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Managing Future Development Conditions in the National Flood Insurance Program

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ABSG Consulting Inc.

October 2006

Prepared under subcontract to the American Institutes for Research
as part of the 2001–2006 Evaluation of the National Flood Insurance Program

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REPORTS IN THE EVALUATION OF THE NATIONAL FLOOD INSURANCE PROGRAM (NFIP)

This Evaluation consists of a series of reports assessing questions identified and prioritized by a steering committee about the National Flood Insurance Program (NFIP). The reports of the Evaluation will be posted on the FEMA website as they are finalized. The website URL is http://www.fema.gov/business/nfip/nfipeval.shtm. The reports in the Evaluation are:

The Evaluation of the National Flood Insurance Program – Final Report
American Institutes for Research and NFIP Evaluation Working Group

Assessing the Adequacy of the National Flood Insurance Program's 1 Percent Flood Standard. Galloway, Baecher, Plasencia, Coulton, Louthain, and Bagha, Water Policy Collaborative, University of Maryland.

Assessing the National Flood Insurance Program's Actuarial Soundness. Bingham, Charron, Kirschner, Messick, and Sabade, Deloitte Consulting.

Costs and Consequences of Flooding and the Impact of the National Flood Insurance Program. Sarmiento and Miller, Pacific Institute of Research and Evaluation.

Developmental and Environmental Impacts of the National Flood Insurance Program: A Review of Literature. Rosenbaum, American Institutes for Research.

The Developmental and Environmental Impact of the National Flood Insurance Program: A Summary Research Report. Rosenbaum and Boulware, American Institutes for Research.

An Evaluation of Compliance with the National Flood Insurance Program Part A: Achieving Community Compliance. Monday, Grill, Esformes, Eng, Kinney, and Shapiro, American Institutes for Research.

An Evaluation of Compliance with the National Flood Insurance Program Part B: Are Minimum Building Requirements Being Met? Mathis and Nicholson, Dewberry.

Evaluation of the National Flood Insurance Program's Building Standards. Jones, Coulbourne, Marshall, and Rogers, Christopher Jones and Associates.

Managing Future Development Conditions in the National Flood Insurance Program. Blais, Nguyen, Tate, Dogan, Petrow, ABSG Consulting; and Mifflin and Jones.

The National Flood Insurance Program's Environmental Reviews: An Assessment of FEMA's Implementation of NEPA and Executive Order 11988. Rosenbaum, American Institutes for Research.

The National Flood Insurance Program's Mandatory Purchase Requirement: Policies, Processes and Stakeholders. Tobin and Calfee, American Institutes for Research.

The National Flood Insurance Program's Market Penetration Rate: Estimates and Policy Implications. Dixon, Clancy, Seabury, and Overton, RAND Corporation.

Performance Assessment and Evaluation Measures for Periodic Use by the National Flood Insurance Program. Miller, Langston, and Nelkin, Pacific Institute of Research and Evaluation.

State Roles and Responsibilities in the National Flood Insurance Program. Mittler, Morgan, Shapiro, and Grill, American Institutes for Research.

Managing Future Development Conditions in the National Flood Insurance Program (NFIP)

Prepared as part of the 2001-2006 Evaluation of the National Flood Insurance Program (NFIP)

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EXECUTIVE SUMMARY

As floodplains are developed and permeable surfaces are replaced with non-permeable surfaces, there is an increased chance of flooding. Additionally, the incorporation of storm water management systems typically means that large quantities of water are collected, increasing discharges, and potentially creating a higher flood stage elevation downstream. Because of these changing conditions it has put an emphasis on the relationship between development, the floodplain, and floodplain management.

In 1999, the Federal Emergency Management Agency (FEMA) convened a committee to establish a framework for conducting the first comprehensive evaluation of the National Flood Insurance Program (NFIP). The NFIP, created under the National Flood Insurance Act of 1968, is administered by the Department of Homeland Security (DHS) through the Mitigation Division. The committee produced a set of questions to guide an evaluation that would assess the NFIP's effectiveness and efficiency.

One question raised was whether current floodplain management techniques typically applied by communities to manage the NFIP properly address changing conditions within a given watershed, and what effect they have on decreasing future costs and consequences of flooding – one of the primary goals of the NFIP.

In 2000, FEMA contracted with the American Institutes for Research (AIR) to perform a comprehensive evaluation of the NFIP. As part of the evaluation, AIR subcontracted with ABSG Consulting to conduct a sub-study that would analyze practices of managing future conditions in the floodplain. The objective of the study is to analyze the consequences (cost and benefits) of managing future conditions.

To analyze this issue, the sub-study would use both a qualitative (interviews) and quantitative (computational analysis) assessment. The interviews will be used to identify the cost, while, computational analysis will be used to identify the benefits (avoided losses). To best identify the costs associated with floodplain management, it was determined to select communities that are known to be using floodplain management regulations that exceed the NFIP minimum standards. By analyzing these communities the project team could identify the additional costs associated with implementing and enforcing floodplain management programs.

The project team visited each of the selected communities and arranged interviews with a cross section of people affected by floodplain regulations. The purpose of the interviews was to establish a qualitative understanding of the communities' perspectives on how their floodplain management regulations, especially those exceeding normal standards, may have changed development trends, the costs of development, and the ability to meet development demands within the community. The interviews were semi-structured for free flowing discussion. The interviewer was free to ask pointed questions in response to the interviewees' answers. The interview process also provided the opportunity to work with the local staff to identify available flood data for our computational analysis effort.

To perform the computational analysis, the project team incorporated the local data into the HAZUS-MH[1] Flood Model (hereafter referred to as HAZUS) developed by the National Institute for Building Sciences (NIBS) for FEMA. The benefits (avoided losses) will be identified by comparing the current and future inventory against the current and future 100-year floodplain. While working with annualized losses would provide a more accurate assessment of the losses avoided, many communities do not have the necessary data to perform this assessment. Three (3) return intervals are required in order to properly extrapolate and estimate annualized losses. Based on this fact, the project team opted to perform the comparative analysis for the 100-year flood.

There were five (5) initial communities; they included: Mecklenburg County, North Carolina; Escambia County (specifically Pensacola), Florida; Harris County (specifically Houston), Texas; Larimer County (specifically Fort Collins), Colorado; and Grand Forks County (specifically Grand Forks), North Dakota. After the initial interviews were completed some communities were eliminated from the list. For various reason discussed in Chapter 4, Escambia County (Pensacola), Florida, and, Grand Forks, North Dakota were removed from the study. In an effort to maintain a satisfactory number of communities in the study the County of DuPage, Illinois was added to the list. The results from the interviews (qualitative) and computational (quantitative) process can be found in Chapters 5 and 6, respectively.

Based on the results from the interviews and computational analysis, the project team has drawn the conclusion that costs associated with managing future conditions are negligible. Many of the interviewees believe that there are other factors that have more of a significant impact on costs. Additionally, the computational assessment determined that managing to future conditions provide substantial avoided losses. This was largely due to the fact that many of the existing structures in the floodplain were greatly impacted by anticipated development.

The analysis was performed three times using a variation of the analysis inputs so the increased impact caused by development within the watershed could be seen more clearly.

- Current Inventory with Current Flood Conditions: The first analysis looked at the potential existing conditions losses. For this study, potential existing conditions losses are defined as the 100-year flood losses for the buildings that currently exist in the community and the flood conditions for the 100-year flood used as the design condition flood for the community.
- Current Inventory with Future Flood Conditions: The second analysis examined the 100-year flood loses for the buildings that currently exist in the community, but the 100-year flood is what is anticipated at build-out assuming no additional management of the floodplain (such as on-site storage) as the development progresses. (On-site storage is assumed to prevent any change in the 100-year flood conditions).
- Future Inventory with Future Flood Conditions: The final analysis explores the 100-year flood losses for the built-out conditions (current plus zoned future development) against the build out 100-year flood conditions used in the second analysis.

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[1] Hazards United States or HAZUS® is a trademark of the Federal Emergency Management Agency.

When comparing the results, the difference between the first and second analysis represents the impact created by the changing flood conditions on the existing inventory, that is, the losses created on existing structures by unmanaged development within the watershed. The difference between the second analysis and the third analysis represents the losses attributed to the development of structures within harms way, that is, the new structures placed in the areas that are flooded during the 100-year event. Finally, comparing the first analysis to the third analysis represents the total losses that could potentially be avoided with managing the floodplain to the future conditions.

