Panel Decision & Report

SRP VTWB062111 Barre, Washington County, VT

November 16, 2011

National Institute of
BUILDING SCIENCES

Table of Contents

Summary

Based on the submitted scientific and technical information, and within the limitations of the SRP, the Panel has determined that, although the community's data satisfies NFIP standards, it does not negate FEMA's data.

Introduction

This report serves as the recommendation to the Federal Emergency Management Agency (FEMA) administrator from the National Institute of Building Sciences (NIBS) Scientific Resolution Panel (SRP). SRP's are independent panels of experts organized, administered and managed by NIBS for the purpose of reviewing and resolving conflicting scientific and technical data submitted by a community challenging FEMA's proposed flood elevations. The SRP is charged with helping to efficiently resolve appeal and protest issues between FEMA and communities by acting as an independent third party in the effort to obtain the best data possible for the community's Flood Insurance Rate Maps (FIRM's).

Panel

Panel ID: VTWB062111
Panel Name: Barre, VT
FEMA Region: 1
Panel members:

- **Michael C. Menoes, Ph.D. P.E.,** Mr. Menoes is a senior hydrologist at Hydrosphere Engineering. He received his Ph.D. from University of Maryland in 2003. He has taught university courses in water resources engineering, ground water hydrology and open channel hydraulics. He has performed specialized consulting engineering in the water resources engineering field for nearly 20 years. His work has included field data collection, the simulation of hydrologic and hydraulic systems, writing and updating stormwater and floodplain regulations, authoring numerous reports, and presentations at numerous public meetings. Mike Menoes has completed or reviewed more than 20 floodplain delineation projects since 2004. Additionally, Mike Menoes has taught short courses for professional engineer's continuing education in the field of hydrology, open channel hydraulics, and the use of HEC-RAS and the Storm Water Management Model hydraulic simulation programs.
- **John Loper, P.E.,** Mr. Loper is the founder and Principal Hydrologist at Interflow Engineering LLC. As a water resources engineer and project manager, he has seventeen years of experience in hydrologic and hydraulic modeling, water resources investigations, and floodplain management. His experience includes the application of state-of-the-art hydrologic and hydraulic modeling programs and techniques to over 20 watersheds and water bodies, with recent emphasis on the development and application of integrated groundwater and surface water models. Mr. Loper

has also provided independent peer review services and expert witness testimony related to a variety of hydrologic, hydraulic, and hydrodynamic modeling applications for such clients as Florida's Water Management Districts and various local governments

- **Carolyn Gilligan, P.E.,** Ms. Gilligan, a senior technical consultant at LJA Engineering, Inc., has more than 28 years of experience in hydrology and hydraulics, including FEMA submittals, watershed studies, drainage studies of major waterways, design of stormwater detention systems, drainage channels and stormwater collection systems. During her tenure at LJA, Ms. Gilligan has successfully completed over 40 FEMA Letters of Map change, including several revisions reflecting leveed areas along the Brazos River. Most recently, she provided the flood frequency analysis for the re-mapping of the Brazos River in Fort Bend County, Texas.
- **Charles Patterson, Ph.D., P.E. CFM,** Dr. Patterson is a Senior Hydro Engineer with Allgeier, Martin and Associates, Inc., Rolla, Missouri, where he is responsible for hydrologic and hydraulic analysis and design and expert witness research. Dr. Patterson has also served as an Adjunct Assistant Professor, Missouri University of Science and Technology (formerly University of Missouri-Rolla), Rolla, Missouri, where he has taught the following graduate courses: Open Channel Hydraulics, Hydraulic Engineering & Advanced Hydraulics, Water Infrastructure Engineering, and Hydraulic Structures. He has also taught undergraduate Fluid Mechanics and undergraduate Water Resources. He received a B.S. in Civil Engineering (1988), M.S. in Civil Engineering with an emphasis in Hydraulics and Hydrology (1994), and Ph.D. in Civil Engineering with an emphasis in Hydraulics and Hydrology (1998), each from the University of Missouri-Rolla.
- **Robert Billings, P.E., PH, CFM,** Mr. Billings received his Bachelor of Science in Civil Engineering from UNC-Charlotte in 1995 and is and a Masters of Civil Engineering in 2005. Following several years in the private sector, Mr. Billings joined the staff of Mecklenburg County Storm Water Services in July 2001. He has over 15 years of experience in water resources engineering and managing FEMA related flood studies. Mr. Billings is currently a project manager in Mecklenburg County's Flood Mitigation program and is responsible for the implementation of a multi-million dollar, federally funded buyout program.

Basis for Appeal

The City of Barre, Vermont (City) is appealing the peak discharges in FEMA's proposed 2009 Flood Insurance Study (FIS). These 2009 peak discharges are based on HEC-1 modeling. The 2009 peak discharges replace FEMA's 2007 peak discharges that were based on regression equations. The 2007 peak discharges replaced the 1984 discharges that were based on flow transposition.

The City contends that FEMA's 2009 hydrologic methodology produces results that are less accurate than those developed by flow transposition.

