

# Biltmore Village Emergency Flood Response Plan



US Army Corps of Engineers  
Nashville District

March 2009

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# Executive Summary

## 1.0 PROJECT PURPOSE AND HISTORY

### 1.1 Project Purpose

The purpose of this project is to develop a Basic Emergency Flood Response Plan (EFRP) for the Biltmore Village area. This document is the Basic EFRP. The intent of the plan is to provide guidance and recommendations which allow the owners, merchants, employees and residents (referred to as “you” in the document) to take action to protect themselves and minimize loss or damage in the event of rising flood waters. The plan includes structure-specific recommendations for both short- and long-term protection of your structures to the maximum practicable depth, and includes guidance on what actions to take after notification of an imminent flood event storm.

Your participation in the project is voluntary. The Nashville District, Corps of Engineers (Corps) and City of Asheville (CoA) encourage you to read this document and give serious consideration to implementing measures to protect yourself and your structures. Such implementation would be at your sole expense.

Although this plan and the flood proofing recommendation have been developed for the Biltmore Village area, the flood proofing concepts are not applicable only to Biltmore Village. The Corps encourages the local governments and stakeholders in Biltmore Village to share this document with others who may benefit.

### 1.2 Project History

In back-to-back weeks in September 2004, Asheville and the surrounding communities were flooded by remnant hurricanes Francis and Ivan. The damages were especially significant and concentrated in Biltmore Village. The State of North Carolina quickly passed the Hurricane Recovery Act of 2005 (Senate Bill 7) which directed funding of a comprehensive planning study to alleviate suffering caused by the flooding. It is a priority with the North Carolina Department of Environment and Natural Resources (NCDENR) and CoA to identify measures that can be taken to reduce future flood damages and to implement those measures. This EFRP project was identified by NCDENR as one of the highest priorities. The Corps executed a Planning Assistance to the States Cost-sharing Agreement with CoA on September 27, 2007 for preparation of the Biltmore Village EFRP. The project is equally funded by the Corps and CoA.

### 1.3 Historical Significance of the Biltmore Village Area

There is a vast wealth of historic properties located within the study area. It is critical that the effects of the various flood proofing options presented in this plan be considered prior to implementing the options. The following comments are made pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for Compliance with Section 106 codified at 36 CFR Part 800.

Almost all of Biltmore Village is listed in the National Register of Historic Places (NR), as well as being a locally designated Historic District (LHD) by the City of Asheville. Further, the Biltmore Estate is a National Historic Landmark (NHL); its gatehouse is located within the study area.

Owners of buildings listed in the NR or buildings that contribute to the historic district or an NHL are advised to consult with the North Carolina State Historic Preservation Office (HPO) before undertaking any permanent flood mitigation measures.

Furthermore, building owners in the Biltmore Village LHD must obtain approval from the HPO and the Asheville Historic Resources Commission (HRC) before undertaking any exterior alterations, including placement of hooks or bolts for use in temporary flood proofing. A Certificate of Appropriateness (COA) from the HRC will be required for any alterations to the exterior of the structure. An application for a minor work COA can be obtained by contacting the HRC or visiting their website at [http://www.ashevillenc.gov/business/development\\_services/DevBoardsComm/default.aspx?id=1112](http://www.ashevillenc.gov/business/development_services/DevBoardsComm/default.aspx?id=1112) . Owners are also advised to consult with commission staff when planning permanent flood mitigation measures.

Some permanent flood proofing measures recommended in this plan, particularly alteration of windows, doors, and application of veneers, may alter or destroy historic materials and character-defining features of historic buildings. These measures should not be undertaken without consultation with the above-referenced agencies and organizations. Evaluated within a Section 106 review, these measures would be considered an adverse effect and would jeopardize a building owner's use of state and federal rehabilitation tax credits.

Some measures, if applied selectively, would not necessarily harm a building's historic character. For example, several buildings in the Biltmore Village NR Historic District implemented permanent flood proofing measures, after they were approved as part of a Section 106 undertaking and state and federal rehabilitation tax credit review. The approved measures included: replacement of damaged wooden floor structures with poured concrete floor and foundation systems; elevation of electrical, HVAC, and utility systems; and selective fill-in of windows and basement doors and stairwells. It is always necessary to evaluate the effects of permanent flood proofing measures to historic buildings on a case-by-case basis.

The points of contact for consultation are Jennifer Cathey (phone 828-274-6789, email [Jennifer.cathey@ncdcr.gov](mailto:Jennifer.cathey@ncdcr.gov) ) in the Asheville office of HPO for technical advice and Renee Gledhill-Earley in Raleigh (phone 919-807-6579, email [renee.gledhill-earley@ncdcr.gov](mailto:renee.gledhill-earley@ncdcr.gov) ) for all other HPO matters. Point of contact with the CoA HRC is Stacy Merten (phone 828-259-5836, email [smerten@ashevillenc.gov](mailto:smerten@ashevillenc.gov) )

The following lists account for buildings with historic designation within the study area. Building numbers are as shown on the maps located within Appendices A and B.

Contributing buildings (and units) in the Biltmore Village National Register Historic District: 0 through 9, 11, 24, 25, 31, 37, 42, 49, 51-55, 60, 61, 75, 83, 84, 86, 89, 90, 91, 93, 94, 97, 100 and 107.

Contributing buildings in the Biltmore Estate NHL District: 105

Biltmore Hardware Building (individually listed in NR): 22 and 26.

## **2.0 PROJECT ACTIVITIES**

Though the Corps prepared this document, CoA officials and the stakeholders in Biltmore Village provided significant input that was incorporated into the plan. Also, the plan has been reviewed by NCDENR and the HPO.

The project boundaries were determined by the Corps and CoA. The study area includes 74 structures which involve approximately 53 owners and 105 businesses. Figure 1 shows the boundaries and the existing 100-year inundation area in Biltmore Village. Though the Corps' goal was to provide protection up to the 100-year flood event level, portions of Biltmore Village are more vulnerable to flooding than others and achieving a 100-year level of protection was not possible for the more flood-prone structures. The Corps' approach was to recommend temporary flood proofing methods that would protect each structure up to the maximum level of protection afforded by those measures (which is three feet) and permanent measures on a structure-by-structure basis.

## **3.0 DEVELOPMENT OF THE EFRP**

The overall EFRP consists of the Basic plan presented in this document, plus Appendices A (Temporary Flood Proofing Measures) and B (Permanent Flood Proofing Measures) and the structure-specific plan to be prepared by you. After review and consideration of the recommendations in this document (including the Appendices), you need to decide if you want to implement any or all of the recommendations. If so, you will need to develop your structure-specific plan.

Temporary flood proofing measures consist of plastic sheeting, plywood, caulk, sandbags and other quick, short-term solutions. They can only be used up to a limited level of flooding, generally three feet above the first floor elevation. Appendix A contains a detailed discussion of temporary flood proofing measures, including the materials that

may be needed, how they can be obtained and estimated costs. It also contains flood elevation data and temporary flood proofing suggestions for each structure.

Though permanent flood proofing is not normally addressed in an emergency action plan, the Corps has included it in this plan for your benefit. Permanent flood proofing measures are those, like relocation and raising, which are implemented once and offer long-term flood protection. Appendix B contains a detailed description of these measures as well as flood elevation data and permanent flood proofing suggestions for each structure.

The scope of work for this project did not allow the Corps to evaluate each structure and its site in sufficient detail to guarantee that the structure will withstand water standing a certain height above the first floor or that the permeability of the soil around the structure is such that we can recommend with confidence what pumping capacity should be used to keep the structure dry during a flood. It is incumbent upon you to be responsible for these important considerations. It may be that you or a number of other interested individuals will want to jointly hire a contractor and/or a consulting engineer to evaluate your properties.

#### **4.0 YOUR SUPPLEMENT TO THE EFRP AND NEXT STEPS AFTER RECEIPT OF THIS BASIC EFRP**

After receipt of this plan, the sequence and recommended schedule of the primary activities incumbent upon you are as follows:

- 1) As soon as possible before June 1, 2009 - Read this document and determine what, if any, measures from Appendices A or B you want to consider implementing. If you choose to incorporate any of the recommended flood proofing, have your property evaluated by a contractor or consulting engineer.
- 2) Before June 1, 2009 - Develop your structure-specific plan to supplement this Basic EFRP.
- 3) Before June 1, 2009 - If you decide to use temporary flood proofing measures, purchase and store the necessary materials and equipment and pre-cut any plywood to the correct sizes.
- 4) Before June 1, 2009, if possible; otherwise, before June 1, 2010 - If you decide to utilize permanent flood proofing measures, implement those measures.

Note that June 1, 2009 is the recommended goal because it is the official start of the next hurricane season. It would still be to your advantage to develop your plan, obtain materials and equipment for the temporary measures, or implement permanent measures, even after that date.

## **5.0 THE EFRP IN ACTION**

When the EFRP is put into use, the sequence of the primary EFRP activities is:

- 1) Notification of an Imminent Flood Event,
- 2) Implementation of the Plan,
- 3) Evacuation and Related Activities,
- 4) Monitoring of Flood Proofing during the Flood Event,
- 5) Notification to Return and Public Information during and after the Flood, and
- 6) Post-flood Recovery.

Those primary activities are discussed in detail in this plan. It needs to be stressed that a primary way that implementation can start is for you to decide for yourself when to implement the EFRP. This decision would be based upon an extended weather forecast, your comfort level, the amount of time required for you to prepare your structure and other factors.

Though it is not possible to develop a schedule for all flood events and all structures, a conceptual schedule of the primary EFRP activities is:

- 1) As much as 72 hours before arrival of flood event – Receive notification of the potential flood event, and cut plywood for any closures (if not already cut).
- 2) 72-24 hours before arrival of flood event - Implement your flood proofing plan.
- 3) 24 hours or less before flood waters reach your structure – Evacuate.
- 4) During the event - Monitor news via radio and weather radio, TV (including the City Channel), the world wide web, the newspaper and the City web site. If allowed and if you choose to take the risk, periodically survey the structure and flood proofing. Prepare for post-storm recovery.
- 5) After the storm – If needed, CoA dispatches damage assessment teams. CoA coordinates with citizens about re-entry and gives re-entry notification. Re-enter and perform post-storm recovery.

## **6.0 INFRASTRUCTURE AND RESOURCE MANAGEMENT**

Because flood events can affect the CoA infrastructure in many ways, this plan discusses how the infrastructure (electrical power, water and wastewater treatment, transportation, and health and government services) can be affected by flooding events and how the City plans to recover this infrastructure after a flood event. Contact information for the key Asheville and Buncombe County departments and utilities, and federal agencies is located in Table 1.