In Mecklenburg County, for example, the building and content damage resulting from future conditions flooding represents a nearly 440% increase from the damage associated with existing conditions flooding. Even in Fort Collins (Larimer County), where the increased flooding is relatively minor, the future conditions flooding may result in a 37% increase in flood damages from the 100-year event. To existing structures, the future conditions flood can mean that more structures are impacted by flooding (as seen by the addition of some occupancies in the analysis tables that were not there before) and those that were impacted before, have increased levels of damage. For example, in Harris County, the future conditions flood could create a 1,300% increase in flood losses in the existing inventory alone. In fact, with the exception of Mecklenburg County, the existing inventory represented the majority of the additional losses caused by the future conditions flood.

Based on the results from the interviews and computational assessment, the project team also made some recommendations. The primary recommendation is that communities should be encouraged to manage future conditions in the watershed. As identified in the study, there are two (2) approaches to managing future conditions: 1) managing the watershed to the anticipated 100-year build-out flood conditions; and, 2) attempting to avoid or delay the flood waters from entering the stream system thereby reducing or preventing an increase in the hydrograph. This study is not making a recommendation or distinction between the two (2) approaches; just the recommendation that communities should manage future conditions in the watershed. The communities should select the approach that best suits their needs.

The study also provided other recommendations/observations on: flood maps; establishing and maintaining flood studies; floodplain management programs; data collection guidelines; lack of knowledge; public awareness; special flood hazard areas (SFHA); and local economics.

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1. INTRODUCTION

1.1 Nation Flood Insurance Program (NFIP)

The National Flood Insurance Program (NFIP) was created under the National Flood Insurance Act of 1968 and is currently administered by the Mitigation Directorate, as part of the Department of Homeland Security through the Mitigation Division. The goals of the NFIP[2] can be stated as follows: 1) decrease the risk of flood losses; 2) reduce the costs and adverse consequences of flooding; 3) reduce demands and expectations for federal disaster assistance after floods; and 4) restore and preserve the natural and beneficial values of floodplains.

The regulatory standards of the NFIP are minimum standards in that they are generally applicable everywhere within participating communities and provide a basic measure of protection. Results from previous NFIP studies suggest that buildings built to the minimum NFIP regulations experience 80 percent less damage through reduced frequency and severity of losses.[3] However, they are still subject to damages due to changes in the watershed, larger storms, filling of the floodplain, incomplete understanding of the system hydrology and hydraulics (H&H) used to define the regulatory floodplain, and development within the entire watershed.

As of 2006, the NFIP membership exceeds 20,000 communities with more five (5) million policy holders paying annual premiums whose total exceeds $2.2 billion.

1.2 Special Flood Hazard Areas (SFHAs)

As part of the NFIP, and in cooperation with state and local agencies, communities, and mapping contractors, FEMA has produced Flood Insurance Rate Maps (FIRMs) depicting Special Flood Hazard Areas (SFHAs) for over 20,000 communities nationwide. The SFHA (also referred to as the 100-year flood zone) represents the flood that has a one percent (1%) annual chance of occurring in any given year, sometimes referred to as the “base flood”. The base flood is the national standard used by the NFIP and all federal agencies for the purposes of regulating development and requiring the purchase of flood insurance.

As discussed in *Assessing the Adequacy of the National Flood Insurance Program’s 1 Percent Flood Standard* (Galloway *et al*., 2006), the “100-year flood”, also known as the “1 percent annual chance flood,” is a statistical construct: it is a flood that has a certain discharge that produces a specific flood elevation, and has a 1% chance of occurrence in any one year. In

[2] These ultimate outcome goals were reached by a consensus of FEMA and the NFIP Evaluation team in the 2002 *Design for the Evaluation of the National Flood Insurance Program*. The fourth goal is not included in statute, however. The primary legislatively stated purposes of the 1968 Act creating the NFIP were to “Through insurance, better indemnify individuals for flood losses that created personal hardships and economic distress; reduce future flood damages through State and community floodplain management regulations; and reduce Federal expenditures for disaster assistance and flood control” (42 USC 4001).

[3] Source: Implementation of Community Floodplain Management Ordinances during Post-Disaster Reconstruction and Federal Agency compliance with Executive Order 11988-Floodplain Management, FEMA Memorandum to Regional Directors, September 22, 2005

reality, the 100-year flood represents a range of discharge and elevation values because of the uncertainties in the information available for its computation and the resulting use of probability distributions to portray the possibilities. Development may take place within the SFHA provided that the development complies with local floodplain management ordinances, which must meet the minimum federal requirements.[4]

The 100-year flood zones on the FIRMs reflect varying degrees of analysis. The 100-year flood zones in communities with limited existing or potential development are typically mapped by approximate methods. In contrast, other 100-year flood zones are mapped by detailed methods reflecting complex hydrologic and hydraulic studies that analyze flood duration, drainage area, structures, the amount of impermeable surface, and other factors that affect flood hazards. These studies assign statistical probabilities to different size floods. This is done to understand what might be a common or ordinary flood for a particular area versus a less likely or severe flood for that same river or coastline. Flood studies developed using detailed methods include the computed elevation to which floodwaters are anticipated to rise during the base flood. Detailed flood studies are a vital part of a floodplain management program and provide the necessary flood elevations, flood velocities, wave action areas, and floodway dimensions to ensure newly constructed buildings are built to minimize flood damage.

The accuracy of the FIRMs and the 100-year flood zones are dependent on the accuracy of the computation of the 1% flood and the accuracy of the topographic information available for the area being mapped. The myriad of factors involved in generating the flood map make it difficult to ascribe to the level of accuracy that is frequently given to it by communities. Many interpret the 1% flood line as an assurance that development above that elevation or outside that line are guaranteed to be safe from the 1% flood.

The 100-year flood zones also only reflect existing conditions; they do not incorporate future development. Following the passage of the Flood Disaster Protection Act of 1973, a decision was made that property owners, under certain circumstances, were mandated to purchase flood insurance. Since future development was often driven by local political, social, and economic conditions and attitudes, the property owners could not be mandated to purchase flood insurance based upon development that may never occur.

Another issue effecting the 100-year flood zone is that, as floodplains are developed and more of the ground surfaces are paved (e.g., made impervious or non-absorbing), the risks and expected elevations of flooding increase. The predicted elevation of the “base flood” increases, and the 100-year flood zone subsequently spreads beyond their mapped boundaries. FEMA’s present policy of mapping 100-year flood zones based on current development conditions means, among other things, that, in rapidly developing areas and areas downstream, FIRMs may become outdated shortly after their completion (FEMA, 2000). As a result, some development could be constructed without proper protection from the flood hazard it may face throughout its life span.

This may also mean that some development is either uninsured or paying rates that do not accurately reflect their risk. Flood insurance rates are based on the building’s risk of flooding.

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[4] Communities participating in the NFIP must adopt legally enforceable floodplain management measures that are compliant with 44 CFR §60.3 of the NFIP regulations.

Most insurance rates are determined based on the elevation of the lowest floor of the building in relation to the base flood elevation. Enforcement of floodplain management regulations by communities and incorporation of updated estimates of base flood elevations on FIRMs are critical for the NFIP to achieve its objectives of protecting lives and property and making flood insurance available within participating communities at affordable insurance premium rates.

Additionally, as floodplains are developed and more surfaces are paved, expected discharges and subsequent frequency and elevations of flooding are increased. While asphalt or concrete efficiently transports water to a storm drain, where it is then conveyed via pipe or culvert into a swale, stream, river, or other receiving water, this effectiveness means that large quantity of water enter into out-falls very quickly, thereby rapidly increasing discharges and potentially creating a higher flood stage elevation.

1.3 Managing Future Development Conditions Project

In 1999, the Federal Emergency Management Agency (FEMA) convened a committee to establish a framework for conducting the first comprehensive evaluation of the National Flood Insurance Program (NFIP). The outcome of the committee's sessions was a set of questions to guide an evaluation that would assess the NFIP's effectiveness and efficiency. One of the questions raised was whether current floodplain management techniques typically applied by communities to manage the NFIP properly addresses changing conditions within a given watershed and what effect they had on decreasing future costs and consequences of flooding – one of the primary goals of the NFIP.