Data Submitted by the Community and FEMA

The following data used to generate the challenged flood elevations and the contesting data submitted by Barre has been provided to the Panel:

- "Winooski River Flood Control Reconnaissance Study, City of Montpelier, Vermont, Appendix Volume 1 of 2, Revised Main Report", prepared for the Department of the Army, New York District, U.S. Army Corps of Engineers, Appendix A, Hydrology and Fluvial Hydraulics, Appendix A1a, Supporting Fluvial Hydrologic Data (HEC-1) http://panels.floodsrp.org/files/?artifact_id=2580;
- United States Geological Survey (USGS) Water-Resources Investigations Report 02-4238, Flow-Frequency Characteristics of Vermont Streams, Scott A. Olson, 2002 http://panels.floodsrp.org/files/?artifact_id=2618;
- February 5, 2010 Dubois & King, Inc. letter to Mr. Michael Miller, Director, Planning & Zoning Department Barre, Vermont, re: Review of Proposed 2009 Barre Flood Insurance Rate Maps http://panels.floodsrp.org/files/?artifact_id=2572;
- February 3, 2010 City of Barre letter to Engineering Management Branch, Mitigation Directorate, Federal Emergency Management Agency, re: Appeal of the Proposed 2009 Flood Hazard Map Amendment http://panels.floodsrp.org/files/?artifact_id=2573;
- August 6, 2010 FEMA letter to Michael Miller, City of Barre, Vermont, re: Appeal Resolution for City of Barre, Vermont http://panels.floodsrp.org/files/?artifact_id=2576;
- October 4, 2010 City of Barre letter to Mr. Michael J. Goetz, Risk Analysis Branch, U.S. Department of Homeland Security, Region 1, re: Appeal Resolution for City of Barre, Vermont http://panels.floodsrp.org/files/?artifact_id=2575;
- November 23, 2010 FEMA letter to Michael Miller, City of Barre, Response to Appeal Resolution Comments from the City of Barre, Vermont http://panels.floodsrp.org/files/?artifact_id=2577;
- Table A, Comparison of Peak Discharges for Stevens Branch, Washington County, Vermont, May 5, 2011 http://panels.floodsrp.org/files/?artifact_id=2581;
- Study Chronology, fall 2006 to March 2010 http://panels.floodsrp.org/files/?artifact_id=2582.

Summary of Panel Procedures

Based on the scientific and technical information used by FEMA to generate the flood maps and the data submitted by the community, but limited to the contested data, the Panel shall:

1. Review FEMA data for sound engineering practice and principles, and compliance with NFIP mapping standards;
    a. Review community data on a point-by-point basis and determine if:
    b. It satisfies NFIP mapping standards, and
2. It is superior to FEMA data;
3. Attend oral briefings by the community and FEMA;

4. Establish its decision based on these reviews and recommend either the acceptance or denial of the community submitted data for inclusion in a revised flood map in part, or in whole;
5. Recommend one of the following explanations:
    - FEMA's data does not satisfy NFIP mapping standards defined in FEMA's Guidelines and Specifications for Flood Hazard Mapping Partners (NFIP standards) and must be revisited.
    - The Community's data satisfies NFIP standards and wholly corrects or negates FEMA's data.
    - Portions of the Community's data satisfy NFIP standards and correct or negate FEMA's data.
    - The Community's data does not satisfy NFIP standards, thus FEMA's data is not corrected, contradicted, or negated.
    - The Community's data satisfies NFIP standards and is correct, but does not negate FEMA's data.

Recommendation

The Panel is limited to providing a decision that rejects or supports the appeal as filed based on knowledge or information submitted by the appellant indicating whether the hydrology for determining the Base Flood Elevations (BFE's) proposed by FEMA are scientifically or technically correct. Based on the submitted scientific and technical information, and within the limitations of the SRP, the Panel has determined that, although the community's data satisfies NFIP standards, it does not negate FEMA's data. Additional comments and recommendations, as well as the rational for these findings are presented below.

Rationale for Findings

The sole basis for an appeal is "the possession of knowledge or information indicating that the elevations being proposed with respect to an identified area having special flood hazards are scientifically or technically incorrect". The central issue to be decided is, therefore, whether or not the appeal contents prevail under either the "scientific correctness" standard or the "technical correctness" standard as defined in 44 CFR. 59.1, and reiterated below:

> "**Technically incorrect**" means that the methodology(ies) used to determine the BFE's has been erroneously applied due to mathematical or measurement error, changed physical conditions, or insufficient quantity or quality of input data

The Panel agrees that the methods used by FEMA to determine the discharges are technically correct.

> "**Scientifically incorrect**" means that the methodology(ies) and, or assumptions that have been used are inappropriate for the physical processes being evaluated or are otherwise erroneous.

Scientific correctness is often a matter of degree rather than an absolute. Demonstrating that alternative methods or applications result in more correct estimates of the hydrology used for determining the base flood elevations thus would demonstrate that FEMA's estimates are incorrect. In

evaluating the method of flow transposition promoted by the City, the Panel does not believe that this method results in discharges that are "more correct" than those determined by FEMA. The Panel does agree, however, that the method used by FEMA to determine the peak discharges used for mapping Stevens Branch could be improved.