## **7.0 MAINTENANCE OF THE EFRP**

It is recommended that you and the City perform periodic maintenance on the EFRP. This maintenance should consist of three components:

- To maintain the accuracy and effectiveness of the plan, the City and stakeholders should review the plan annually. This review and any required updating should be completed before June 1 of each year, which is the start of hurricane season.
- If the plan is implemented due to a flood event early enough in the hurricane season to warrant doing so, the plan should be reviewed (similar to the review addressed above) no later than 30 days after implementation. This will allow lessons learned to be incorporated into the plan in advance of the next flood event.
- Concurrent with the annual review, all phone numbers (including those for CodeRED and points of contact in Table 1) should be confirmed and CodeRED tested.

## **8.0 EFRP BROCHURE**

A summary of the plan, including the key activities (starting with notification of an imminent flood event) and contact information, has been condensed into a brochure. Two copies of this brochure are attached as Appendix C. It is recommended that you keep a copy of the brochure in plain sight as a reminder that the plan exists and how to implement it.

**Biltmore Village  
Emergency Flood Response  
Plan**

**March 2009**



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## **1.0 PROJECT PURPOSE AND HISTORY**

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The purpose of this project is to develop a Basic Emergency Flood Response Plan (EFRP) for the Biltmore Village area. This document is the Basic EFRP. The intent of the plan is to provide guidance and recommendations which allow the owners, merchants, employees and residents (referred to as “you” in this document) to take action to protect themselves and minimize loss or damage in the event of rising flood waters. The plan is intended to guide you in providing both short- and long-term protection of your structures to the maximum practicable depth, and includes guidance on what actions to take after notification of an imminent flood event, including evacuation and post-flood recovery.

The study does not consider any permanent alternative that protects the entire Biltmore Village area; flood damage reduction alternatives of that magnitude are being considered in other studies.

Your participation in this project is voluntary. The Nashville District, Corps of Engineers (Corps) and City of Asheville (CoA) encourage you to read this document and give serious consideration to implementing measures to protect yourself and your structure. Such implementation would be at your sole expense.

Although this plan and the flood proofing recommendations have been developed for the Biltmore Village area, the flood proofing concepts are not applicable only to Biltmore Village. The Corps encourages the local governments and stakeholders in Biltmore Village to share this document with others who may benefit.

### **1.2 Project History**

In back-to-back weeks in September 2004, Asheville and the surrounding communities were flooded by remnant hurricanes Francis and Ivan. The damages were especially significant and concentrated in Biltmore Village. The State of North Carolina quickly passed the Hurricane Recovery Act of 2005 (Senate Bill 7; SB7) which directed funding of a comprehensive planning study to alleviate suffering caused by the flooding. It is a priority with the North Carolina Department of Environment and Natural Resources (NCDENR) and CoA to identify measures that can be taken to reduce flood damages in the future and to implement those measures. NCDENR hired Carter & Burgess who, with the assistance of numerous stakeholders in the watershed, developed a list of priorities for the Swannanoa watershed. One of the highest priorities was development of an EFRP for Biltmore Village. The Corps executed a Planning Assistance to the States Cost-sharing Agreement with CoA on September 27, 2007 for preparation of the Biltmore Village EFRP. The project is equally funded by the Corps and CoA.

### **1.3 Historical Significance of the Biltmore Village Area**

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Furthermore, building owners in the Biltmore Village LHD must obtain approval from the HPO and the Asheville Historic Resources Commission (HRC) before undertaking any exterior alterations, including placement of hooks or bolts for use in temporary flood proofing. A Certificate of Appropriateness (COA) from the HRC will be required for any alterations to the exterior of the structure. An application for a minor work COA can be obtained by contacting the HRC or visiting their website at [http://www.ashevillenc.gov/business/development\\_services/DevBoardsComm/default.aspx?id=1112](http://www.ashevillenc.gov/business/development_services/DevBoardsComm/default.aspx?id=1112) . Owners are also advised to consult with commission staff when planning permanent flood mitigation measures.

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Some measures, if applied selectively, would not necessarily harm a building's historic character. For example, several buildings in the Biltmore Village NR Historic District implemented permanent flood proofing measures, after they were approved as part of a Section 106 undertaking and state and federal rehabilitation tax credit review. The approved measures included: replacement of damaged wooden floor structures with poured concrete floor and foundation systems; elevation of electrical, HVAC, and utility systems; and selective fill-in of windows and basement doors and stairwells. It is always necessary to evaluate the effects of permanent flood proofing measures to historic buildings on a case-by-case basis.

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The following lists account for buildings with historic designation within the study area. Building numbers are as shown on the maps located within Appendices A and B.

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Contributing buildings in the Biltmore Estate NHL District: 105

Biltmore Hardware Building (individually listed in NR): 22 and 26.

## **2.0 PROJECT ACTIVITIES**

### **2.1 General.**

Though the Corps prepared this document, CoA officials and the stakeholders in Biltmore Village provided significant input that was incorporated into the plan. Also, the plan has been reviewed by NCDENR and the HPO.

The Corps and CoA hosted a “kick-off” meeting at the Corner Kitchen on October 22, 2007 to discuss the project; at that meeting, which was attended by a small group of stakeholders, it was agreed that an owner/tenant/resident questionnaire should be prepared and distributed to collect information useful in developing a meaningful plan. Soon thereafter, the Corps developed its internal project team which consisted of the Corps’ National Nonstructural Flood Proofing Committee (NFPC), David Ford and Associates and personnel from the Corps’ Nashville District. The role of the NFPC was to offer technical assistance on the temporary and permanent flood proofing measures. David Ford’s role was to help determine the content of the EFRP and provide document review.

The boundaries of the study area are shown in Figure 1. The Corps and CoA worked together to determine the project boundaries. The project includes 74 structures which involve approximately 53 owners and 105 businesses.

The Corps reviewed the latest hydraulic data, set up the structure data base, identified the owner/tenant/resident for each structure and obtained contact information, distributed the questionnaire, attempted numerous times to contact each owner/tenant/resident in an effort to obtain the maximum number of completed questionnaires, evaluated the 34 completed questionnaires received, surveyed the first floor elevations of the structures, met with the NFPC and stakeholders at the Biltmore Estate and visited Biltmore Village to receive input from the stakeholders and inspect the structures, and developed this plan and its recommendations.

### **2.2 Hydrology**

Through meetings with the Biltmore Village Merchants Association, the Corps understood that a good design event to use in developing this EFRP would be the September 2004 event in Asheville. However, after several site visits to Biltmore Village, the Corps determined that for many of the structures in Biltmore Village protecting with temporary flood proofing measures to the level of the 2004 floods is not possible because those measures are not designed to protect a structure against a flood more than about three feet above the first floor.

Similarly, in considering providing protection for all structures up to the 100-year flood event level, achieving this is not possible for the more flood-prone, low-lying structures. A large portion of Biltmore Village is inundated during a 100-year event.

Ultimately, the Corps decided to recommend temporary flood proofing for each structure up to the maximum level of protection afforded by those measures (which is three feet) and permanent measures on a structure-by-structure basis. Using the latest hydrology and hydraulic modeling conducted for the CoA by Brown and Caldwell Engineering and Schnabel Engineering, respectively, the Corps developed frequency-flood depth curves and used first floor elevations from each structure in Biltmore Village to determine at what level each structure would be flooded by particular frequency events and to what flood frequency each structure can be protected using temporary flood proofing measures.

### **3.0 DEVELOPMENT OF THE EMERGENCY FLOOD RESPONSE PLAN (EFRP)**

The overall EFRP consists of the Basic plan presented in this document, plus Appendices A and B, and the structure-specific plan to be prepared by you.

#### **3.1 Your Development of the Structure-specific Plan**

After review and consideration of the recommendations in this document (including the Appendices), you need to decide if you want to implement any or all of the recommendations. If so, you will need to develop your structure-specific plan. If you already have such a plan, that plan can be reviewed, modified as needed, and used to supplement this Basic plan.

If you choose to implement some or all of temporary flood proofing measures (from Appendix A), you should include those measures in your plan. If you intend to incorporate permanent flood proofing measures (from Appendix B), you should develop an interim plan that can be used while the permanent measures are being developed and constructed. Ideally, you would implement permanent flood proofing in lieu of or in addition to temporary flood proofing.

The plan should ensure that the measures can be employed for your structure as quickly as possible once the threat of flooding is imminent.

You should consider having an escape plan to implement in the event that flood waters rise so fast that a quick escape from the structure is necessary. Having a flotation device of some sort may be very useful in that event. Fortunately, only a few structures within Biltmore Village are at a low enough elevation for this to occur.

Though not recommended because of personal safety issues, you need to consider whether and how you will return to the structure during the flood to monitor the flood proofing measures and whether and how you will re-enter the building to check on it. If allowed and if you are willing to take the risk, you could return to the structure to ensure that the measures are performing properly; of particular importance is confirming that any pumps are working properly and are adequate for the amount of water entering the structure. This monitoring should be done by two individuals.

Among the items that the plan should include are:

- 1). Notification of a flood event – How you will be notified
- 2). Implementation
  - a. Any temporary measures (from Appendix A or other) that will be implemented
  - b. Sequence of implementation
  - c. Confirming that you have all materials, equipment, etc. needed, and that they are stored in a known, safe location

- d. Labor sources to help in implementing
  - e. Handling of business equipment, records, inventory, etc.; where to put them, how to get them there.
  - f. Whether you want to disconnect electricity
  - g. Building security – how to secure it, whether the security system will function during a flood, whether the flood proofing measures interfere with security.
- 3). Evacuation
    - a. Need for an escape plan
    - b. Where go after evacuation
    - c. How to confirm everyone’s safety (pre-designated meeting place, cell phone?)
  - 4). Monitoring
    - a. How will you stay informed during the event
    - b. Whether and how you will return to the structure to check on it and the flood proofing measures
  - 5). Notification to return – How will you be notified
  - 6). Post-flood Recovery
    - a. What steps you will take upon re-entry
    - b. How you will perform clean-up and other activities

### **3.2 Flood Proofing Recommendations**

The main goal of this document is to provide you with effective means by which to protect yourselves and minimize damage to your structures and contents during a flood event.

The responsibility for flood proofing each structure, including the purchasing of flood proofing materials and the implementation of flood proofing, lies with you. In order to provide you with the maximum number of options, this document includes both temporary (Appendix A) and permanent (Appendix B) flood proofing measures. You need to decide which, if any, of the temporary or permanent flood proofing measures you want to incorporate into your personal plan. Any temporary or permanent flood proofing should be accomplished in accordance with all applicable state and local codes, and all necessary permits should be obtained. Permits can be obtained from the CoA Development Services Center at 828-259-5846.

The following sections provide some general notes on flood proofing for all structures.

#### **3.2.1 Temporary Flood Proofing**

Temporary flood proofing measures can only be used up to certain levels of flooding and, therefore, may or may not protect a structure from incoming flood waters. In general, temporary flood proofing of a structure is recommended when the anticipated flood event will not put water higher than three feet above the first floor and if cost or other factors do not allow incorporation of the recommended permanent measures. Temporary flood proofing should not be used in cases where it could endanger people or cause failure or collapse of any part of the structure. In many cases, you should consult a structural



engineer or contractor to determine what loads (based on depth of flooding) your particular structure can withstand.