In 2000, FEMA contracted with the American Institutes for Research (AIR) to perform a comprehensive evaluation of the NFIP. As part of the evaluation, AIR subcontracted with ABSG Consulting to conduct a sub-study that would assess the consequences (cost and benefits) of managing future development. To understand this issue, this sub-study identifies several communities that are known to be using floodplain management regulations that exceed the NFIP minimum standards, specifically managing their anticipated future flood conditions. Because of the intensity of modeling and data collection required for the qualitative analysis, it was decided by FEMA, AIR, and the project team to minimize the number of communities in the study.

Additionally, this project initially tried to attempt to examine both riverine and coastal flood conditions. However, based on discussions with subject matter experts, future conditions in the coastal area is more highly dependent on meteorological and geographic conditions other than the development of impervious surfaces or an increase in the number of habitable structures. For that reason, this project focused its attention on the riverine flood areas. Section 1.5 provides further discussions of the reasoning for excluding coastal flooding from this study.

1.4 Managing Future Development Definition

Managing Future Development, for this study, refers to actions taken to ensure that conditions of the watershed are maintained or improved to the predetermined condition. Typically, development modifies the percentage of the land area that is considered impervious to rainfall, which subsequently leads to modified discharges. There are typically two (2) approaches to managing the watershed: 1) managing to the anticipated 100-year build-out flood conditions; and, 2) attempting to avoid or delay the flood waters from entering the stream system thereby reducing or preventing an increase in the hydrograph.

The second approach is generally accomplished through the use of temporary or permanent on-site storage, with limits on the rate at which the water can be discharged into the storm water system, and subsequently, the watershed. The approach is to require all subsequent development to retain the increased runoff (up to 100-year flows) on site and discharge the runoff over a period of several days.

Many communities across the country have recognized the impact of new development on the 100-year flood zone and have implemented programs to mitigate potential increased base flood elevation or floodplain limits. These programs are designed to promote sustainable development; development that incorporates measures to lessen the impacts of their effects on the watershed. This effort is consistent with the watershed management program espoused by the Association of Floodplain Manger's (ASFPM) "No Adverse Impact" program. As defined in an ASFPM white paper[5], a "No Adverse Impact" refers to:

> "*an action taken by one property owner that does not adversely impact the rights of other property owners, as measured by increased flood peaks, flood stage, flood velocity, and erosion and sedimentation.*"

1.5 Managing Future Development for Coastal

The following discussion is intended to clarify reasons for not including coastal flooding in the future conditions project. The methodology for the identification of the 100-year flood zone for coastal areas is done slightly different than for riverine. NFIP coastal flood hazard mapping methods (as outlined in the April 2003 Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix D – Guidance for Coastal Flooding Analysis and Mapping) produce maps that reflect existing conditions, i.e., those known or postulated to be in existence at the time the flood insurance study is conducted. These methods consider the following parameters associated with the establishment of the base flood or 100-year flood:

- ***stillwater elevations*** -- due to ambient sea level, astronomical tide and/or storm surge conditions;
- ***wave effects*** such as shoreline wave lengths and wave heights, wave setup, wave propagation over flooded land, wave run-up and overtopping (run-up is the phenomenon in which a wave crest runs up along a slope to a level that is higher than the original wave crest due to the momentum of the wave), and if required, tsunami wave run-up;
- ***topography,*** modified to account for expected storm-induced erosion under base flood conditions; and,

[5] ASFPM White Paper on No Adverse Impact published in 2004 of the ASFPM website http://www.floods.org/NoAdverseImpact/whitepaper.asp

- ***land cover*** such as the presence of vegetation, dunes, buildings, or other "obstructions" and unobstructed areas, all of which modify wave effects.

Note that climate change is not explicitly included above. This study recognizes the fact that climate change can alter storm meteorology (e.g., frequency, intensity, track, etc.) and flood conditions over time, but assumes the effects will be included, implicitly, through consideration of the stillwater elevation and wave effects parameters.

The typical coastal flood study draws analysis transects perpendicular to the shoreline, and considers each of the above parameters along each transect. One or more models (e.g., erosion assessment, WHAFIS (Wave Height Analysis for Flood Insurance Studies), RUNUP (wave run-up computation)) are used to determine base flood conditions along each transect, depending upon the nature of the flooding and terrain at a given transect. Base flood conditions are interpolated between transects by the study contractor, and a FIRM is created.

Future conditions can potentially modify the parameters and flood hazard zones shown in the FIRM, thereby affecting the accuracy of FIRMs mapped on the basis of existing conditions. The future conditions considered by this study are described below, followed by a discussion of how they may affect flood hazard zones and Base Flood Elevations (BFEs), and a summary table at the end of this section.

1.5.1 Coastal Erosion

Coastal erosion is usually taken to mean long-term erosion, where the shoreline retreats at or around an average rate over a period of decades. However, shorelines (and dunes and bluffs) can also retreat during a single storm. FEMA's current flood hazard mapping procedures for coastal areas incorporate storm-induced coastal erosion, but do not incorporate long-term coastal erosion. This discussion distinguishes between *long-term coastal erosion* and *storm-induced coastal erosion*.

FEMA's current flood hazard mapping procedures for coastal areas incorporate storm-induced erosion, but do not incorporate long-term erosion.

Storm-induced Coastal Erosion

FEMA coastal flood mapping methods account for base flood induced erosion of dunes and bluffs by elevated water levels and waves. Storm-induced erosion should not be considered a future conditions parameter that will alter flood hazard mapping results. While future changes in the base flood water level and wave conditions may affect the outcome of storm-induced erosion calculations, water levels and wave conditions are each addressed separately as future conditions parameters.

Long-term Coastal Erosion

Long-term erosion at a shoreline is the net result of a variety of factors (e.g., sediment losses from storms, tidal inlets, submarine canyons, longshore transport gradients, sea level rise, dredging or mining, etc.) averaged over several decades. Shorelines rarely recede at a constant rate; instead, erosion occurs in a cyclic fashion, with seasonal and episodic influences resulting in periods of erosion, periods of stability and periods of accretion. On shorelines suffering from long-term erosion, the periods of erosion outweigh or overwhelm the periods of stability and accretion.

1.5.2 Topography

The net result of long-term erosion is a horizontal recession of the beach/dune/bluff profile or the net loss of land over time. However, since the recession profile is dynamic, and responds to a variety of forces, the shape of the profile at a given site can vary substantially over time. As the profile recedes beaches can narrow or widen; the dune can be created or destroyed, and upland elevations can increase or decrease.

The NFIP flood hazard mapping results are sensitive to the topography (profile shape) at the time the calculations are made. Thus, flood hazard zones and BFEs can vary at a given site, depending upon when the flood hazards are mapped. Fortunately, NFIP coastal mapping methods account for some of this variability by ignoring any dune whose cross-sectional width is sufficient to prevent its loss during the base flood. Moreover, the most dynamic changes usually occur at the shoreline itself, seaward of most development. The landward portion of the profile (where most development exists) does not fluctuate as readily as the shoreline.

1.5.3 Buildings and Development

Buildings and development can affect local topography as the number/distribution of buildings change, and the exposure grows. Topographic alterations typical of development can affect the inland extent of flooding, and the magnitude of wave effects and buildings can alter the obstruction coefficients used in the Wave Height Analysis for Flood Insurance Studies (WHAFIS) models. Generally, in wave velocity zones (V zones) or those zones where waves and the surge pressure can increase damage to buildings, the effects of topographical alterations are minimal – compliant buildings are elevated on open foundations and will have minimally disturbed the topography (due to lack of a structural fill), resulting in a minimal effect on flood extents and wave transmission. “A zones”, areas subject to inundation by the 100-year flood source without the additional velocity hazard, cause larger topographic alternations since buildings can be elevated on fill and with solid foundations. However, barring large-scale alterations of coastal upland areas, the effect of future A zone construction on flood hazards should be localized and minimal as well.

1.5.4 Sea Level Rise

The primary effect of rises in the sea level is to increase ambient water levels and to provide a higher platform upon which storm surge and wave effects can propagate (inundation). The wave effects will increase as water depths increase. Currently the effects of sea level rises are handled through postulated adjustment and landward recession of beach profiles in response to higher water levels (e.g., Bruun rule). However, there is no consensus, on the magnitude of the rise in sea level. While some believe the recession is over than 100 times greater than the vertical rise in water level, others (e.g., Galvin[6]) dispute this.

