B. Sources for Flood Information

To develop an effective manufactured home installation strategy applicable to a flood hazard area, several hydrological factors must be evaluated. These include the regulatory floodplain boundaries and the anticipated flooding characteristics for the site, such as location of the floodway, depth, velocity, duration, rate-of-rise, and frequency. Various sources for this information are available. Also, there are methods by which portions of such information can be individually developed.

As part of the NFIP, FEMA develops FIS reports that contain the most current and detailed information available for a community. Such studies can include a FIRM and a Flood Boundary and Floodway Map (FBFM). Although studies completed prior to 1986 are no longer separate from FIRMs, many communities still have pre-1986 studies and an FIS report from which the following information can be obtained:

- Floodplain and floodway boundaries
- Stream profiles that show the elevations of the 100-year or "base flood" (a flood that has a 1-percent chance of being equaled or exceeded in any given year) and other flood events
- Mapped base flood elevations that can be used to develop flood depths for a specific site in combination with other data
- Flood velocity data
- Flood frequency data
- Flood discharge data
- Historical flood information

FIS reports can be extremely valuable sources for much of the information necessary to evaluate a potential manufactured home site. The specific hydrologic data elements, and ways to obtain them, are described below.

B.1 Map Modernization and Risk Mapping, Assessment, and Planning (Risk MAP)

FEMA developed a plan in 1997 to modernize the FEMA flood mapping program. The plan outlined the steps necessary to update FEMA's flood maps for the nation to digital format and streamline FEMA's operations in raising public awareness of the importance of the maps and responding to requests for revision. Since 1997, the plan has continually evolved as new

products, processes, and technical specifications have been developed and implemented within current funding levels. The goal of FEMA's Map Modernization Plan is to upgrade the 100,000 panel flood map inventory by the following methods:

- Develop up-to-date flood hazard data for all flood-prone areas nationwide to support sound floodplain management and prudent flood insurance decisions
- Provide the maps and data in digital format to improve the efficiency and precision with which mapping program customers can use this information
- Fully integrate FEMA's community and State partners into the mapping process to build on local knowledge and efforts
- Improve processes to expedite creating and updating the maps
- Improve customer services to speed processing of flood map orders and raise public awareness of flood hazards

Building on the Map Modernization Program, FEMA's Risk Mapping, Assessment, and Planning (Risk MAP) is a seamless program aimed at reducing losses of life and property through effective local mitigation activities enabled by quality flood hazard data, risk assessments, and mitigation planning. Risk MAP will provide an integrated national assessment of risks based on digital flood hazard data and web-accessible data. Risk MAP information and tools will help communities develop informed mitigation plans that will reduce losses from natural hazards.

The goals of Risk MAP are:

- Flood Hazard Data: Address gaps in flood hazard data to form a solid foundation for risk assessments, floodplain management, and actuarial soundness of the National Flood Insurance Program.
- Public Awareness/Outreach: Ensure that a measurable increase of the public's awareness and understanding of risk results in a measurable reduction of current and future vulnerability.
- Hazard Mitigation Planning: Lead and support State, Local, and Tribal communities to effectively engage in risk-based mitigation planning resulting in sustainable actions that reduce or eliminate risks to life and property from natural hazards.
- Enhanced Digital Platform: Provide an enhanced digital platform that improves management of Risk MAP and also improves communication and sharing of risk data and related products to all levels of government and the public.
- Alignment and Synergies: Align Risk Analysis programs and develop synergies to enhance decision-making capabilities through effective risk communication and management.

B.2 Flood Study Software Programs

FEMA has approved the use of several modeling programs to support the NFIP and flood hazard mapping. These programs were created by various agencies and organizations, including the

U.S. Natural Resources Conservation Service (NRCS), U.S. Army Corps of Engineers (USACE), U.S. Department of Agriculture (USDA), U.S. Geological Survey (USGS), and FEMA mapping contractors. Information about approved software is available at the FEMA website at http://www.fema.gov/plan/prevent/fhm/frm_soft.shtm. The models can be organized into several categories:

Nationally Accepted Models

- **Coastal Models:** coastal storm surge, coastal wave height, and coastal wave effect models, including FEMA Surge, AdCIRC, WHAFIS 3.0, and RUNUP 2.0.
- **Hydrologic Models:** single event, continuous event, and interior drainage analysis models, including HEC-1, HEC-HMS, and TR-20.
- **Hydraulic Models:** one-dimensional steady flow, one-dimensional unsteady flow, two-dimensional steady/unsteady flow, and floodway analysis models, including HEC-RAS, HEC-2, and WSPRO.