With all these disclaimers, temporary flood proofing can be an effective way for you to at least limit the damages caused by flooding. Appendix A contains flood elevation data and a detailed discussion of temporary flood proofing measures for each structure, and information on the materials that may be needed, including how they can be obtained and estimated costs.

### 3.2.1.1 General

In temporary flood proofing, utilities and HVAC units must be considered. Where possible, vital utilities and HVAC units should be raised to a reasonable level; otherwise, the flood proofing plan needs to include protection of these because they are often associated with wall penetrations that offer a way for water to enter the structure.

Generally, most structures can hold up to three feet of water above the first floor elevation; however, without a proper structural analysis of an individual structure, failure of that structure can occur due to the significant force of the water against the walls.

For smaller, more frequent storm events, the City may not be able to notify you prior to a rise in waters because these storms can develop fairly rapidly. This means that you would not have time to implement the full-scale temporary flood proofing measures presented in Appendix A. However, by implementing certain measures outlined in this document and in Appendix A, such as installation of back flow valves and sump pumps, you can still provide some protection to your property during these smaller events. Applying a layer of clear water resistant sealant on the outside of the structure makes the outside walls less porous, which would reduce the rate of seepage into the structure and lessen the load on sump pumps. In addition to these flood proofing improvements, having boards pre-cut to the correct size or using sandbags for door openings can be very effective in defending against these smaller, more frequent events.

### 3.2.1.2 Structure-specific Evaluation

The scope of work for development of the EFRP does not allow the Corps to evaluate each structure and its site in sufficient detail to guarantee that the structure will withstand the force of flood waters standing a certain height above the first floor elevation or that the permeability of the soil around the structure is such that we can recommend with confidence that a particular pumping capacity will be adequate to keep the structure from flooding due to seepage. In the following sections, the Corps has presented some guidance regarding structural integrity and soil permeability. However, as previously mentioned, it is incumbent upon you to follow through and be responsible for these important considerations. It may be that you or a number of interested individuals will want to jointly hire a licensed consulting engineer to evaluate your structure and perform relevant soil testing.

### 3.2.1.2.1 Considerations for Site and Structural Evaluation

An evaluation by a qualified consulting engineer can give you confidence that your structure will withstand the forces applied by the height of water for which you want to protect your structure. The scope of work for such an evaluation would consider items including, but not limited to, the following:

1. Interviews and collection and review of data
  - a. Flood proofing goals of the owner/tenant/resident
  - b. Layout and dimensions of the structure, adjacent soil and other significant features such as crawl space, basement, slab on grade, doors, windows, porches, HVAC unit and sanitary drain backflow preventer, utilities and other structural constraints.
  - c. Construction methods and materials
  - d. Flood history and any structural or architectural problems or limitations
  - e. Recommendations for the structure in Appendices A and B of this plan
2. Testing
  - a. Permeability testing of soil adjacent to and beneath the structure
  - b. If warranted, drilling and sampling soil to determine soil characteristics
3. Evaluation and recommendations
  - a. Height to which the structure can be protected
  - b. Methods of modifying the structure to allow protecting to the greatest depth of water
  - c. Any other suggestions for flood proofing, including site grading, berming of soil fill and redirecting flood waters
  - d. Cost estimate for any structural modifications.

The cost of such an evaluation could range from several hundred to several thousand dollars, depending upon the tasks included in the scope of work and the complexity of the structure.

### 3.2.1.2.2 Soil Permeability

The Corps contacted a geotechnical engineering company in Asheville which has limited experience characterizing soils at two sites in Biltmore Village. Though they did not conduct laboratory testing of the soils, their description of the general conditions encountered (based on visual classifications) is that they found soft, alluvial, high plasticity silts (MH) to depths of about 12 to 16 feet below the existing ground surface. On a micro basis, the estimated permeability is less than  $1 \times 10^{-6}$  cm/sec. They indicated that the macro permeability may be influenced by thin, occasional sand seams, but ground water inflow from this zone into test pits was very slow, un-noticeable in one to two hours. The silts were underlain by a thin layer of gravel and cobbles (SM to GP) that ranged from about 1 to 2 feet thick. Those materials were variable, ranging from sands in

some areas to essentially clean cobbles in other areas. Rapid water inflow occurred when the test pits penetrated this layer. Residual soils were encountered beneath the cobbles. The residual soils were typical saprolitic micaceous silty sands (SM); they transitioned rapidly to weathered rock. Auger refusal occurred at depths of 11 to 30 feet (typically 20 to 25 feet). The prevailing water table was about 5 feet below the surface during their explorations; it might have been lower than normal because their work was done during the current severe drought.

Because soil conditions vary significantly within Biltmore Village, the above description should be viewed as common but not applicable to every site. For structures with a shallow crawl space or none at all, it is likely that the soil types of concern (for surface to shallow subsurface soil) fall in the range of silty sand to sandy silt, with the majority of soils being sandy silt. The permeability rate for a typical site is likely to be between  $1 \times 10^{-5}$  cm/sec and  $1 \times 10^{-6}$  cm/sec.

For structures with basements, the presence of occasional seams of sandy deposits can be a factor in estimating seepage rates. Because the groundwater table in the area is relatively high, structures with basements are likely to experience infiltration of groundwater even in normal conditions; inflow of water would obviously increase during a period of increased rainfall.

A complicating factor is that a significant amount of fill material has been placed in the area over the past 100 years; the permeability rate of this material can be extremely variable.

Because of the unknowns regarding soil type, it is recommended that you take a conservative approach when estimating permeability or obtain the advice of a licensed consulting engineer to assess the soil type and characteristics specific to your site.

### 3.2.1.3 Water Removal

Removal of flood waters from a structure prior to inundation of the first floor can be one of the most important ways to protect a structure from flooding. The use of sump pumps is one of the easiest ways to do this. For most of the structures in Biltmore Village, the Corps recommends installation of one or more sump pumps. In most cases, the installation of these pumps is relatively simple. Appendix A contains a general recommendation for the needed pumping capacity. However, it is best to have a consulting engineer determine the needed capacity. Because electricity may be lost during a flood event, you should consider powering the pumps with a gasoline-powered electric generator (located outside the structure) or batteries.

An alternative to each structure owner purchasing, installing and maintaining a power supply and sump pump is for the City or Progress Energy to provide a generator (temporary or permanent) on near-by high ground that would supply electricity to the area if power were interrupted during flooding. This is a topic that should be discussed in the future.

#### 3.2.1.4 Maintenance of the Plan, Materials and Equipment

Once you have established a temporary protection plan, it may be beneficial to test the plan for efficiency and effectiveness. The materials and equipment should be stored in such a manner that they will not be damaged and should be monitored on a regular basis to ensure that they will be effective when and if needed. For instance, blue plastic can become damaged with holes from animals or normal weathering and should be replaced if any damage occurs, and plywood should be stored such that it will not rot or be damaged by termites. In cases where a generator or sump pump is used, you should test the generator and pump on a regular basis to ensure that they work. Reserves of fuel should be kept in a cool dry place and checked periodically to ensure that the quality of the fuel has not diminished over time. In some cases, a fuel stabilizer can be added to the fuel to allow for longer storage times. If fuel quality becomes an issue, the fuel may need to be replaced.

#### 3.2.2 Permanent Flood Proofing

Permanent flood proofing is not a subject which is normally a component of an emergency action plan because it can not be implemented on short notice; however, it has been included as Appendix B of this document for your benefit.

In general, the Corps recommends that the permanent flood proofing measures be used when possible to limit the effects of flooding. Permanent flood proofing includes six types: Acquisition, Relocation, Dry Flood Proofing, Wet Flood Proofing, Elevation (Raising a Structure), and Levee and Floodwall Protection. Appendix B contains a detailed description of all of these types of permanent flood proofing as well as flood elevation data and permanent flood proofing suggestions for each structure.

A brief description of each type of permanent flood proofing is as follows:

- Acquisition is essentially the purchase by an entity of a structure that is highly flood prone. After acquisition, the structure is usually removed.
- Relocation involves the owner moving a building to a location outside the flood hazard area.
- Dry flood proofing measures include installing a flood proof barrier on the exterior of the structure; this can include the use of closure structures and low walls.
- Wet flood proofing measures involve the removal of any damageable materials, utilities, or merchandise from the threat of flood waters. This could include the raising of electrical systems, conversion of plaster walls to a non-damageable material such as concrete blocks, and allowing flood waters to move in and out of the structure as unobstructed as possible.

- Elevation or raising a structure as a flood proofing measure is self explanatory. Structures can be raised onto an open or closed foundation. Raising on an open foundation occurs when a structure is raised on piers or some other open support structure. Raising on a closed foundation occurs when a structure is raised on fill (essentially an earthen hill).
- Levees and floodwall protection are a major undertaking in most cases and are used only when it is proven feasible at the conclusion of an extensive study. However, they are very effective for protection against flooding, especially in areas where there are many structures that need protection.

It is important to note that there is no way to guarantee that a structure has been totally and completely flood proofed because flood proofing can only be achieved to a certain level of protection, and there is always some possibility, even if very small, that a flood will occur to a level greater than that to which a structure has been protected.

#### **4.0 YOUR SUPPLEMENT TO THE EFRP AND NEXT STEPS AFTER RECEIPT OF THIS BASIC EFRP**

Upon receipt of this plan, the sequence and recommended schedule of the primary activities incumbent upon you are as follows:

- 1) As soon as possible before June 1, 2009 - Read this document and determine what, if any, measures from Appendices A or B you want to consider implementing. If you choose to incorporate any of the recommended flood proofing, have your property evaluated by a contractor or consulting engineer.
- 2) Before June 1, 2009 - Develop your structure-specific plan to supplement this Basic EFRP.
- 3) Before June 1, 2009 - If you decide to use temporary flood proofing measures, purchase and store the necessary materials and equipment and pre-cut any plywood to the correct sizes (it is better than waiting until notification of an imminent flood event).
- 4) Before June 1, 2009, if possible; otherwise, before June 1, 2010 - If you decide to utilize permanent flood proofing measures, implement those measures.

Note that June 1, 2009 is the recommended goal because it is the official start of the next hurricane season. It would still be to your advantage to develop your plan, obtain materials and equipment for the temporary measures, or implement permanent measures, even after that date.

Once you have acted (or chosen not to act) on these four steps, you can supplement the Basic EFRP with your structure-specific plan and will then be prepared for the next flood event.

## **5.0 THE EMERGENCY FLOOD RESPONSE PLAN (EFRP) IN ACTION**

As previously stated, this document contains the Basic EFRP, which is to be supplemented by your structure-specific plan. In this section, the EFRP is laid out in a sequential manner to make it easier to understand and implement.