Table 1 provides a listing of the future conditions parameters known to exist within the coastal flood hazard areas. The parameter could either have a primary influence on the subsequent hazard or have a secondary influence. For example, long-term erosion will have a primary influence on wave effects (by reducing dune height or reservoir and reducing distance to the structures), and the topography (by literally removing terrain). Long-term erosion has a secondary effect on land cover, as lost soil reduces the amount of vegetation. Long-term erosion has little or no impact on the stillwater elevation because it changes only the terrain impacted by the hazard, and not the flood hazard itself.

TABLE 1. Future Coastal Flood Conditions Parameters and Their Influence on Hazard Maps

Future Conditions Parameter	**Effect of Future Conditions Parameter on:**			
	Stillwater Elevation	**Wave Effects**	**Topography**	**Land Cover**
Long-Term Erosion	**--**	**P**	**P**	**S**
Flood Protection Structure	**--**	**P**	**P**	**--**
Beach/Dune Nourishment	**--**	**S**	**P**	**S**
Buildings and Development	**--**	**S**	**S**	**P**
Sea Level Rise	**P**	**S**	**S**	**--**

P = primary or principal influence of future conditions parameter on flood hazard mapping results
S = secondary or minor influence
-- = no influence or negligible influence

[6] Galvin, C. 1983. *Sea Level Rise and Shoreline Recession*. in ASCE Proceedings of Coastal Zone '83. pp. 2684-2705

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2. METHODOLOGY

2.1 Overview

The first step in the methodology was to determine which communities would be included in this study. Working with both FEMA and AIR, the project team developed community selection criteria and identified communities that have adopted higher floodplain management regulations. After assessing the communities against the criteria, the final selection was completed.

After the selection of the communities, a methodology was developed to achieve the project's goal (identifying the cost and benefits of implementing watershed management programs to address management of future conditions). It was determined that the project team would perform both a qualitative and quantitative approach. A series of interviews with key local personnel would aid in the qualitative approach; while the project team would utilize HAZUS-type methodologies to complete the quantitative approach.

The interviews provided the project team with detailed background information that helped understand the flood history of the community, the current management methods, and the amount of development that has occurred since the NFIP was implemented within the community (costs). The interviews also tried to identify the ramifications (i.e., political consequences, law suits, takings) from the enforcement of NFIP and increased floodplain management standards. These interviews attempted to capture the perspectives of a broad cross-section of stakeholders in the land-use and risk management process, while remaining sufficiently limited so OMB approval was not required.

HAZUS and HAZUS-type methodologies were utilized to complete the quantitative approach. With this approach the project team would have to collect community-specific GIS-based data. The community-specific GIS-based data included parcel level data from the County Tax Assessor, shape files of the county parcel boundaries, and flood hazard data. During the data collection process, the project team discovered that the flood hazard data varied among the communities; one modified the flood maps to reflect future development, while others enforced floodplain management programs (requiring land owners to retain water) and thus did not revise the flood maps for new development. This process aided in the identification of the benefits from the implementation of managing future conditions.

After the communities have been identified and the necessary data collected or processed, the project team followed the below methodology:

Create a Study Region for Each Community

The primary purpose of the study region is to provide the analysis foundation for the project. The analysis would be done using local inventory data and local flood data thereby bypassing the "Level 1"[7] analysis possible within HAZUS.

Duplicate the Study Region

Two (2) study regions are required to perform the analysis. Because the project team was using point level data, it is necessary to dedicate study regions to the selected inventory. The first is dedicated to the "Existing Condition" inventory although the flood conditions would vary from the existing 100-year flood (study case 1) and the future conditions 100-year flood (study case 2). The second study region would be dedicated to the "Future Condition" inventory (build out) and the future 100-year flood.

Generate Two (2) Building Inventory Tables

The project team processed the assessor data for import into the User Defined Facilities table in HAZUS. Two tables were generated. One (1) table will have the existing building inventory (those where the assessor data file defines an improvement on the parcel) and one with the future building inventory. Again the future inventory includes both the current structures and a HAZUS baseline building at the centroid of all vacant parcels. Each of the database tables had the specific information needed by the flood model to perform the loss estimation analysis.

Create Flood Depth Grid and 100-year Return Intervals

The flood depth grid for the existing and future 100-year flood conditions were developed using the Flood Information Tool (FIT). The FIT uses the cross section information, attributed with the flood elevations, a bounding floodplain polygon, and a digital elevation model to develop an estimated grid with the depth of flooding. This information is in a format that is readily imported into HAZUS for use in the damage assessment.

Select Flood Depth Grid and 100-year Return Intervals

The flood depth grid developed from the FIT was imported into HAZUS and the 100-year return interval selected for the analysis. The first study region (the region with the existing building inventory) would have two (2) study cases, the first with the current flood FIT data and a second using the future conditions FIT data. The second study region (the region with the future building inventory) would have only the future conditions FIT data.

[7] A Level I analysis refers to the analysis that can be performed within HAZUS entirely using the baseline data supplied with the model. This data is based on the US Census and Dunn & Bradstreet data and is performed at the census block level. This level of analysis was not sufficiently detailed enough for this study and therefore local data at the point level was used.

Process Data in HAZUS

On the Analysis menu, the project team selected the User Defined Analysis and the flood model was allowed to process the loss estimates. In the duplicate region, the analysis was repeated. The results from each analysis was extracted from the SQL Server database and brought into Excel to format into charts and tables as seen in the report.

2.2 Community Selection Process

The selection of the communities followed a three (3) step process: 1) identify communities known to have adopted higher floodplain management regulations; 2) ensure that, in totality, the communities represented a cross section of flood communities; and, 3) that each community possessed adequate GIS-based data to perform the quantitative analysis.

In collaboration with FEMA and AIR, the project team created a list of communities located in flood areas known to have implemented floodplain management regulations that include management of the future flood conditions. It was agreed that analyzing these communities would provide valuable information which could be used to meet the project's goals. Communities were selected purposively in a way that allowed geographic diversity to better relate the results to other communities. The project team tried to select communities that may have experienced a range of legal, institutional, and other barriers to the adoption and implementation of higher floodplain standards.

2.3 Interview Process (Qualitative Assessment)

The goal of the interviews was to establish a qualitative understanding of the communities' perspectives on how the implementation of floodplain management, especially those who have adopted higher than normal standards, may have changed development trends and costs within the community. The sampling pool and the loose format of the interviews were designed to ensure that we were not seeking duplicate information from more than 10 people within each given community or from our sampling as a whole. Although the interviews were not formally structured, the project team tried to cover the following topics with each stakeholder regarding the community's floodplain management and flooding history. The main topics include:

- overall history and impact of floods on the community;
- impact of implementing the NFIP on development trends and costs;
- impact of implementing "future condition management" on development trends and costs;
- impact on building standards; and,
- impact on development trends.

The subjects of floodplain management and flooding history were covered to examine if the respondents felt the flood risk was significant and warranted increased regulation. The discussion of community impacts of the NFIP included community perceptions, impacts on land use, environmental impacts, financial impacts, and social impacts. These questions provided the background information for each community regarding the status and direction of their flood program.

Implementation of the NFIP was discussed to discover whether the communities were participants in the Community Rating System (CRS) and what issues they encountered implementing the program. Additionally, the project team developed questions to identify any legal issues the community may have encountered. This provided further information about how some community residents felt about the NFIP implementation.

A stratified purposive sample was used to select individuals to interview within each selected community. The sample frame was stratified by community and job category. Within each community individuals who were contacted to participate in the study included community officials, developers, insurance agents, and lenders. Each person was contacted by telephone with an explanation of the study and request to participate. If the person accepted the request to participate, then in-person or telephone interviews were scheduled.

The interviews were done in a semi-structured, open-ended interview format, but the general topics were discussed in the interview. This allowed the project team to be flexible if a topic of particular interest arose and for the respondent to expand in areas that they were particularly knowledgeable. Each interview was approximately one (1) hour in length.

2.4 Computational Process (Quantitative Assessment)

The computational analysis focused on the losses avoided for the 100-year flood. While working with annualized losses would provide a more accurate assessment of the losses avoided, existing data is limited. Three (3) return intervals are required in order to properly extrapolate and estimate annualized losses. The project team opted to perform the comparative analysis for the 100-year flood. To perform the analysis, the project team used the HAZUS-MH[8] Flood Model (hereafter referred to as HAZUS) developed by the National Institute for Building Sciences (NIBS) for FEMA. The flood model provided a consistent scientific analysis tool for comparisons.

