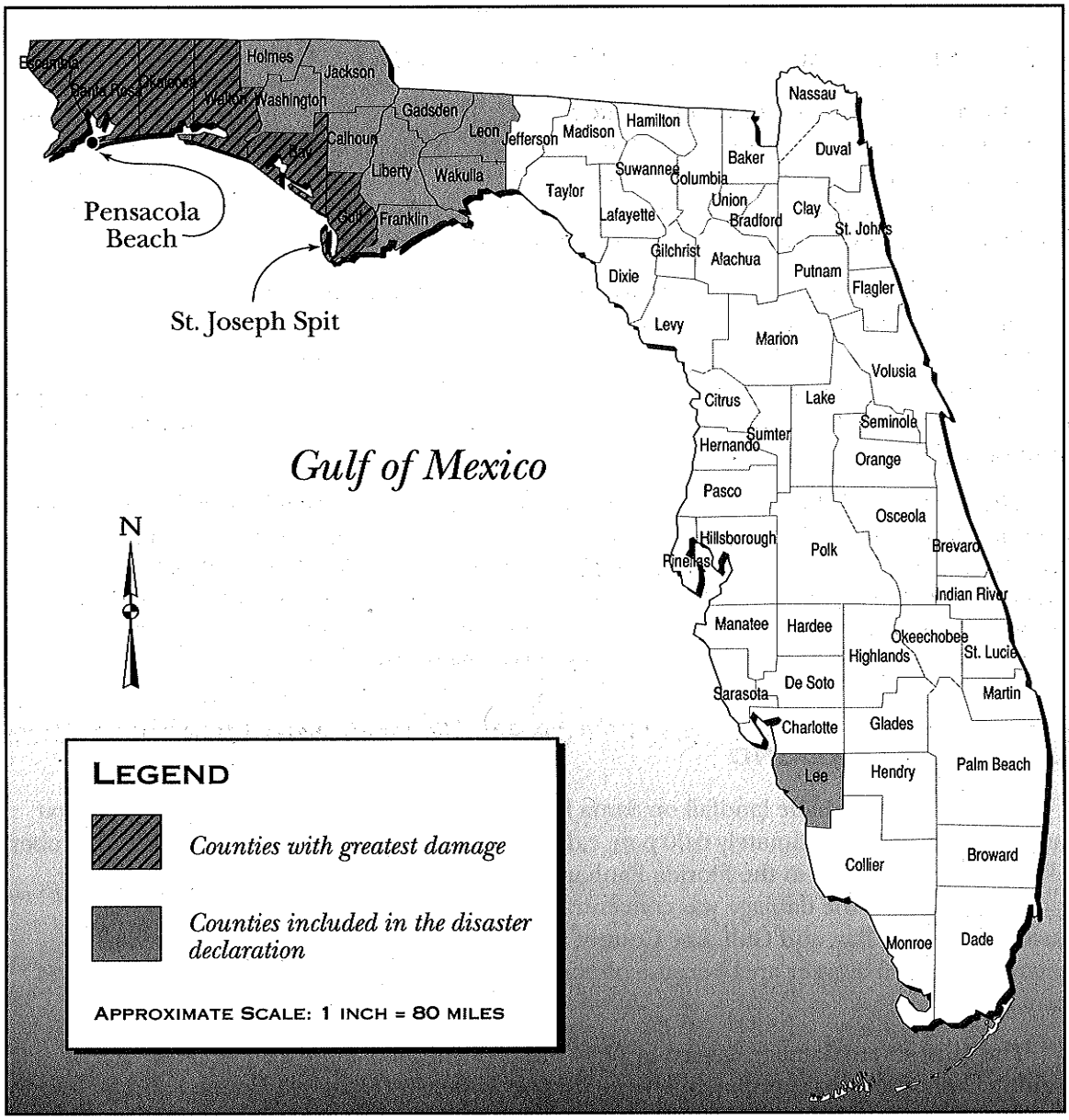

Figure 1-1 Florida counties included in the Hurricane Opal Federal disaster declaration.

Data from the FDEP (1995) indicate that approximately 990 coastal structures along the Gulf of Mexico shoreline incurred 50 percent or more damage (i.e., substantial damage). This total includes over 500 single-family dwellings and over 300 multi-family structures (containing 1,000 dwelling units and 800 motel/hotel units). The FDEP data also show that over 3 miles of concrete and timber bulkheads and retaining walls were damaged or destroyed. According to State of Florida estimates, more structures were damaged or destroyed by the effects of flooding and erosion during Hurricane Opal than in all other coastal storms affecting Florida in the past 20 years combined.

Preliminary estimates from the insurance industry show total insured losses from wind damage from the storm to be approximately $2 billion, making Opal one of the most costly natural disasters to affect the United States (ranking only behind Hurricane Andrew; the Northridge, California, earthquake; and Hurricane Hugo).