Coastal model outputs include stillwater elevations (FEMA Surge and AdCIRC), wave height profiles along a transect (WHAFIS 3.0), and wave run-up elevations (RUNUP 2.0). Hydrologic model outputs are generally discharge values. Hydraulic model outputs include floodway analyses (where applicable) and flood elevations for 10-, 2-, 1-, and 0.2-percent exceedance probability floods.

Locally Accepted Models

- **Hydrologic Models:** single event models
- **Hydraulic Models:** one- and two-dimensional unsteady flow models

The FEMA website also provides guidance on the use of automated hydrologic and hydraulic (H&H) techniques as part of the NFIP Map Modernization efforts at http://www.fema.gov/plan/prevent/fhm/mm_main.shtm.

B.3 Flood Hazard Boundaries

Flood hazard boundaries must be identified for the different degrees and types of flooding, including floodways, floodway fringe areas, coastal high hazard areas, coastal fringe areas, and shallow flooding areas. These boundaries are significant for determining the specific flood hazard zones that would be part of a proposed development site and, thereby, influence site development. In addition, boundaries indicate where floodplain management regulations and flood insurance requirements apply. Flood hazard boundary data can be obtained from FBFMs, FIRMs, and floodplain maps, or can be developed from topographic maps, zoning maps, aerial photographs, and related hydrologic data.

B.4 Flood Depth

Flood depths are determined by the difference between water surface elevations at times of flooding and normal ground surface elevations. This information is important both in determining the elevations at which floodwaters will likely cause damage and in defining the appropriate elevations for flood insurance and floodplain management regulations. Flood depths also influence the hydrostatic forces in effect during flooding, including the horizontal loads that can cause lateral displacement or overturning and the vertical loads that can cause uplift and flotation. Therefore, it is important to know the flood depth to determine appropriate foundations for the site.

Flood depths for a particular site can be derived using a FIRM showing BFEs in combination with a topographic map depicting ground elevations. Flood depth data are also available from various technical studies that include flood elevations, water surface profiles, or stream and coast cross-sections. In the absence of official reports, information on flood depths can be obtained from site surveys and historical records.

B.5 Floodwater Velocity

The average and maximum velocity of floodwater determines the hydrodynamic forces that influence horizontal loads in excess of hydrostatic loads. Velocity also affects the magnitude of debris impact loads (i.e., force of flotation objects carried by floodwaters), and can increase erosion and affect soil stability on slopes. Data on water velocity are listed in Floodway Data Tables and are often included in FIS reports. Data might also be available from various floodplain technical studies or determined by special hydrological studies. FIS Floodway Data Tables include the mean velocity of floodwaters (for the base flood event) within the floodway. These mean velocities can be used to estimate the upper limit of floodwater velocity in the adjacent flood fringe portion of the floodplain.

Velocity can also be calculated by assuming floodwaters are at a uniform flow, estimating some floodplain characteristic, and using Manning's Equation:

$$V = \left(\frac{k}{n}\right)\left(\frac{A}{P}\right)^{2/3}(S)^{1/2}$$

Where: V = Average flow velocity (fps)

k = 1.49, unit conversion

A = Cross-sectional flow area (square feet) (shaded area, Figure B-1)

P = Wetted perimeter of A (feet) (labeled in Figure B-1)

$\left(\frac{A}{P}\right)$ = Hydraulic radius (feet)

S = Gradient (feet/feet) (use average ground surface slope within a reach from approximately 0.5 mile upstream to approximately 0.5 mile downstream)

n = Manning's channel roughness coefficient, empirical value developed through lab testing of flow through a pipe