The computational analysis for this project was performed three (3) times for each community using a variation of the inputs so the increased impact caused by development within the watershed could be seen more clearly. The analyses can be identified as: 1) Current Inventory with Current Flood Conditions; 2) Current Inventory with Future Flood Conditions; and, 3) Anticipated Inventory with Future Flood Conditions.

The first analysis looked at the potential existing conditions losses. This analysis examined the current 100-year flood impacts against current building inventory. The second analysis examined the 100-year flood impacts for existing buildings, but analyzed it against the anticipated 100-year flood which assumes build-out with no additional floodplain management (such as on-site storage). As the development progresses, on-site storage is assumed to prevent a

[8] Hazards United States or HAZUS® is a trademark of the Federal Emergency Management Agency.

change in the 100-year flood conditions. The third and final analysis considered the anticipated built-out conditions (current inventory plus zoned future development) against the build-out 100-year flood conditions.

Using HAZUS, the depth of flooding from the depth grid cell can be determined at each building's location (latitude and longitude). This depth of flooding is used to define the depth of the water at the structure. The foundation type is then used to define the height of the first floor in the structure. The subtraction of the two defines the depth of the water within the structure. This is input into the default depth/damage functions to determine the percentage of replacement cost of the structure that has been inundated and damaged.

For single family residential structures, the default damage functions were derived from the Federal Insurance Administration's credibility weighted loss functions modified to account for policy exclusions (See the HAZUS Technical Manual for detailed discussions of all of the depth damage functions within HAZUS). For the other occupancies, a variety of U.S. Army Corp of Engineer depth-damage functions have been selected as the default functions because of their general applicability throughout the United States. Default functions were used since the functions have been reviewed and approved by the HAZUS Flood Model Oversight Committee for their applicability throughout the nation. Using consistent damage functions in all of the analyses allows for more direct comparison of the changing flood conditions by removing the variable of damage function selections.

The results of the HAZUS analysis are essentially an estimation of loss associated with the inundation based on the percentage of the replacement cost that has been damaged (classified as benefits for this study). Likewise, functions within HAZUS allow for the estimation of loss to the structure contents and (for selected occupancies) inventory that is sold from the location. Results are in terms of dollars and can be aggregated to represent the total losses for the flood being examined. For this report, contents and inventory are being aggregated together to provide a representation of the total non-building related damage.

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3. COMMUNITY SELECTION PROCESS SUMMARY

There were five (5) initial communities identified to be part of this study; they included: Mecklenburg County, North Carolina; Escambia County (specifically Pensacola), Florida; Harris County (specifically Houston), Texas; Larimer County (specifically Fort Collins), Colorado; and Grand Forks County (specifically Grand Forks), North Dakota.

Working with FEMA and AIR, the project team, developed a list of criteria for the community selection. As stated previously, the purpose of the criteria is to ensure that the selected communities represent a good cross section of characteristics found within flood communities. Below is a list of the initial selection criteria:

- A community that has mapped existing future condition hydrology for the riverine or coastal flood hazard;
- A community that has not mapped future conditions hydrology (at least one);
- A community where either coastal or riverine flooding could be defined as the predominant flood threat;
- A community located in large watersheds;
- A community located in small watersheds;
- A community that has attempted to manage flooding and runoff on-site; and
- A community experiencing both low and high development rates[9]

Utilizing the list of communities, the project team assessed whether or not all of the criteria was met. The communities and the project team's identification of relevant characteristics are summarized in **Table 2**.

TABLE 2. Case Study Communities and Selection Criteria Characteristics

Communities	Characteristics
Mecklenburg County, North Carolina	• Riverine flooding conditions predominate • Future conditions hydrology has already been mapped • Floodplain management policies already considered future conditions hydrology • High growth rate
DuPage County, Illinois	• Riverine flooding conditions predominate • Future conditions hydrology has already been mapped • Future conditions is considered in floodplain management policies • Low to medium growth rate
Houston, Texas	• Riverine flooding conditions predominate • Future conditions hydrology have not been mapped • Floodplain management policies already considered future conditions hydrology • Medium-High growth rate
Fort Collins, Colorado	• Riverine flooding conditions predominate • Future conditions hydrology has already been mapped • Floodplain management policies already considered future conditions hydrology • High growth rate

After the project team completed site visit and/or conducted the interviews some communities were eliminated from the list. Escambia County (Pensacola), Florida was eliminated because

[9] Community growth rates established through a comparison of total population in the 2000 Census vs the total population in the 1990 Census. Verification was made onsite through discussions with community leaders.

other research has shown that development within coastal areas will not have a direct impact on the flood conditions in terms of the area of inundation. As discussed later in this report, development will have some impact on the flood conditions outside of the scope of this project. Likewise, Grand Forks, North Dakota was removed as their future conditions planning assumed protection from their soon to be completed levee. The project review committee agreed that assuming levee failure was outside the scope of this project. In an effort to maintain a satisfactory number of communities in the study the County of DuPage, Illinois was added to the list. With the addition of DuPage County, the total number of communities in the study was four (4).

4. INTERVIEW PROCESS RESULTS (QUALITATIVE ASSESSMENT)

4.1 Overview

As previously stated, the communities selected for this study are all known to have incorporated higher floodplain management practices than what is required under the NFIP. Because of this the interview questions were designed to elicit responses which would illustrate the challenges (costs) of the increased regulations. The objective was to determine if the implementation of watershed management programs created additional issues or compliance problems within the community.

For this study, the project team interviewed community officials, developers, floodplain managers, insurance agents, mortgage lenders, federal officials, and state officials. **Table 3** shows the number of people interviewed within each county by occupation. Again, the interviews were intended to familiarize the project team with the community and their perspective on the relative success and cost associated with the floodplain management strategy chosen. These interviews are primarily to support the technical analysis of this project. Another research team is performing more detailed interviews to support this requirement.

TABLE 3: Number of Interviews Performed By Occupation

County/City	Community Official	Developer	Floodplain Manager	Insurance Agent	Mortgage Lender	State Official	Total
Mecklenburg	2	3	1	2	1	1	10
Larimer	3	0	1	2	0	1	7
Harris	1	2	1	1	0	1	6
Escambia	1	0	2	2	0	1	6
Grand Forks	2	0	2	2	1	1	8
DuPage	1	2	1	1	0	1	6
Total	**10**	**7**	**8**	**10**	**2**	**6**	**43**

NOTE: Because federal officials are not considered part on any one county, the numbers are not reflective in this table. For a summary of the results refer to section 4.8. Interviews with Escambia and Grand Forks County were conducted prior to the determination to drop them from the study. Interviews for DuPage County were conducted after inclusion into the study.

The majority of the interviews were conducted in person but a few interviews (i.e., federal officials, state officials) were conducted via telephone. Prior to performing the interviews, each interviewee was provided with a background of the project describing the effort to determine the costs and benefits resulting from management of future conditions. Appendix 2 provides the base interview guide used in this study. The interviews were semi-structured and were unique to the conditions of each community.

After all the interviews were completed, qualitative analysis methods searched for patterns and themes in the interview data. The data was analyzed using a coding scheme based on specific topics of interest and the interview guide topic. Data within each code category, data was analyzed for common threads or themes. Then, consensus-coding methods were used to increase the validity of the findings. Consensus-coding is an approach where multiple reviewers will meet and reach a consensus regarding the meaning of the interview subject’s responses as they are tabulated for use in the analysis.

4.2 Community Officials

The community officials interviewed were selected based on their roles in land use management. The officials, who are locally elected or appointed, include city managers, city council members, county administrators, and mayors. Each plays a role that can make or change flooding regulations and practices. Their decisions affect the local floodplain and watershed management. In the interviews with the community officials, the questions were focused on community impacts and history of flooding.

In response to our areas of focus, the interviewed officials were aware of the flood history of their communities and even those areas where flooding occurred most often. Generally, the agreement was that the future conditions regulations were implemented without a heavy political fight, but community officials still receive occasional threats of lawsuits and the development community will occasionally try to make the regulation of the building industry an issue during elections. When asked about specific lawsuits, only two communities could recall lawsuits. In one city the suit was settled when the city bought the land; and the other city lost the suite and the home was built. Ironically, in the city that settled, a later suit was filed that claimed that the city did not do enough to protect the residents. The outcome of that suit was not discussed as the interviewee went on to other topics. It can be inferred that most of the cities had relatively little legal trouble related to their floodplain regulations.