The City proposes that using transpositional data from the Dog River gage provides a more accurate measure of discharge for Stevens Branch at its confluence with Gunners Brook. The Panel members disagree for the following reasons:

- The flow in Stevens Branch is regulated by the East Barre Dam and Reservoir, while the Dog River does not have any flood control structures. The effect of the dam and reservoir on the Stevens Branch flood flows cannot be neglected in determining the 100-year discharge for Stevens Branch.
- The lack of statistically significant events at the Dog River gage raise questions as to the validity of using the Dog River gage to predict the 1-percent annual exceedance probability on Stevens Branch.
- No specific evidence was provided by the City. The discussion presented in its February 3, 2010 letter to FEMA did not provide detailed documentation supporting their premise that the Dog River gage reflected discharges that could accurately be transposed to the Stevens Branch drainage basin.

FEMA uses the HEC models prepared for the 1994 *Winooski River Flood Control Reconnaissance Study for the City of Montpelier* (1994 COE Study) which were developed to evaluate "alternatives for long term flood control to mitigate damages resulting from fluvial and ice jam caused events". The HEC-1 model was "calibrated to the local river gages in 1986"; the Snyder unit hydrograph coefficients were developed "using flow data measured from and calibrated to the Dog and Mad river gages". Routing between computations points was done using the Muskingum method. The HEC-1 model was calibrated by adjusting the loss coefficients "until the computed peak discharges at the USGS gages matched the flood flows using the Flood Frequency analysis (log-Pearson III distribution of data)".

The 1994 HEC-1 model was subsequently revised. In 1999 the COE HEC-1 model was used by Dubois and King "to develop flood hydrographs at various locations along the Winooski River for use in the DAMBREAK – Special Studies Project" (1999 Study). In 1999, the HEC-1 model was revised "for the Stevens Branch watershed to incorporate additional sub-areas (flow change locations) along Stevens Branch" and "was calibrated to match the 100-year peak discharges for Stevens Branch at the confluence of Jail Branch and at the confluence with the Winooski River".

The Panel believes that the HEC-1 model FEMA used to determine discharges for the Preliminary FIS is also deficient for the following reasons:

- According to the December 27, 1993 HEC-1 Model Summary of Discharges the peak discharges for actual events at locations other than USGS gage number 04286000 were interpolated based on ratios from the HEC-1 model. This indicates that although the model was calibrated at the

downstream model limit (DA = 397 square miles), no actual calibration was done for Stevens Branch.

- Since no actual calibration was done for Stevens Branch originally, the flows generated in the 2009 HEC-1 model, although professing to be calibrated at the confluence of Stevens Branch and Jail Branch and at the Stevens Branch confluence with the Winooski River are not actually calibrated to gage data and thus the accuracy of these estimates of the 100-year peak flow is unknown.

In addition, the following inconsistencies between the HEC-1 models of Stevens Branch drainage basin should be resolved:

- In the HEC-1 model used for the 1994 and 1999 Studies the Stevens Branch/Jail Branch drainage basin was divided into five sub-basins, three of which reflected Jail Branch upstream and downstream of the East Barre dam. The total area of the drainage basin was shown to be 119.0 square miles. When the model was revised in 2009 the Stevens Branch drainage basin (independent of the Jail Branch drainage basin, which was not revised) was divided into 18 sub-basins. The total area of the Stevens Branch and Jail Branch combined drainage basins was shown to be 115.2 square miles.
- Although the Snyder unit hydrograph coefficients for the Jail Branch sub-basins were not revised, the Muskingum "X" value was changed. The 2009 HEC-1 results show a time-to-peak almost one-half of the time computed in the 1994 COE model at the confluence of Jail Branch and Stevens Branch.
- While the 2009 computed peak flow for Stevens Branch at the confluence with the Winooski River is within 0.2 percent of the 1994 peak flow, the time-to-peak is 40-percent earlier.

Additional Recommendations and Comments

Although flow transposition is an acceptable method of determining peak flows for use in Flood Insurance Studies, it is the opinion of the Panel that the Dog River gage does not provide a reasonable estimate of the peak flow for Stevens Branch. The Panel does support use of a HEC-1 model; however, FEMA's HEC-1 model of Stevens Branch needs further refinement to provide an acceptable flow to use for establishing the BFE's and the floodway along Stevens Branch. The Panel would like FEMA to consider the following suggestions:

- Develop a Flood Frequency Analysis (FFA) that considers the effect of the flood control reservoirs;
- Using a HEC-1 mode that has been calibrated for another purpose and for another location is considered unacceptable. To be acceptable, FEMA should calibrate the HEC-1 model of the Winooski River to the results of the FFA and use measured high-water marks to verify the peak flows at locations other than at a single gage;
- FEMA should use the best available data to determine the coefficients for each of the drainage basins in the HEC-1 model.

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