When the EFRP is put into use, the sequence of the primary EFRP activities is:

- 1) Notification of an Imminent Flood Event,
- 2) Implementation of the Plan,
- 3) Evacuation and Related Activities,
- 4) Monitoring of Flood Proofing during the Flood Event,
- 5) Notification to Return and Public Information during and after the Flood, and
- 6) Post-flood Recovery.

A conceptual schedule and details of these steps are presented in the following sections.

### **5.1 Conceptual Schedule of the Primary EFRP Activities**

Many factors determine the schedule of EFRP activities, including: the nature and predictability of the rain event, your personal level of comfort, the amount of flood preparatory work to be done and the labor resources available. Considering that there is no single correct schedule, it is still worthwhile to develop a conceptual schedule of your critical EFRP activities, which is as follows:

- 1) As much as 72 hours before arrival of flood event – Receive notification of the potential flood event, and cut plywood for any closures (if not already cut).
- 2) 72-24 hours before arrival of flood event - Implement your flood proofing plan, including installation of flood proofing measures (plywood, plastic, sandbags, pumps, etc.) and relocating or elevating valuables and any hazardous materials.
- 3) 24 hours or less before flood waters reach your structure – Evacuate.
- 4) During the event - Monitor news via radio and weather radio, TV (including the City Channel), World Wide Web, CoA web site and newspaper. If allowed and if you choose to take the risk (see section on Monitoring of Flood Proofing during the Flood Event for additional guidance), return to periodically survey the structure and flood proofing, especially pumps (adequate capacity, discharge, fuel, batteries), condition of any polyethylene sheeting, sandbags and door closures. Prepare for post-storm recovery.
- 5) After the storm – If needed and available, CoA dispatches damage assessment teams. CoA coordinates with citizens about re-entry and gives re-entry notification. Re-enter and perform post-storm recovery.

## **5.2 Primary Activities in EFRP**

In the following sections, the primary steps in EFRP implementation are discussed in detail.

### **5.2.1 Notification of an Imminent Flood Event**

Implementation starts with some indication that a flood event may be imminent. There are a number of ways in which you may receive notification that it is time to implement the EFRP.

A primary way that implementation can start is for you to decide for yourself based upon an extended weather forecast, your comfort level, the amount of time required to prepare and other factors when to implement the EFRP.

Another way is by receiving word from CoA. A determination for evacuation would be based upon the threat of imminent flooding; a mandatory or non-mandatory evacuation could be called. The authority for a mandatory evacuation comes from the Governor, County Commission Chair or City Mayor. The City will make notification via all available local media outlets (radio, newspaper and television) through press releases, as well as via information posted on the CoA web site and the City Channel. Also, the City would use the “CodeRED” citizen notification system, which is a reverse 911 system for contacting potentially affected citizens through land phone line and/or cell phone. If you are interested in having a phone number added to the list of those contacted in advance of a flood event, you may go to the CoA website for more information about doing this. In addition, if there is imminent danger and if the resources are available, the City Engineer will contact the Fire and Police departments who will go door-to-door with written notification of mandatory evacuation; in lesser events, the City could implement a voluntary evacuation.

Evacuation is not always necessary for an incoming flood event, so you need a way of knowing the difference between an event that may flood just a few structures (and not your structure) for a limited amount of time and a catastrophic event that requires complete evacuation. In all cases of potentially damaging events, the City and the National Weather Service will attempt to notify the public (through the outlets mentioned above) that the event is coming and how you in Biltmore Village should respond. However, you are encouraged to purchase a weather radio so you can receive information released by the National Weather Service. Forecasting the extent of flooding from an incoming event is very difficult, especially in this urban area, so you will need to use good personal judgment in advance of a potential flood event.

Because storms can develop quickly in the Asheville area, minor “floor-wetting” flood events can occur so quickly that implementing large scale temporary flood proofing measures may not be possible. In these situations, a warning may never come and evacuation may not be necessary. However, you still have flood proofing options



available such as sandbags in doorways, sump pumps and backflow valves (discussed more fully in later sections). The point of discussing this type of storm is that you should always be aware of developing weather using local radio and television reports, the National Weather Service websites or other internet sites, and weather radios. The City may not be able to provide timely notification because of the difficulty of accurately predicting rapidly developing storms.

### **5.2.2 Implementation of the EFRP (including the Structure-specific Plan)**

You will implement the EFRP, including your individual structure-specific plan, which may include incorporation of temporary water proofing, elevating equipment, valuable papers and inventory, installing and starting pumps and other activities.

### **5.2.3 Evacuation and Related Activities**

Critical components of the EFRP are evacuation and several related activities. This section of the plan includes: 1) Evacuation, 2) Flood Search and Rescue Plans, 3) Evacuation Routes and Traffic Control Measures, 4) Transportation Assistance, and 5) Temporary Shelter.

#### **5.2.3.1 Evacuation**

In the event of an imminent flood event posing danger or injury to life, the City will take one of two actions: 1) local Fire and Police departments will (if resources are available) become involved in the evacuation of Biltmore Village, or 2) the City of Asheville will implement a voluntary evacuation. In the former case, the City Engineer will contact the Fire and Police departments which will, resources permitting, begin evacuation of Biltmore Village when it becomes evident that an impending event will cause imminent danger to public health and destructive flooding to the Biltmore Village area. Once you are aware of the need to evacuate (whether it be by notification from the City or other means), you should prepare your structure for the flood, have all personnel gather their belongings, relocate all vehicles and evacuate all personnel from the area as soon as possible. You may want to disconnect electrical service to your structure at the main circuit breaker panel before evacuating.

All Souls Church has offered the use of their porches for coordination during a flood, assuming the flood waters have not reached their high ground. In a flood event, individuals can retreat to the church porches to stay dry, coordinate activities, etc. That may also be a good meeting place to be sure everyone is accounted for.

In the future, the stakeholders in Biltmore Village should contact the City and All Soul's to discuss whether an electric generator can be placed at All Soul's during a flood to provide power and light.

During any major flood event there is a possibility that your structure will be extensively damaged. In order to prevent extensive loss or damage to high value items, it is

recommended that your structure-specific plan consider relocating away from your structure or to a higher elevation, those items which would be difficult or impossible to replace.

It is important that you take action in a responsible manner when the City or the National Weather Service orders an evacuation. For large flood events forecast well in advance of their arrival (much like the floods in September 2004), most of you should have sufficient time and means to evacuate the affected area completely. However, for smaller, local events, flooding can occur quickly and with little warning.

You should heed the warnings of the City and the National Weather Service with all seriousness and should not enter a flooded area. There are potential criminal charges for crossing a barricade after the area is evacuated and re-entry is forbidden. Though protection of your structure and its content are very important, the safety of you and other members of the public is obviously the highest priority.

#### 5.2.3.2 Flood Search and Rescue

If anyone should find himself trapped in the flood waters or unable to evacuate the area in a timely manner, they should try to call the Fire and Police departments at 911 immediately. In the event that telephone service is not available during the flood, the individual should make every attempt (without risking injury) to contact another person in the area so that the Fire and Police departments can be notified - it can be dangerous to wade into flood waters because the current of these waters can be deceptively swift. If contact can not be made, the individual should stay above the flood water within the structure ensuring that they have a way out and (if possible) that they have sufficient food and water in case they are stranded for an extended period of time.

Once an individual has left the flooded area, it is suggested that they arrange for transportation away from the area. Though emergency flood shelters may be designated and City transportation to the shelters should be available, individuals in Biltmore Village should not need to use such a shelter.

#### 5.2.3.3 Evacuation Routes and Traffic Control Measures

The preferred evacuation route from the Biltmore Village area is south on Hendersonville Road. Alternate routes (dependent upon the nature of the flooding) are northwest on McDowell Street and north on Biltmore Avenue. A map of these routes is shown in Figure 2.

City authorities will be responsible for any traffic control measures such as road closures. It should be expected that at some point during the emergency, access to the flooded area might be restricted. You should contact the CoA Traffic Engineering Department to learn their plans for limiting traffic to and from the area.

#### 5.2.3.4 Transportation Assistance

If you do not have transportation from the affected area, the City provides it. In fact, the City currently offers transit service to the Biltmore Village area, which would be available prior to an event until the flooding constitutes a situation unsafe for travel through and around the area. To inquire about the City's transit service, please contact Asheville Transit System (ATS). If you will have trouble evacuating due to a disability or need any special assistance, please contact the ATS as quickly as possible after notification of the evacuation. You can become familiar with transit routes by calling or visiting the ATS website, [www.asheville.com/transportation/transit.html](http://www.asheville.com/transportation/transit.html)

#### 5.2.3.5 Temporary Shelter

As previously stated, individuals in Biltmore Village should not need to use a temporary shelter.

### **5.2.4 Monitoring of Flood Proofing during the Flood Event**

If a mandatory evacuation is declared, the owner should not return to the structure to monitor the flood proofing until such notification is made by the City.

In the event of a non-mandatory evacuation, in the interest of personal safety, it is recommended that the owner not return to their structure during the flood; the owner would be doing so at their own risk.

If not in a mandatory evacuation and if the owner is willing to accept the risk, two people (you or any designated individuals) may choose to periodically return to the structure during the flood event to confirm that it is holding up well under the flood conditions and that the temporary flood proofing measures are effective. It would be especially important to confirm that any generators and pumps are working properly and are adequate for the amount of water seeping into the structure. If there is concern that the pumping capacity is not adequate, additional pumps may need to be installed.

### **5.2.5 Notification to Return to the Structure and Public Information during and after the Flood**

The City Fire and Police departments will assess conditions in Biltmore Village. Police, Fire and Code Enforcement personnel will be responsible for security of the area. The City will coordinate with local radio and TV stations which will provide the public accurate, timely and useful information and instructions. After either a mandatory or non-mandatory evacuation, notification to return would be communicated by the City via all available local media outlets as well as on the CoA web site and the City Channel.

The City Fire and Police departments will coordinate re-entry activities. However, re-entry is not recommended until a CoA damage assessment team has assessed the area;

individuals who enter before the assessment are doing so at their own risk. If you are concerned about the safety of your structure and want the City to inspect it, you can contact the CoA Building Safety Department. The link to their webpage is: [http://www.ashevillenc.gov/departments/building\\_safety/default.aspx?id=344&ekmensenl=12\\_submenu\\_0\\_link\\_4](http://www.ashevillenc.gov/departments/building_safety/default.aspx?id=344&ekmensenl=12_submenu_0_link_4)

## **5.2.6 Post-flood Recovery**

In an effort to return Biltmore Village to a pre-emergency level of service, the City (in conjunction with Biltmore Village and other interested organizations) will address short-term and long-term recovery needs. These needs are addressed in the following sections.