When asked about their perception of the impact the regulations had on development, the officials commented that restrictions in the floodplain reduced the value of existing structures in the controlled area, but new home values continued to increase. Nearly all stated that floodplain management was not a major factor in the increasing development costs. The officials cited other land use and environmental regulations, site location, local traffic, and overall mobility as factors that have a greater influence on the value of a home. All officials felt that development was strong in their communities and that using the floodplain wisely (such as greenways and recreation) have added aesthetic value to their city even if some residents felt that property values may have decreased.

4.3 Developers

The developers that were interviewed are land developers and contractors in the local areas specializing in both residential and commercial development. The land development companies ranged from small -home offices to large corporations. Each developer has experience in building inside and outside the SFHA and has developed to a range of regulatory requirements. Their interviews focused on community regulations and the effects on the permit process, the cost of doing business, and the sale of their products.

Developers who have worked in the community for long periods of time were aware of the flood history and areas prone to flooding. When asked their general opinion of the NFIP, developers tended to look at the regulatory aspects, which they view negatively, mainly because it affects what and how they can or cannot build. They indicated that it has affected how they develop the land and has had added some increased costs to development in the floodplain. However, several were quick to point out (similar to the community officials) that other land use and environmental regulations had a greater impact on development and costs more than the floodplain regulations.

Interestingly, half of the developers interviewed believed that the NFIP enhanced the value of the land adjacent to greenways and this allowed them to sell homes near the open space at a higher price. This same group of developers also believed it has helped to preserve natural habitats. The other half of the developers thought the NFIP had little or no impact on their cost and the sale value of the structures, nor they did not know of any environmental improvement or impact.

Legally, the developers did not have any direct issues with the NFIP and the associated regulations except to state that there is a perception of "takings". A "taking" occurs when a government agency has significantly reduced the economic value of land or significantly restricts the entitled use on the land. In most states, if a taking has occurred, the government entity is required to reimburse the land owner the fair market value of the land. One developer related an example, stating that "farmers are paying property tax based on assessed value of their property, but if a portion of their land within the floodplain then the regulations has effectively reduced the market value of the land because it has reduced development opportunities. This can be perceived as a taking from the farmer's perspective."

Aside from restrictions on development within the floodway and the floodplain, the developers did not identify specific changes in development trends that could be attributed to the future conditions floodplain management. Generally they agreed that development trends are driven by the market and other intangibles such as views, location, etc. This also reflected comments made by the community officials.

4.4 Floodplain Managers

The floodplain manager of each community was the project team's main point of contact. The floodplain manager is the person in charge of enforcing the flood regulations. Each has been with his or her community for at least seven (7) years, and they are all certified floodplain managers, indicating their expertise in the field. In their interviews, they all provided detailed information on the community impacts and history, program implementation, and building standards.

The floodplain manager's general opinion of the NFIP, based on the programs they have implemented, is positive, but they expressed concern about repetitive loss structures. The floodplain managers are the only stakeholders who knew how much of the land in their community was built after entering the NFIP. It ranged from 15-70%. Discussions of their land use practice revealed that there is no development in the floodway, except in Harris County, Texas, where floodway development has to meet Base Flood Elevation (BFE) plus eighteen (18) inches and cannot increase the flood elevations above 1-foot.

Floodplain managers believe that the NFIP has increased the natural value of floodplains due to the programs that are being administered citing that it has increased the use of floodplains for natural recreation in their communities. They all expressed the opinion that they have seen an increase in the cost of homes in or near the SFHA, but the availability has not been affected and they did not attribute increasing housing costs solely to their programs. They see the Community Rating System (CRS) program as a beneficial program because it helps them exceed the minimum NFIP standards and has given floodplain managers a tool to implement regulations. However, they expressed frustration with the required paperwork, the program benefiting individuals rather than the community, and their perception that it promotes development by reducing premiums.

None of the floodplain managers interviewed could remember any major political or legal issues related to the floodplain management regulations in their community beyond the "posturing" of developers and landowners about the reducing the value of their land and takings. However, a few of the floodplain managers have used the legal system to force compliance with their regulations.

4.5 Insurance Agents

The 11 insurance agents interviewed were all local agents identified using the Internet yellow pages. Insurance agents have the most interaction with property owners and are one of the major sources of flood insurance information for them. The number of flood policies written per year varied among agencies – some wrote two (2) policies per year, while others wrote dozens of policies per year. Not all of the agents were equally knowledgeable about flood issues, but they all answered the questions to the best of their knowledge.

Many of the insurance agents had a detailed knowledge of their communities' flood history and areas with the tendency to flood. None of the insurance agents felt they could provide input into whether the NFIP and the future conditions management had any impact on building costs or changes in development standards and trends. They commented that they did not see any changes in development after their community had entered the NFIP. However, there was an observation by some agents that regulations have increased the setback zones in their communities.

4.6 Lenders

Lenders are a part of the banking industry. They are the ones who inform property owners that flood insurance is required during the loan processing. The lenders interviewed were all identified using the Internet yellow pages. The majority of lenders declined to be interviewed. For this reason, there are no results to report here.

4.7 State Officials

The state officials that were interviewed are all State NFIP Coordinators. Their job is to perform a variety of activities that support implementation of the NFIP in their states; and in many states, they are the principle point of contact between FEMA and participating communities. They are the liaisons between the local floodplain managers and FEMA. A number of the NFIP Coordinators are also certified floodplain managers. Their interviews were conducted by phone.

Most of the NFIP Coordinators knew about the flood history of the communities in our study. They felt that the NFIP has been widely accepted in their state and these communities in particular. Some mentioned that they feel that the regulations are forced upon the communities and the rural communities do not like it. However, the residents see the need for the flood insurance. The state officials had a wide range of answers regarding the question on land use practices and most maintained support of local decision making authority.

The majority of the state officials said that there was no impact on the cost and availability of housing in or near the SFHA. In terms of the CRS, the NFIP Coordinators felt the communities have reacted positively to the program. They cited positive outcomes that included the reduction in insurance premiums, reduction in flood losses (in the communities of this study), and a public perception that something is being done about floods.

4.8 Summary

In summary, the interviews demonstrated that most of the stakeholders had a fairly good understanding of the history of flooding in their community and the areas in their community with the greatest risk. In the communities addressed in our study, the cost of development in the community may have increased, but this increase is negligible when compared to cost increases caused by market forces and other regulations. There is agreement that the floodplain can become an amenity and has value, but there is disagreement as to whether this value plays any role in development trends, increased cost, or housing supply.

There have been some legal challenges to the regulations but not as much as conventional wisdom might have indicated. Litigation has included developers suing to develop property and people suing stating that the community has not done enough to protect the residents. Almost all of the lawsuits have occurred in one community and the others report little or no activity.

Politically, it appears that the regulations may be used as a political issue from time to time. It does appear that members of the community will complain more than they will actually try to create a political movement out of the issue.

The sampling is obviously not statistically relevant, but these are communities that have been leaders in implementing floodplain regulations dealing with future flood conditions. These communities have effectively tested the waters and did so successfully.

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5. COMPUTATIONAL PROCESS RESULTS (QUANTITATIVE ASSESSMENT)

5.1 Overview

The primary objective of the computational process was to aid in the identification of benefits for the study. Whenever possible, the computational analysis was completed using the HAZUS. As stated previously, the project team collected data from the selected communities including up-to-date parcel level tax assessor's data. This data allowed the project team to view the current land use designations of the parcels, and the current value of the improvements (if any). The collected data allowed the project team to assign the HAZUS occupancy classifications to the parcel based on the occupancy identified by the assessor. The value of the contents was determined using a direct relationship between the occupancy class and building value and a content value multiplier (e.g., for residential structures, content value is approximately 50% of structure value) used in the HAZUS model.

Using the user defined facilities capabilities within HAZUS and the default damage functions; it is possible to perform an analysis that will define the losses that are created by the changing flood conditions. This is determined by comparing the current inventory losses from the current 100-year flood and the future 100-year flood. It is also possible to compare the impact of the changing inventory. This is determined by comparing the existing inventory losses with the future 100-year flood and the future inventory losses caused by the future 100-year flood.

Because anticipated build-out inventory and build-out 100-year flood hazard data typically do not exist, some data sets needed to be created. Using the current inventory and 100-year flood conditions as a basis, the data was process to create the needed data sets. Below is the methodology followed to create the required data sets:

Current Inventory Data

This includes the tax assessor data and GIS-based parcel data within the study area. Using the unique parcel number included in the GIS-based parcel data and the tax assessor data the data sets can be combined. This combination allows analysis of key information to be processed at specific geographic locations.