1.3 HURRICANE OPAL — STORM CONDITIONS

Hurricane Opal was classified as a Category 3 storm on the Saffir-Simpson scale at the time of landfall, with a central pressure of 940 millibars (mb) and recorded sustained wind speeds of approximately 110 to 115 miles per hour (mph). Recorded wind speeds rapidly decayed to 86 to 92 mph just inland. The storm was moving north-northeast with a forward speed of 22 mph at landfall (National Oceanic and Atmospheric Administration 1995).

Water level data from a National Oceanic and Atmospheric Administration (NOAA) tide gage on the Panama City Beach pier show a peak water level of approximately 8.5 feet above Mean Lower Low Water (MLLW) at 6:00 p.m. c.d.t., nearly 8 feet above the predicted astronomical tide. Water level data from the NOAA gage at Apalachicola show a peak water level of approximately 6.6 feet MLLW at 7:30 p.m. c.d.t., approximately 6 feet above the predicted astronomical tide.

High-water mark surveys conducted after Hurricane Opal (Michael Baker, Jr. 1995) show that water levels ranged from approximately 8 to 11 feet National Geodetic Vertical Datum (NGVD) along Santa Rosa Island between Pensacola Beach and Fort Walton Beach, approximately 12 to 20 feet NGVD between Destin and Seagrove Beach, and approximately 8 to 12 feet NGVD along Panama City Beach.

1.4 LOCAL, STATE, AND FEDERAL SITING AND BUILDING CODE REQUIREMENTS

Construction along and near the shoreline in the study area was generally governed by one or more of the following: the Standard Building Code, enforced by local or county governments; NFIP construction requirements — in identified Special Flood Hazard Areas — enforced by local or county governments; and State construction requirements for structures seaward of the Coastal Construction Control Line (CCCL), enforced by FDEP, Bureau of Beaches and Coastal Systems (formerly known as the Florida Department of Natural Resources, Division of Beaches and Shores).

FIRMs which show Base Flood Elevations (BFEs) that include wave height effects were adopted by communities in the study area between June 1983 and August 1987. (The base flood, also referred to as the 100-year flood, is the flood that has a 1-percent probability of being equaled or exceeded in any given year and is the basis for the regulatory requirements of the NFIP.) Because the NFIP Flood Insurance Studies on which the FIRMs are based were completed at different times, during which V-Zone mapping criteria were evolving, some of the studies accounted for wave setup, wave runup, and erosion, and others did not.

The Flood Insurance Studies indicate that the predicted 100-year stillwater (or storm surge) elevations along the majority of the Gulf of Mexico shoreline in the study area range from 4 feet to 6 feet NGVD. In the same area, V-Zones generally range from 100 to 300 feet in width and the wave crest elevations in the V-Zone range from 7 to 9 feet NGVD. Higher elevations are indicated for the Pensacola Beach and Perdido Key areas, where the predicted 100-year stillwater elevations range from 8 feet to 12 feet NGVD, V-Zones range from 200 to 400 feet in width, and V-Zone wave crest elevations range from 12 to 15 feet NGVD.

The State of Florida established the CCCL along Florida's sandy beach shorelines to delineate those areas subject to erosion or other adverse impacts during a 100-year storm. Specific elevation and construction requirements are enforced by the State seaward of the CCCL. With the exception of Bay County, the portions of the CCCL in the study area were adopted by the State between 1982 and 1991 and reflect anticipated 100-year storm impact zones. However, the pre-Opal CCCL in Bay County was essentially unchanged from a 50-foot setback line established by the State in 1975 and did not include all areas subject to 100-year storm impacts. After Hurricane Opal, the State adopted a revised CCCL for Bay County on an emergency basis. The new line is 100 feet landward of the pre-Opal line and became effective on October 16, 1995. Reconstruction of many damaged or destroyed structures along the Bay County shoreline will now be subject to CCCL construction requirements.

The FDEP has also completed its own studies that predict 100-year stillwater elevations along the Gulf of Mexico shoreline. FDEP studies for the reach between Escambia and Bay Counties generally show 100-year stillwater elevations ranging between 11 feet and 12 feet NGVD. The 5-foot to 6-foot difference between FDEP and NFIP 100-year stillwater levels is attributed to the inclusion of dynamic wave setup by FDEP.

A comparison of V-Zone boundaries and the location of the State's CCCL had not been completed at the time this report was prepared (a comparison is expected by late 1996). However, the State's foundation and elevation requirements seaward of the CCCL (i.e., pile penetration requirements and lowest floor elevations) are known to be more stringent than NFIP V-Zone requirements. Likewise, the State's wind load requirements seaward of the CCCL are known to be more stringent than the wind load requirements of the Standard Building Code. According to the FDEP (1995), no major habitable structures located seaward of the CCCL and permitted by the State under current standards sustained significant structural damage during Hurricane Opal. In contrast, the FDEP reported that over one-half of the pre-existing major habitable structures seaward of the CCCL (i.e., structures either not permitted by the State or constructed prior to State permitting requirements) sustained structural damage during the storm.