### **5.2.6.1 Continuity of Operations Plan**

Business owners in Biltmore Village can help themselves tremendously by developing a continuity of operations plan tailored to the specific business. This type of plan typically addresses the responsibilities of owners and employees after the flooding has receded, and contains contacts of persons or businesses that will be instrumental in recovering after a flood. This plan can be very cost-effective by allowing continuation of services more quickly.

### **5.2.6.2 Human Health and Welfare Protection**

The City holds the public's health and welfare as the principal concern in an emergency event. As mentioned in the "Water and Wastewater Treatment Facilities" section, water and wastewater are often adversely affected during flooding events. Therefore, the City has a plan to monitor and control water and wastewater concerns during an event. After the event has occurred, the City Water Resources Department will identify any issues that pose a threat to the public's health and welfare and mobilize to make any necessary repairs to the water infrastructure as soon as possible. Some of these issues include: contaminated drinking water supplies, waste contaminated areas, and damaged water and wastewater infrastructure. The City will keep the public informed of any progress or setbacks in the post-flood effort of getting the water and wastewater systems back online. Also, some flooding events can cause outbreaks of waterborne diseases especially when flood waters pond in areas of population for extended periods of time. The City will monitor any reports of these diseases and stay in front of any type of outbreak.

### **5.2.6.3 Personal and Building Safety**

Before re-entering your building, you should be aware of electrical hazards (or insure that the electricity is still turned off if you disconnected it before evacuating), inspect the foundation for damage and be sure the building does not appear to be in danger of collapse. Be sure to watch for any construction materials that could fall.

The CoA will make every effort to provide damage assessment teams in the area affected by the flood. The resources to provide damage assessment may be affected by the scope

of the flooding and resource needs throughout the area. If a damage assessment team can be made available, this team will determine if hazardous conditions exist.

Upon re-entering your building, you should use great caution and be aware of the risks to you and others. You should:

- wear appropriate protective clothing and shoes,
- not use matches or other open flame,
- be aware of animals (especially snakes) that may have entered the building during the flood,
- be aware of fire hazards such as broken gas lines or flooded electrical circuits,
- check for sewer or water line damage; if you suspect damage, avoid using the system or drinking the water, and
- dispose of any food, including canned goods, that came in contact with the flood water.

In some cases, flooding can cause structural damage to buildings, roads, and bridges. Therefore, the City will quickly identify these types of structural issues within the city that pose safety issues. The City will designate buildings and structures that may not be occupied, and may go as far as condemning some buildings and structures. The City will also address fire safety issues where electrical systems could be damaged. A key concern in Biltmore Village is whether a structure is safe for the employees and public; the City has the power to prohibit entrance into any structure they deem unsafe.

#### 5.2.6.4 Business Recovery

Biltmore Village is composed primarily of businesses reliant on the patronage of the public. Therefore, each business should take responsibility to plan for its recovery within the guidelines of the City's efforts. The City will offer several services for recovering from a flooding emergency, and businesses should utilize these services to expedite the recuperation. The following sections describe in detail how the City and individual owner should address recovering a business from a flood event.

##### 5.2.6.4.1 Debris and Sediment Removal

Flood events typically result in the accumulation of large amounts of debris and sediment in the affected area especially when their buildings are densely clustered. In the common areas of Biltmore Village, the City Sanitation Division of Public Works will provide assistance with the removal and disposal of debris and sediment. The City understands that the removal of these materials is vital to the recovery of the businesses in Biltmore Village, and will help to remove these materials as quickly as possible after the event. The City's response in this regard will depend upon whether the City has to respond to safety-related problems caused by the flood event. For individual business owners, the removal of debris and sediment from their particular business is solely the business owner's responsibility; however, owners should work with the City to safely and quickly dispose of these materials. The City Public Works Department will prioritize clean up

efforts using public conveyance systems based on their importance and transportation classifications. If necessary as deemed by the City, the City can also contract outside assistance for the debris removal effort.

#### 5.2.6.4.2 Structural and Interior Damage

Flood waters are a very powerful and destructive force capable of causing structural damage. As part of the overall effort, the City will inspect each affected structure to ensure that the building is safe to occupy. Owners should alert the City to any structural issues that they observe. Only when a business is deemed structurally sound should an owner reopen the business. During a flood event, other damages to a building can occur such as damages to the walls, electrical system, water and wastewater systems, and business merchandise. All of these items will need to be repaired or replaced by the owner to the extent that none of these issues pose a safety risk to the public.

If the resources are available, the City will set up a temporary permitting office near Biltmore Village.

#### 5.2.6.4.3 Financial Recovery

Because Biltmore Village is comprised predominantly of businesses, financial recovery is primarily based on the ability of each individual business to reopen. In cases of major floods, the involvement of the Federal Emergency Management Agency (FEMA) and the American Red Cross may be necessary. Business owners should leverage this assistance as they see fit in order to return to normal operations as quickly as possible. FEMA offers many attractive products in their assistance program such as grants and low interest loans. More information on FEMA's assistance products can be found at <http://www.fema.gov/hazard/>. It is also possible that assistance can be obtained from state and other local governments, private nonprofit agencies, and volunteer resources. Each business owner should explore all of these options. The City will communicate as much as possible with the public to keep them abreast of any assistance opportunities. In some cases, the City has waived permit fees associated with demolition and repair of structures.

## **6.0 INFRASTRUCTURE AND RESOURCE MANAGEMENT**

Various levels of flood events can affect the infrastructure of a municipality in a multitude of ways, thus impacting the Biltmore Village area. This section of the EFRP focuses on how the infrastructure can be affected by flooding events and how the CoA plans to recover this infrastructure after a flood event. Contact information for the key Asheville and Buncombe County departments and utilities, and federal agencies is located in Table 1.

### **6.1 Maintenance of Vital Services**

Maintenance of vital services such as electrical power, water and wastewater treatment, transportation, health and government services, and volunteer resource management are the responsibility of the City. If any of these services is lost, the City will work diligently to get the lost services back on line because they understand the consequences to the businesses of Biltmore Village when these services are not available. Each of these services is discussed in the following sections. You can do very little to control these components; however, you can encourage the City to remain prepared for all catastrophic events.

#### **6.1.1 Electrical Power**

If an emergency flood event occurs and electrical power is lost to Biltmore Village, the City will implement a plan to restore power. This plan will include the determination of affected power facilities and the identification of downed power lines, flooded power vaults, damaged transformers, and other equipment that poses a hazard to the public.

#### **6.1.2 Water and Wastewater Treatment Facilities**

Contamination of drinking water and flood waters can occur during flood events. This section addresses the procedures for identifying, limiting, and eliminating contamination at water treatment plants and contamination of flood waters from waste water treatment plants. In 2004, flooding affected several water utilities within the City; however, because water services to Biltmore Village are provided from a plant outside of the Swannanoa River Watershed, water services in the area were not affected.

##### **6.1.2.1 Water Treatment Plants and Drinking Water**

In cases where drinking water supplies become contaminated, the City will be responsible for monitoring all components of the water supply system to determine if contamination has occurred and for decontaminating and repairing the water supply system. In most cases, the city will prohibit the consumption of any water source deemed contaminated until further notification. The city will notify the public once it is safe to consume drinking water.

#### 6.1.2.2 Wastewater Collection and Treatment

In many cases, minor flooding can enter and affect the wastewater treatment system. The CoA will be responsible for identifying sites of contamination, monitoring the spread of contamination, controlling the extent of contamination, and cleaning up the contamination sites or areas affected by the contamination. The City will also be responsible for providing other avenues to deal with sewage and waste when the wastewater system is offline, such as portable latrines. As part of the post-flood evaluation, the City will also investigate the wastewater system to address any structural or operational damage caused by flooding.

#### 6.1.3 Transportation

During flooding events, transportation infrastructure and personal means of transportation can be adversely affected. The City will identify and repair any damages to the transportation infrastructure in a timely manner and may prioritize the repairs based on public need. The City will also be aware that there could be an increased demand on public transportation as personal means of transportation but that some means of public transportation may be inoperable due to damage by the flood. Biltmore Village is comprised predominantly of commercial and retail businesses; therefore, the public's ability to access the area is important to the financial vitality of the area. Of course, issues of safety must be addressed before Biltmore Village will be reopened to the public.

#### 6.1.4 Health and Government Services

Biltmore Village does not contain any health service facilities or any vital government services; however, the City will ensure that these services are available where necessary in other areas of the City. If Biltmore Village were to sustain massive health-related injuries or issues due to a flood event, the City will provide temporary emergency health facilities through an onsite temporary facility, aid from other government agencies or businesses, or transportation to other facilities not affected by the event.

#### 6.1.5 Volunteer Resource Management

In many emergency situations, volunteer resources (manpower or equipment) can provide great benefit during a time of need. However, if these resources are not employed in a controlled manner, these resources can, in fact, obstruct the flood response and recovery efforts. Procedures for managing volunteer resources will be directed by the City. The City will determine what resources are to be provided, develop an inventory of available resources, and manage the resources in a manner that coalesces with the City's response and recovery efforts.



## **7.0 MAINTENANCE OF THE EFRP**

It is recommended that you and the CoA perform maintenance on the EFRP. This maintenance should consist of three components:

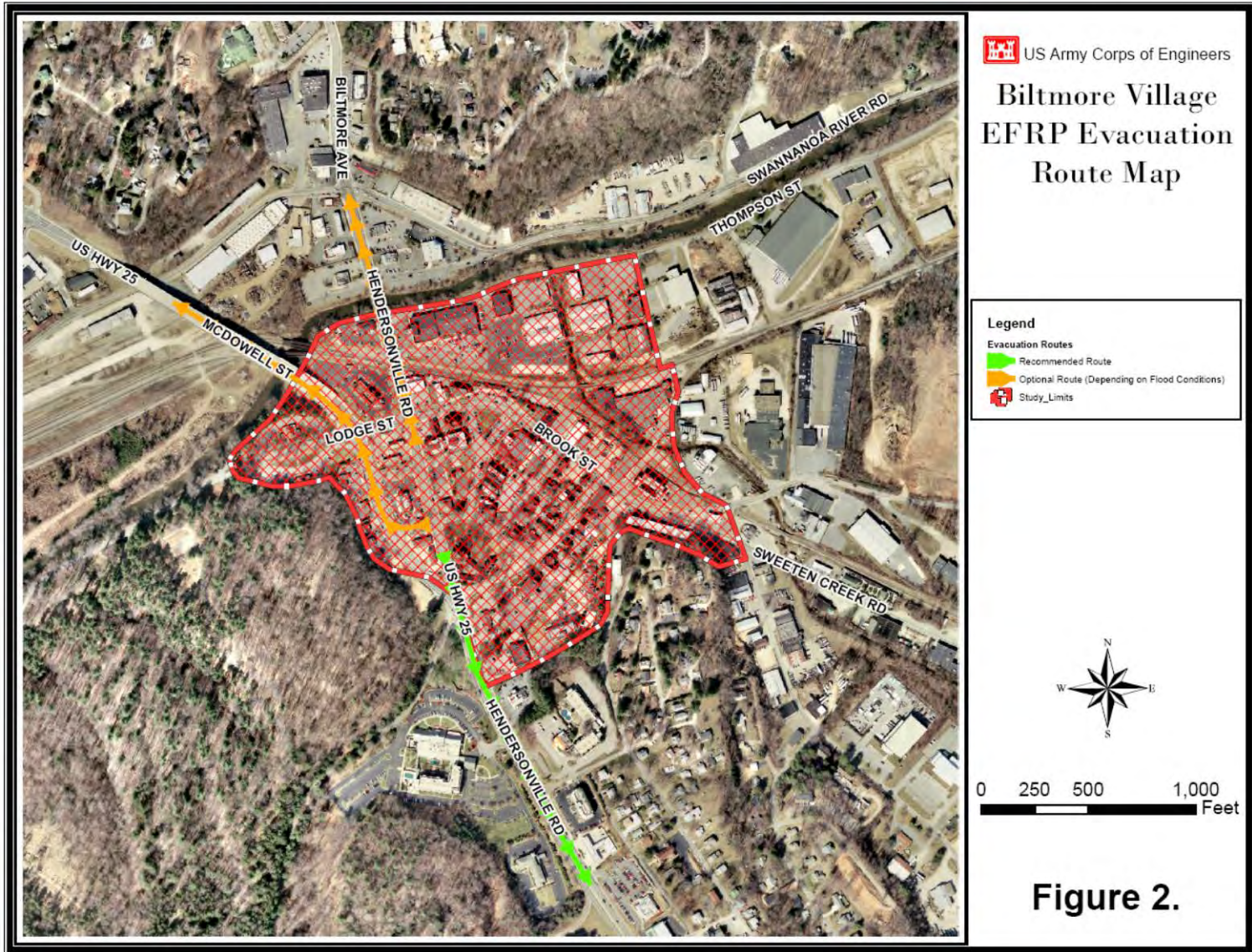
- To maintain the accuracy and effectiveness of the plan, the City and stakeholders should review the plan annually. This review and any required updating should be completed before June 1 of each year, which is the start of hurricane season.
- If the plan is implemented (due to a flood event) early enough in the hurricane season to warrant doing so, the plan should be reviewed (similar to the review addressed above) no later than 30 days after implementation. This will allow lessons learned to be incorporated in advance of the next flood event.
- Concurrent with the annual review, all phone numbers (including those for CodeRED and points of contact in Table 1) should be confirmed and CodeRED tested.

## **8.0 THE EFRP BROCHURE**

A summary of the plan, including the key activities (starting with notification of an imminent flood event) and contact information, has been condensed into a brochure. Two copies of this brochure are attached as Appendix C. It is recommended that you keep a copy of the brochure in plain sight as a reminder that the plan exists and how to implement it.







**Table 1. Contact Information**

<b>Entity</b>	<b>Contact Person</b>	<b>Phone Number</b>
Asheville Office of Mayor	Mayor Terry M. Bellamy	(828) 259-5600
Asheville City Engineer	Cathy Ball	(828) 259-5617
Asheville Stormwater Services	McCray Coates	(828) 232-4567
Asheville Fire and Rescue	Chief Gregory Grayson	(828) 259-5636
Asheville Police	Chief William Hogan	(828) 252-1110
Asheville Building Safety	Robert Griffin	(828) 259-5726
Asheville Public Works	Mark Combs	(828) 259-5935
Asheville Water Resources	David Hanks	(828) 259-5955
Asheville Transit System	Mariate Echeverry	(828) 253-5691
Asheville Traffic Engineering	Bobby Croom	(828) 259-5943
Buncombe County Emergency Management Services	General Information Line M. Jerry VeHaun	(828) 255-5636 (828) 255-5638
Progress Energy		(800) 452-2777
AT&T		(888) 757-6500
PSNC Energy (natural gas)		(877) 776-2427
American Red Cross (Mountain Area Chapter)		(828) 258-3888

## **Appendix A: Temporary Flood Proofing Measures**

### **1.0 General**

The responsibility for flood proofing, including the detailed planning, the purchasing of flood proofing materials and the implementation of flood proofing, lies solely with the owner, tenant or resident of each structure. To offer as many options as possible to the stakeholders in Biltmore Village, this EFRP contains both temporary (this Appendix A) and permanent (Appendix B) flood proofing measures. This appendix provides information and recommendations on temporary flood proofing; structure-specific information and flood proofing guidance are presented at the end of this appendix.

The goal of the Corps of Engineers was to provide in this document guidance for protection up to the 100-year flood level for all structures; however, due to the great depth of 100-year flood waters in the lowest lying areas of Biltmore Village, not all structures can be protected to that level. Only structures in the study area that had first floor elevations below the 100-year level were considered for temporary measures. For structures already above the 100-year level, flood proofing measures to protect to an even higher level can be implemented. Because of the diversity of structures in this study, this document could be useful in providing examples of flood proofing techniques to individuals outside Biltmore Village.

Temporary flood proofing measures are those which, in order to protect a structure, must be implemented every time there is a risk of flooding. You should weigh the costs associated with implementing temporary flood proofing measures numerous times as opposed to the long-term security and peace of mind that can come with implementing permanent measures. It is recommended that you transition to more permanent flood prevention measures as soon as reasonably possible.

As discussed in detail in the body of this plan, almost all of Biltmore Village is listed in the National Register of Historic Places (NR), as well as being a locally designated Historic District (LHD) by the City of Asheville. The Biltmore Estate is a National Historic Landmark (NHL); its gatehouse is located within the study area. Owners of buildings listed in the NR or buildings that contribute to the historic district or an NHL are advised to consult with the North Carolina State Historic Preservation Office before undertaking any permanent flood mitigation measures. Furthermore, building owners in the Biltmore Village LHD must obtain a Certificate of Appropriateness (COA) from the Asheville Historic Resources Commission (HRC) before undertaking any exterior alterations. A COA is required for any alterations to the exterior of the structure, including placement of hooks or bolts for use in temporary flood proofing. An application for a minor work COA can be obtained by contacting the HRC or visiting their website.

The primary temporary measures that are recommended for the structures in Biltmore Village are: 1) polyethylene sheeting hung on the structure exterior (usually to a height of

3 feet above the first floor elevation and continued on the ground surface 4 feet from the structure exterior), in combination with door and window closures, 2) clear liquid sealant applied to the structure exterior, in combination with caulking of large cracks in the exterior and placement of door and window closures, 3) sandbag levee (wall) around all or a portion of the structure, and 4) Portadam or similar barrier.

A key difference among the measures is that hydrostatic forces are applied to the structure walls when using the polyethylene sheeting and clear liquid sealant measures, but not with the sandbag wall or Portadam measures.

Implementation of the recommended temporary measures can be successful in reducing or preventing flood damages. The scope of this project does not allow the Corps of Engineers to evaluate the structures and their sites in sufficient detail to guarantee successful flood proofing. In addition to the information provided in this document, there are several factors that you must consider. These factors include:

- Because of the serious nature of flooding and because of unknowns including the velocity of the floodwater and the exact structural condition of each building, it is generally considered wise that no temporary flood proofing measures be placed to a height which exceeds 3 feet above the elevation of the first floor of the structure. The hydrostatic forces of the floodwaters can cause a catastrophic collapse to the walls of a structure due to the lack of lateral resistance from the structure as the flood waters rise higher against the sides of the building. And, since the characteristics of a flood (the depth, velocity and duration) may change during a flood event, it must be noted that it is possible for failure of foundations, walls, and closure panels to occur at a flood depth of less than 3 feet. Without a proper structural analysis of an individual building by a certified professional or contractor, failure of a structure can occur due to the hydrostatic pressures caused by water pooling up against a structure. It is the most important recommendation of the Corps that, after the flood proofing measures have been implemented, all persons evacuate the structure to a safe location.
- Though obvious, it must be stated that a structure could be exposed to a flood event of a depth greater than that for which temporary flood proofing has been provided.
- Smaller, more frequent storm events that can cause localized flooding can occur in the Biltmore Village area. In these events, there may not be sufficient warning time for you to implement all of the temporary measures.
- Preparing a structure for a flood requires significant effort, and it is impossible to accurately predict even one day in advance the depth to which flood waters from an approaching storm may rise. Therefore, you can not be certain that the flood event you have prepared for will actually occur. You must find your own comfort level and balance the risk of not having your structure properly flood proofed versus the risk that the flood proofing effort was not necessary.

- To keep unsanitary water from backing up into the structure during a flood, you should ensure that your sanitary drain line is fitted with a back-flow preventer.
- Downspouts and associated drain lines must be considered. If a Portadam or sandbag levee is used, the downspouts will need to be modified so they can be directed over the protective wall; this would greatly reduce the amount of water to be pumped from the protected area. Also, there may be drain lines that carry water from the downspout that pass under the Portadam or sandbag levee. In that case, the lines must be plugged to prevent flood water from flowing back through them into the protected area.
- Construction associated with the pebbledash type finish used in many of the older structures in Biltmore Village is probably not structurally sufficiently to withstand a significant water load. The force of water at a depth of three feet (and perhaps less) could collapse those walls. Therefore, it is suggested that when the recommended temporary measures include placement of polyethylene sheeting on the exterior of this type structure, a thick layer of plywood (up to 1 inch) be attached to the exterior surface of the structure up to the level of protection. The plywood sheets could be attached to the studs using countersunk threaded anchors with bolts, and the sheeting would be placed over the plywood. Again, structural evaluation by a certified professional or contractor is recommended.

There are numerous characteristics associated with temporary flood proofing, many of which may be unknown to you. Some of these are: 1) characteristics of the flood itself (duration of flooding and velocity of floodwater – note that velocities will generally be greater near the Swannanoa River), 2) the exact condition of the structure being protected (condition of the foundation, crawlspace, basement, and type of construction of the first floor and side walls), 3) the surrounding site conditions (how permeable the soil is, and impacts of the landscaping, air conditioning, utilities and other external features), and 4) the possibility that a rising water table may require the pumping of greater than anticipated volumes of water to keep the structure flood proofed. You should consider having on hand an even greater pumping capacity than recommended (plus additional power supply) in the case of an unforeseen problem.

## **2.0 Planning**

The information in this appendix is provided as a basis for developing temporary mitigation measures to reduce the possibility of extensive flood damages. In order for flood proofing to be successful, a thorough plan for each individual structure needs to be developed and implemented. The plans will vary from structure to structure, depending upon structure type, projected depth of flooding, the velocity of floodwaters, the time available to implement the measures, and the availability of flood proofing materials. In some instances, due to the depth of flooding or the projected velocity of the floodwaters, rather than attempt to keep floodwater out of the structure, it may be more cost effective to remove or elevate to a higher interior location, those items (business records,



electronics, computers, heirlooms, artwork, etc.) which contain a high value, intrinsic or monetary, so as to avoid exceptional loss.