In most cases, the exact location of the building within the parcel was unknown. Accordingly, the project team needed to assume a location for the building; therefore the building or structure was assumed to be located at the centroid of the parcel for each analysis. Since the building was not moved when performing the comparative analysis, this is not likely to affect the results; however, it does introduce some uncertainty, as flood depths and associated damage will vary especially across the larger parcels.

The tax assessor data is typically a very accurate representation of the built environment with respect to all revenue generating properties; however, in some instances (i.e., tax-exempted buildings) some of the data is incomplete. The project team processed the tax assessor data with supplemental information to provide the necessary missing information. The supplemental information was typically first floor height, foundation type, and other detailed parameters with which the assessor typically is not concerned. When this data was incomplete and required supplementing, the project team used the HAZUS national distributions, as discussed below. As this data is constant throughout the analysis, it is assumed to have little effect on the variations in results.

- Foundation type was generated by semi-randomly assigning a foundation type to the parcel based on the occupancy classification and the distribution used in HAZUS (Table 1 in Appendix 3). The assignment is considered semi-random since some effort was taken to maintain the HAZUS distributions over the entire study area. All non-residential development was assumed to be slab on grade.

- First floor heights were determined from the foundation types assigned in the previous step. Table 2 in Appendix 3 shows the assumed first floor heights used in the analysis. Since the project team did not know if the parcel was within the SFHA or not, every structure was assumed to be built before the FIRM was issued, or pre-FIRM, for the purpose of assigning the damage function and the first floor height. This approach is taken because the analysis is not measuring site specific results, but is comparing the change in damage resulting from changes in the height of the flood inundation between the existing 100-year flood surface and the future 100-year flood surface.

Based on input from the tax assessors, the project team attempted to adjust the assessor's valuation to represent engineering replacement value of the structures. In other words, the project team adjusted the value to more closely reflect the estimated cost of building the exact same building today. If this was not possible, the project team used the HAZUS baseline values per square foot by occupancy to develop a representative replacement value. The HAZUS valuation parameters are shown in Table 3 in Appendix 3.

Anticipated Inventory Data

Within the assessor's data, vacant property is usually clearly defined by a parcel use code, and in some cases, the zoning is identified. Future development is assumed to occur with the current approved occupancy. The total floor area and valuation of the projected development is assumed to match that of the typical HAZUS values, which vary by occupancy or use, developed from *RSMeans* "*Square Foot Costs*" (2002), an industry standard engineering cost estimation methodology document. The HAZUS valuation model is summarized in Table 3 in Appendix 3.

The GIS data would occasionally display artifacts of the digitizing process; rights of way and other small areas of vacant land were ignored, as no development was likely to occur on these small slivers of land.

Current Flood Conditions (100-year Flood Area)

This data was often provided in the format of GIS data layers with attribute information. Most common was flood areas/zones (polylines) with flood elevations and discharges. The project team processed the data using the FIT or the FIT-like methodologies to develop depth grids that provided sufficient data for the analysis.

Future Flood Conditions (100-year Flood Area)

This data was often provided in the format of GIS data layers with attribute information. Most common was flood areas/zones (polylines) with flood elevations and discharges. The project team processed the data using the FIT or the FIT-like methodologies to develop depth grids that provided sufficient data for the analysis.

The damage analysis is performed for buildings and contents. For this project, the contents results shown in the figures also includes business inventory (those items for sale by a business entity). The analysis of buildings is based on the depth damage curves by occupancy available within HAZUS. These depth damage curves are presented in the HAZUS Flood Model Technical Manual (2006). Damage to both buildings and contents are provided to give a more accurate representation of the potential savings resulting from the floodplain management strategy the community has chosen.

When selecting the river reaches, the availability of data drove the number of reaches and the area within the community analyzed. Although this makes it difficult to generalize the results to other watersheds in the nation, the project team believes that the analysis process itself is valid and demonstrates the cost and benefits of future conditions management in a measurable way.

The subsequent subsections will provide more detail about the analysis effort within each community. Specific information about the data provided by each community, the communities approach to managing future conditions, and the net results of the analyses are provided. For each community, the project team worked with the local community to identify a river reach or several reaches where there was still opportunity for future development. The community confirmed that these parcels were vacant and entitled for development.

5.2 Mecklenburg County, North Carolina

The project team supplemented this study for Mecklenburg County with a study which was performed using a tabular approach similar to the methodology that was eventually incorporated into HAZUS. This Mecklenburg County study was completed before the completion of HAZUS. Likewise, while the Flood Information Tool (FIT), designed to facilitate import of user-defined flood hazard data into HAZUS, was still in development, a FIT-like methodology was used to develop the flood depth grids for analysis for Mecklenburg County. The project team re-analyzed the Mecklenburg County study data within HAZUS to show that there was no measurable difference using the HAZUS software.

Mecklenburg County is unique among the communities selected for this project in several ways. The county has taken significant steps to understand their watershed, since most the watersheds originate within the county and drain out of the county. The county believes that through aggressive mitigation efforts, such as buy-out programs, such as those they have performed in McAlpine Creek, the overall risk and exposure to flooding will continue to decrease over time rather than increase.

Mecklenburg County has taken the approach of estimating the total discharge for each watershed assuming build-out based on the currently approved land use. With the assistance of high resolution (Light Detection and Ranging; or Laser Imaging Detection and Ranging (LIDAR) based centimeter scale) Digital Elevation Model (DEM) data, the county resurveyed each of the watersheds and performed new hydrology and hydraulic (H&H) modeling. The county also used historic data to generate electronic models of their flood studies that were conducted in 1975. To simulate build-out conditions that were anticipated to occur around 2023, the county modified the percentage of the soil that is considered impervious to rainfall, which subsequently modified the discharges. The result of their efforts are new Flood Insurance Rate Maps (FIRM) that have the effective flood elevations of the 100-year flood that is likely to occur when the area becomes developed to its current approved zoning.

The county continues to allow development to occur without on-site storage of runoff, but does require development to provide buffer area to slow and filter the “flush” of water into the river channel. The flood data provided by Mecklenburg County accounted for these buffer requirements and any potential reduction in flood timing. Their development standards allow for a general assumption of the total impervious area created when a parcel is developed. The floodplain standards require new development to be constructed to the new elevations and therefore maintain the number of structures that can be damaged by floods at the current level.

Mecklenburg County has modified their building ordinances using the increased discharges to establish development standards that specify first floor elevations with a freeboard and a drainage buffer to slow the discharge into the receiving waters.

5.2.1 Flood Data

Mecklenburg County provided the flood data used for the development of their FIRM maps that were certified around 1975. Their flood data included digital representations of their 100-year flood boundary and the stream cross sections attributed with the flood elevation and discharges for several return periods. Likewise, for the “future conditions” flooding, Mecklenburg County provided another dataset of cross sections attributed with the increased discharges and flood elevations generated by their hydrologic and hydraulic (H&H) modeling. This dataset was generated from a series of recent investigations performed by the county. The studies included using high resolution digital elevation models, comprehensive building and flood surveys, and GIS analyses. Mecklenburg was one of just two counties that were able to provide the digital elevation model (DEM) that was used in the development of a portion of their flood studies (the other was DuPage County). The DEM provided by Mecklenburg County was initially such high resolution that the project team needed to reduce the resolution to improve processing time and ease data storage requirements. That is, we reduced the resolution from a grid with cells representing a few inches on a side to a grid representing 20-feet per side.

Figure 1 and **Figure 2** on the next page shows a side-by-side comparison of the resulting flood depth grids produced for the analysis. The differences in the flood conditions are difficult to visualize for a couple of reasons. The first is that improvements in the digital elevation model resolution may offset increases in the modeled flooding. The older flood analysis was performed around 1975 using more coarse data causing the flood surface to be too high in spots and too low in others. Second, the natural terrain of Mecklenburg County may also play a role in that most of the streams have relatively steep channels that constrain the increased discharge. Ultimately the reader can ascertain that the highest flood depth increased from 23 to 25 feet.