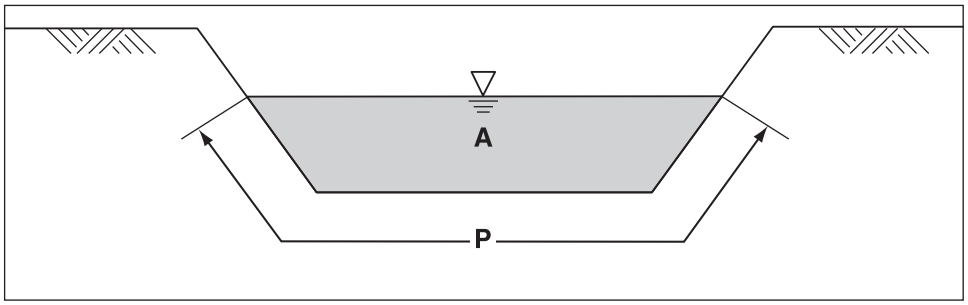

Figure B-1. Stream cross-section for Manning's Equation

B.6 Frequency

Frequency of flooding is a major consideration in evaluating potential installation sites. Frequency of flooding is the probability (in percent) that a random flood event will equal or exceed a specified magnitude in a given time period. Manufactured homes sited at lower elevations near a flooding source will likely have higher frequency of flooding than those located at higher elevations. Flood frequency information is included in FIS reports and other technical floodplain studies. Frequency of flooding can also be statistically determined using historical records.

If manufactured homes are installed on sites vulnerable to high frequency floods (i.e., floods that occur often), there is a greater risk of damage and there will be a need for more frequent evacuations. Not only do frequent evacuations present an increased risk to owners and/or tenants, but also to a community's emergency management officials who provide assistance during evacuations.

B.7 Rate of Rise

The rate of rise is how rapidly water depth increases during a flooding event. This factor is important in evaluating buoyancy hazards and investigating the feasibility of an evacuation plan. The rate can be derived from a stream flow hydrograph that compares flooding depth to time for the area under consideration. Determining the rate of rise requires information that may be obtained from existing hydrological studies, on-site investigations, historical records, and nearby gauge records.

B.8 Duration

The duration of a flood is a function of the rate of rise and fall of water. Duration influences the saturation of soils and building materials, the amount of seepage, and the length of time that a

manufactured home might be inaccessible. Various floodplain technical studies and historical records are sources of information concerning duration of flooding.

B.9 Sources of Information

Tables B-1 and B-2 provide sources of various types of information and assistance.

Table B-1. Floodplain Management Information

Floodplain Agencies	Data Type							
	Floodproofing Information	Preserve Channel Capacity	Development Regulations	Land Use Controls	Floodwater Control	Public Information	Post-Flood Relief	Flood Warning System
Federal Emergency Management Agency	■		■		■	■	■	
U.S. Army Corps of Engineers	■	■	■		■	■	■	■
Natural Resources Conservation Service	■	■			■		■	
Department of Housing and Urban Development			■				■	
National Oceanic and Atmospheric Administration					■			■
U.S. Geological Survey					■			
Federal Highway Administration		■			■	■		
State Floodplain Management Coordinating Agency	■	■	■	■	■			
Regional Authorities	■	■	■		■	■	■	
Local Government Planning Agencies			■	■	■			

Table B-2. Summary of Hydrologic Data Sources

Agencies	Data Type															
	Coastal Surveys and Reports	Flood Control Measures	Flood Boundary Maps	Flood Insurance Rate Maps	Floodplain Information Reports and Technological Studies	Flood Records and Probabilities	Hydrologic Atlases	National Flood Insurance Program Regulations	State Floodplain Regulations	Technical Assistance	Topographic Maps	Zoning Ordinances and Maps	Coastal Modeling Software	Hydrologic Modeling Software	Statistical Modeling Software	Hydraulic Modeling Software
Federal Emergency Management Agency	■	■	■	■				■		■			■	■	■	
U.S. Army Corps of Engineers	■	■	■	■	■	■				■	■	■	■	■	■	■
National Resources Conservation Service		■			■	■								■		
National Oceanic and Atmospheric Administration	■				■	■							■	■		
U.S. Geological Survey					■	■	■				■			■	■	■
State Floodplain Management Coordinating Agency	■	■	■	■		■		■	■	■						
Regional Authorities (e.g., Tennessee Valley Authority)		■			■	■				■	■			■		
Local Government Planning Agency or Municipal Engineer	■	■	■	■	■	■		■	■	■	■	■	■	■		■