If you wish to implement temporary flood proofing measures, you should develop your own structure-specific plan to ensure that the temporary measures can be employed as quickly as possible when the threat of flooding is imminent. This structure-specific plan (discussed in detail in the body of this document) is a component of the overall EFRP; it should include consideration of the temporary flood proofing measures.

Locations for storage of the materials and equipment should be designated far in advance of a flood event. Storage can occur on- or off-site; however, if materials and equipment are maintained off-site, arrangements should be made to transport these materials and equipment to the site for implementation. Because the limited time available to install temporary measures is a critical factor in the prevention of flood damages, site preparation, maintaining the proper inventory of flood proofing materials, and having a well prepared emergency response plan are crucial to a successful outcome. Early preparation can make the difference between minimal dollar damages and a catastrophic event. While even the best laid plans may go awry, nationwide data indicate that the individuals who pay attention to the details, establish a thorough step-by-step process for implementing their temporary flood fight measures, and prepare themselves and their structures prior to the start of the flood season, fare far better than those who rush against time to install temporary measures which have not been thoroughly planned out.

With the information in this appendix, you should determine the type and amount of materials required to be on hand each year through the flood season. A checklist of these items or material requirements should be prepared, including the sequence of placement of materials in order to establish the most time-effective process for implementing the temporary measures. Each year prior to the start of the flood season, you should review the checklist, replace missing or damaged items, and be prepared to implement the entire flood response plan.

In addition, you should develop a procedure for ensuring that all employees, residents and others who may have been in your structure prior to the flood event are accounted for after evacuation. This may be accomplished by planning to contact all personnel via cell phone and/or by arranging to meet at a designated location.

### **3.0 Site Preparation**

The type and amount of site preparation varies with the structure. For many structures, one of the recommendations is that, in order to prevent floodwaters from entering a structure and causing damage, the site surrounding the structure be put in a condition which allows relatively easy and quick installation of temporary flood damage prevention measures. For those structures, if possible, at least four feet of leveled access around all four exposed sides of structure should be prepared. The placement of polyethylene (also known as polyurethane or plastic) sheeting and/or sandbags as a preventive barrier to flooding requires a leveled surface in order to resist seepage into the protected area.

While shrubs, flowers and trees provide character and add value to a property, it is important that they be removed from within the “leveled access area” in order to establish a preventive barrier to flooding. If you are unable to remove landscape items, it is important that a uniform barrier of protection be established by placing polyethylene sheeting or sandbags as close to the protruding plant as possible to develop a cohesive barrier between the ground and the employed protective measures. Even a small weakness in the flood prevention measure could result in catastrophic failure and damage.

Features such as porches and ramps can complicate the flood proofing of a structure. You (and perhaps a contractor) will need to consider these features and decide how to deal with them.

Under certain circumstances, it will benefit you to identify appurtenances such as fence posts, gates, storage sheds and utility boxes which may prevent the establishment of a waterproof barrier. These items should be removed as much as possible from the “leveled access area.” Utilities and HVAC units must be considered. Where possible, vital utilities and HVAC units should be raised to a reasonable level. Otherwise, provisions in the flood proofing plan need to include the protection of these utilities and units. Also, these items are usually associated with wall openings through which flood waters can enter a structure; these openings must be sealed, along with any other holes or cracks in the exterior. Foundation vents will have to be sealed; a small plywood closure sealed with caulk is a good way to do this.

#### **4.0 Water Removal**

Removal of flood waters from a structure to prevent inundation of the first floor is one of the most important ways to protect a structure from flooding. The use of sump pumps is one of the best and easiest ways to do this. For most of the structures in Biltmore Village, the Corps’ recommendation is to install one or more pumps. Loss of electricity during a flood event must be considered; therefore, it is recommended that you provide pumps that can be powered with a battery power supply. In most cases, the installation of these pumps is relatively simple, and in some cases, the use of multiple pumps may be necessary. A more detailed discussion of pumps is presented in Section 5.

#### **5.0 Materials and Equipment**

You should ensure that the materials recommended for your structure have been obtained prior to the start of the projected flood season (June 1). Materials required for implementing a preventive barrier to flooding should be stockpiled in an accessible location. Materials remaining from the previous flood season should be inspected to determine condition for reuse.

The primary materials and equipment are listed below. Table A-1 at the end of this section indicates a potential supplier and approximate costs of these items in the Asheville area as of the date of this document.

- Polyethylene Sheeting.

This sheeting material (also known as visqueen, polyurethane or plastic sheeting) is often recommended for use when employing a temporary waterproof barrier around a structure. The sheeting should be purchased in rolls, typically 5-6 mils thick, and will be cut long enough to extend from no more than 3 feet above the first floor of the structure to, at a minimum, 4 feet out from the structure. The further the “leveled access area” and polyethylene material extend beyond the exterior wall of the structure, the longer the flow path for floodwaters to enter a structure, including the crawlspace or basement, is extended, thus increasing the resistance to seepage. The shorter the flow path is to a foundation, the higher the risks of complete soil saturation around a foundation, resulting in complete inundation of the crawlspace or basement. Once the floodwaters have access to the crawlspace or basement, it becomes more difficult to remove the seepage and to prevent or limit damages.

- Connectors for Attaching Polyethylene Sheeting to Structure Exterior.

The type of connector needed depends upon the type of exterior surface of the structure to which the sheeting is being fastened. Hooks, whether self tapping or through-drilled anchor connection, are normally recommended for use in fastening the polyethylene sheeting to the structure. Spacing of the hooks should be such that no span is longer than 2 feet. Hooks should be placed permanently for continuous use from one flood season to the next.

- Water Resistant Tape for Polyethylene Sheeting.

For firm cohesiveness between the polyethylene sheeting and the exterior structure surface or between adjacent polyethylene sheets, water resistant tape is required. This tape incorporates PVC adhesives and is ideal for use outdoors. Consideration should be given to vinyl coated cloth tapes; these tapes can sustain harsh weather conditions and can be used for repairs to many surface types. It is further recommended that tapes with all-weather properties, brittle resistance and anti-aging properties be obtained.

- Closures panels (plywood and other) and how to attach.

A temporary closure system consisting of 1-inch thick plywood or OSB is often recommended for flood barrier construction at doorways and windows; no closure should have a horizontal or vertical span in excess of 3 feet without incorporating additional supports. Because 1-inch sheeting is expensive, a 1-inch closure can be pre-made by using a grid of screws to connect two boards of lesser thickness. Vent openings can usually be protected with a lesser thickness. MDF and other materials that are not water resistant should not be used. The closure panel should be measured, cut, and identified for the specific location in the temporary flood barrier and should be available for use from one flood season to the next. The panels

should be held in place with water resistant caulking, nails, screws and/or liquid nail.

More expensive metal architectural panels are also available.

- Sand and Sandbags.

Considered to be one of the most durable and easily employed flood-fight products on the market, sandbags are an integral component of many temporary preventive barriers to flooding. Sandbags should be made of nylon or polyethylene.

Generally, bags can be placed in a single row up to 3 bags high. Walls more than 3 bags high should be built in pyramid fashion; these walls should be as many bags-wide at the base as they are bags-high. Bags should be filled between half-way and two-thirds full, should not be tied and should be placed with the top of the bag tucked under the bag. After placement of each layer, the bags should be walked on to provide a better seal with adjacent bags. The bags in each course should be placed so that they cover to the maximum possible extent the joints in between the bags in the same course and also between the bags in the course below. Additional Corps of Engineer guidance on sandbagging is available at [www.nwk.usace.army.mil/flood/sandbagshow.pps](http://www.nwk.usace.army.mil/flood/sandbagshow.pps)

Sandbag closures at doorways and similar openings can work well but must be carefully sealed at the ends. You may prefer to use a plywood or other type closure panel.

- Caulk and Clear Sealant for Structure Exterior.

If any portion of the structure to be protected consists of brick, stone, stucco, concrete, cinder block, or tile, a water resistant sealant may be recommended. It is best to use a clear liquid sealant which may be applied by brush, roller, or sprayer. The sealant should be applied to all porous surfaces, which have been thoroughly cleaned and dried to allow deep penetration and maximum resistance to water. The sealant should be extended above the area of proposed protection for best coverage. Though no government testing programs have rated these commercial sealants, manufacturers' information indicates that these sealants may last up to 20 years without discoloration.

In addition, large cracks and voids in the structure exterior need to be filled. Many products carried by local hardware companies are compatible with the materials on the exterior of the buildings.

- Portadam or similar water barrier.

Portadam is a temporary, portable water barrier (dam) that may be suitable for flood proofing some of the structures in Biltmore Village. It can retain water up to 12

feet in depth and utilizes a free-standing welded tubular steel framework and a flexible, impervious fabric membrane, permitting relatively easy installation in any configuration and over uneven bed contours. 6 to 8 laborers can install a 3- to 5-foot high structure at a rate of about 100 linear feet per hour. Two sandbags per linear foot must be placed to secure the membrane. To prevent sliding, anchors are required if the system is installed on concrete or asphalt. Delivery time is 6-8 weeks for new materials and can be about a week for used materials if they are available.

- Interior Drainage Pump and Power Supply

In order to prevent flood damage due to seepage of floodwaters through the temporary flood barrier or resulting from a rising water table, it may be recommended that pumps be incorporated into the protection measures.

Pumps will be needed inside the structure to collect seepage and rising groundwater. At a minimum, one pump with a capacity of at least 20 GPM should be considered for installation in the structure for every 2,000 square feet of floor space. 115-volt AC powered pumps can be used provided electricity is available throughout the flood event. You may consider installing a permanent sump pump with sump pit, or bringing in one or more pumps for temporary use. If loss of electrical power during a flood is a concern, you could employ a gasoline-powered electric generator to power the AC pump; this would have to be located outside the structure. An option would be to use one or more battery-powered sump pumps. You will have to be aware that the battery life is limited; therefore, a spare battery should be kept on-hand. The life of the battery recommended in the battery powered back-up sump pump listed in Table A-1 is about 10 to 14.5 hours of pump use. Because it is impossible to know how much the pump will be operating, you may need to monitor it periodically and be prepared to replace the battery. If there is no basement or crawl space, you may elect to use a floor-sucker type pump that can maintain the depth of water on the floor to 1/8 inch. If the structure being protected does have a basement or crawlspace, the pump needs to be placed at the lowest elevation in order to work most efficiently. In some instances you may consider cutting a small hole through the floor of a closet space, for concealment purposes, and lowering the pump to the lower level. For a slab on grade structure, the pump should be placed in a location upon the floor where floodwaters may begin to collect. In all cases, you should consider placing the pump at a location where the discharge hose is easily positioned to extend beyond the limits of the protection measures. The discharge side of the pump should be sized to match a common 1-inch diameter garden hose or should be equipped with an adaptor to 1 inch.

If there is a sandbag wall or a Portadam type wall, a pump with significant capacity will be needed to collect rainfall, seepage and rising groundwater.

**Table A-1. Materials and Equipment Cost and Vendor List**

<b>Material or Equipment</b>	<b>Vendor</b>	<b>Approximate cost</b>
Polyethylene sheeting	Local home improvement store	\$58 for 6 mil 10' wide by 100' rolls
Connectors for polyethylene	Local home improvement store	Approximately \$1 per hook
Water-resistant tape	Local home improvement store.	\$10.36 for 1 7/8" wide roll x 165' of "house-wrap" tape
Sand	Local sand and gravel supplier	\$26 per cubic yard picked up, or \$90 per 12 cy truck load delivered
Sandbags	Various online sources	Approximately \$0.33 each (in quantity) for 14 x 26 inch polypropylene
Plywood	Local home improvement store	4x8 sheets: 5/8 inch plywood @ \$18, 5/8 inch OSB @ \$10, 3/4 inch plywood @ \$22, and 3/4 inch OSB @ \$11
Other types of closure panels – architectural, metal	See websites: Architectural Metals @ <a href="http://www.hesco.com">www.hesco.com</a> , or Hurricane Protection Industries @ <a href="http://www.floodbarriers.net">www.floodbarriers.net</a>	Varies
Water-resistant caulk	Local hardware or home improvement store	\$24 for 12-tube box of latex caulk
Clear liquid sealant (for exterior building surface)	Local hardware or home improvement store.	\$9 per gal or \$40 per 5 gals of multi-surface sealant (Thompson's or equal)
Drainage pump – floor sucker	Kenny Pipe & Supply @ 252-6421 or Ferguson Enterprises @ 255-9038	\$130 for 115 volt Zoeller model LM44, automatic, keeps water to 1/8 inch depth, about 1,800 gals per hour.
Drainage pump - sump	Local home improvement store	2,000 gals per hour or more, 115 volt: \$100 for 1/3 HP, \$135 for 1/2 HP
Drainage pump – battery-powered back-up sump pump	Sears (on-line if not in local store)	\$210; Direct Current (DC); about 1,200 gals per hour
Portadam or similar barrier	Portadam, Inc. <a href="http://www.portadam.com">www.portadam.com</a> 1-800-346-4793, or Bob Gatta (CEO) at office 856-740-0606 x207 or mobile: 518-577-7034	\$115 per linear foot for 3-foot height (\$80 with used frame and new fabric); \$140 per foot for 4-foot. Includes shipping and training.

## 6.0 Estimating the Required Quantities of Sheeting, Sand and Sandbags

The following discussion has been prepared to assist you in determining the quantities of polyethylene sheeting, sand and sandbags that are needed to protect your structure. Though no two structures are identical, there are generic methods for calculating how much of these materials should be purchased. It is suggested that you purchase a larger quantity of all materials than calculated to eliminate additional trips to purchase more.

### 6.1. Polyethylene Sheeting Hung on the Structure Exterior

For a typical building for which sheeting is recommended, the sheeting will be applied to the walls and on the ground for a distance several feet (say, 4 feet) from the walls. Assuming that the typical structure has 4 sides and a sloping site, the amount of sheeting needed should be calculated for each of the 4 sides and the 4 corners, then totaled.

The shape of the protected portion on each side is a trapezoid (see Figure A-1 below), with the top being the elevation to which the top of the sheeting is to be placed. The wall area (AW, in square feet) to be protected would be calculated by using the following formula (with all measurements in feet):

$$AW = L \times (H1 + H2) / 2$$

To calculate the area (AG, in square feet) to be covered on the ground adjacent to that wall, use:

$$AG = L \times 4$$

The area to be covered on the ground at the 4 corners of the structure would be:  
4 ft x 4 ft x 4 corners = 64 square feet per structure.

The total estimated area (AC, in square feet) to be covered at that structure would be:

$$AC = 64 + (\text{the 4 AW's}) + (\text{the 4 AG's})$$

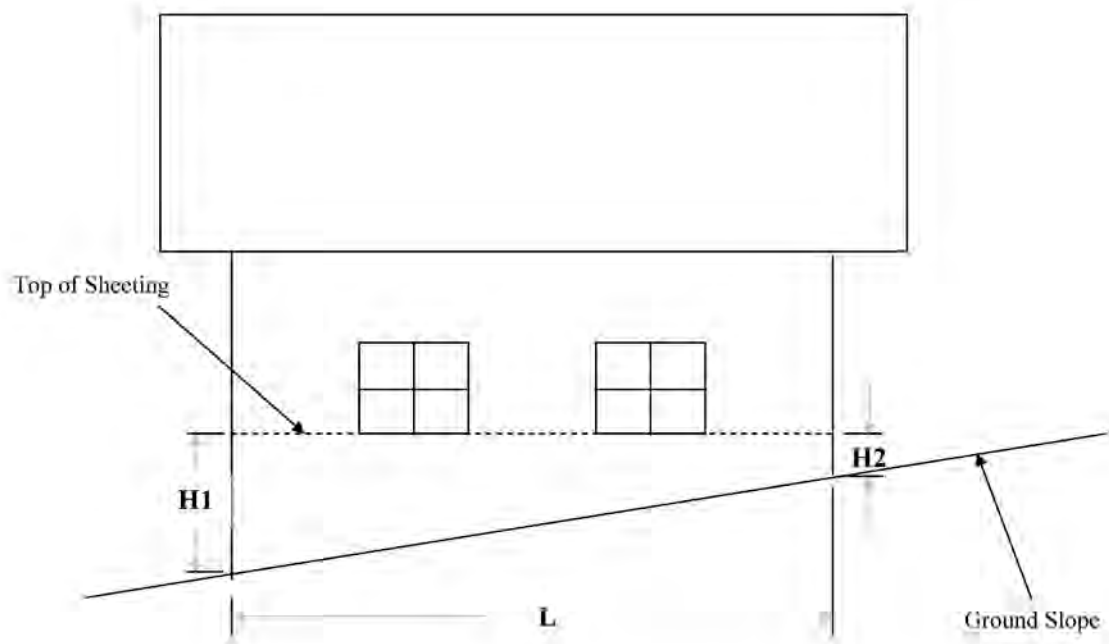
Because this method does not consider doorways, vents or other openings and does not account for waste and overlapping, about 15% should be added to the calculated area. Therefore, the total estimated area (AT, in square feet) of sheeting required would be:

$$AT = 1.15 \times AC$$

Assuming the use of 10-foot wide sheeting, the length (L, in feet) of 10-foot sheeting would be:

$$L = AT / 10$$

The method would be similar for a structure on a site that is flat and would be slightly modified if the width of the sheeting on the ground is other than 4 feet or if the user prefers to purchase 20-foot wide rolls of sheeting.



**Figure A-1. Structure with Polyethylene Sheeting on Exterior Walls**

Example: assume use of 10-foot wide rolls of sheeting on a building that is 30 feet wide and 50 feet deep, is to be protected to a height of 2 feet on the front, on a lot that slopes down 2 feet from the front of the building to the rear (so the height of protection is 4 feet at the rear), and with sheeting 4 feet on the ground.

$$AW = 30 (2 + 2) / 2 + 30 (4 + 4) / 2 + 50 (2 + 4) / 2 + 50 (2 + 4) / 2 = 60 + 120 + 150 + 150 = 480 \text{ square feet}$$

$$AG = 30 \times 4 + 30 \times 4 + 50 \times 4 + 50 \times 4 = 120 + 120 + 200 + 200 = 640 \text{ square feet}$$

$$\text{Area at corners} = 64 \text{ square feet}$$

$$AC = 64 + 480 + 640 = 1,184 \text{ square feet}$$

$$AT = 1.15 \times 1,184 = 1,362 \text{ square feet}$$

$$L = 1,362 / 10 = 136 \text{ feet of 10-foot wide sheeting}$$



## 6.2 Sand and Sandbags

The most common recommended uses for sandbags are in doorways and along the outer edge of the polyethylene sheeting placed on the ground. Assuming the use of 14-inch x 26-inch bags that are filled 2/3 full with dry sand, with the top folded over, it is assumed that each bag will hold approximately 35 pounds of sand and will be about 16 inches long when in place.

The number of bags (N) required would be calculated using the following formula, where LS is the total length (in feet; for doorways, sheeting, etc.) of the line (one bag high) of sandbags to be used:

$$N = 0.75 \times LS$$

The weight (W, in pounds) of dry sand required would be:

$$W = N \times 35$$

The volume (V, in cubic yards) of sand needed would be:

$$V = W / 2700$$

Example: assume the same building as above, with plywood covering the doorways (no sandbags at the doors)(Note – the length of the sandbag row placed atop the sheeting is 8 feet longer than each wall because of the sheeting on the ground).

$$LS = 50 + 8 + 50 + 8 + 30 + 8 + 30 + 8 = 192 \text{ feet}$$

$$N = .75 \times 192 = 144 \text{ sandbags}$$

$$W = 144 \times 35 = 5,040 \text{ pounds}$$

$$V = 5,040 / 2700 = 1.9 \text{ cubic yards}$$

An alternate size sandbag is 15-inch by 27-inch. If this size is used and the bags are filled 2/3 full with dry sand, each bag will hold about 40 pounds of sand and will be about 17 inches long when in place. For these bags:

$$N = 0.71 \times LS$$

$$W = N \times 40$$

$$V = W / 2700$$

## **7.0 Maintenance of the Plan**

Once you have established a temporary protection plan for your structure, it may be beneficial to test the plan for efficiency and effectiveness in order to optimize the plan. The materials and equipment should be stored in such a manner that they will not be damaged and should be monitored on a regular basis to ensure that these materials will be effective when and if needed. For instance, blue plastic can become damaged with holes from animals or normal weathering and should be replaced if any damage occurs, and plywood should be stored such that it will not rot or be damaged by termites.

## **8.0 Site Maps and Structure Sheets**

Please use the following site maps to locate a structure of interest in the study area; structures are denoted by a unique number. Then, refer to the sheet(s) for that structure. The sheets typically contain building photos and the following data: 1) elevation of the lowest ground surface adjacent to the building, 2) first floor elevation, 3) current flood data, including the flood water elevations for various flood event frequencies, relative to the lowest ground and the first floor (negative numbers indicate that the water is below the ground or first floor; positive numbers indicate flooding), and 4) suggested temporary flood proofing measures. Note that NAVD is the North American Vertical Datum, the vertical control datum established for vertical control surveying in the U.S.

Also, note that some structures are indicated on the maps but are not included in the recommendations. These include the Hill Partners mixed-use development on Brook Street (structure numbers 32-35) and the Bohemian Hotel (numbers 38 and 41), both of which are new projects which, by design, should already be protected to at least the 100-year flood elevation. Also, some structures are not identified by number on the master map but are identified on maps A1-3, B1-3 and C1-3.