FIGURE 1. Existing Conditions Flood Depth Grid for Mecklenburg County

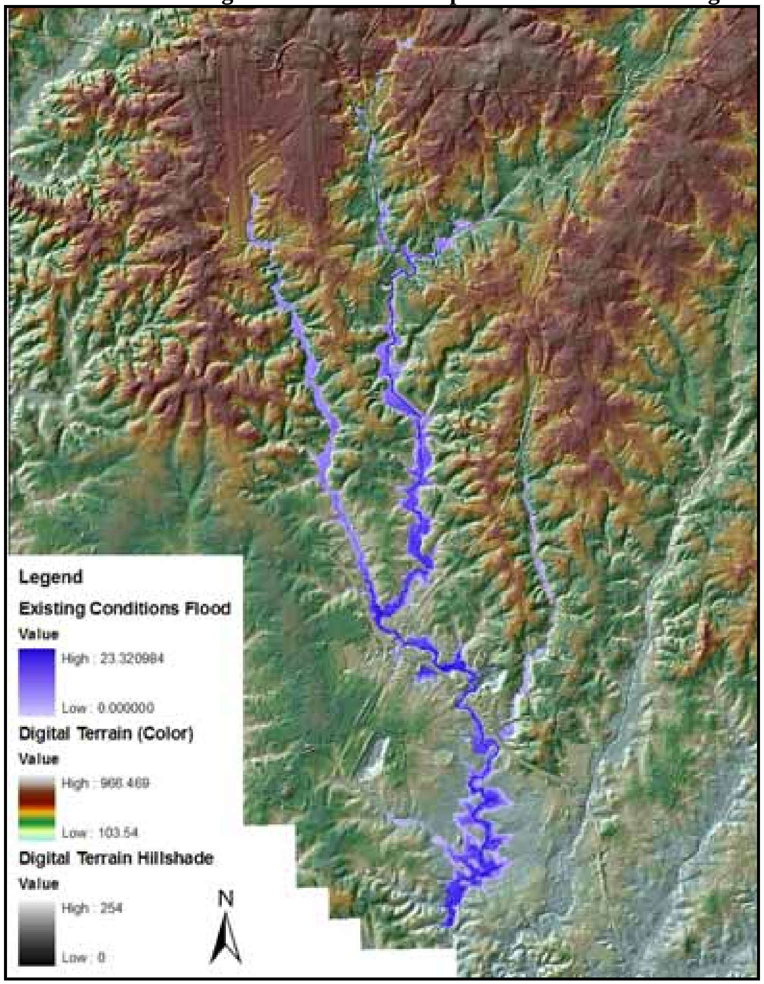
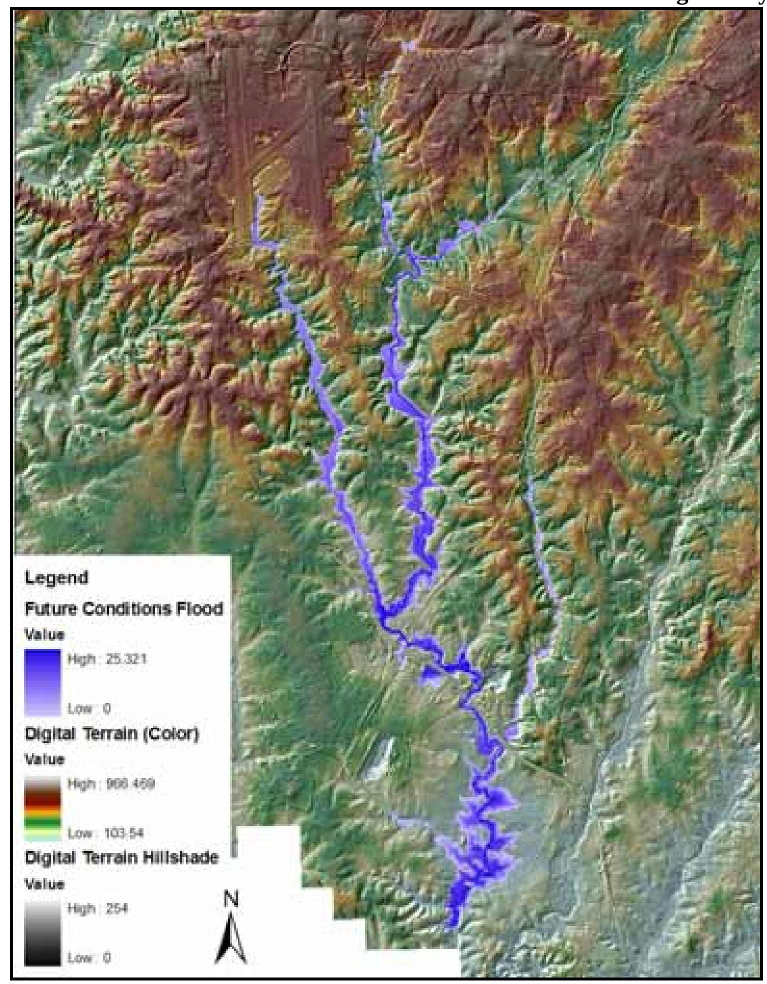
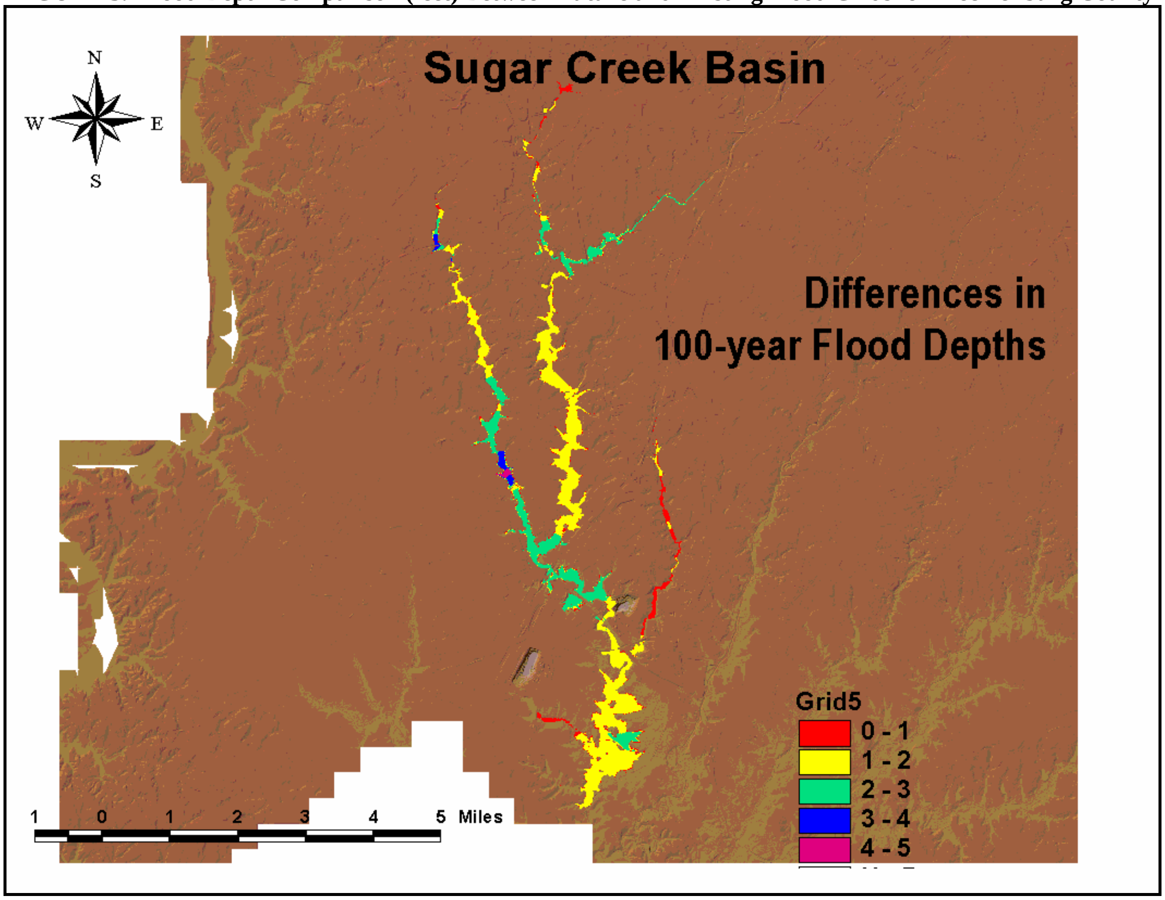


FIGURE 2. Future "Build-out" Flood Conditions for Mecklenburg County



A better way to view the difference between the two flood depth grids is to perform a direct subtraction of the two datasets. Figure 3 shows the net difference and shows areas where the flooding will remain constant and areas where the flood levels can be expected to increase substantially. According to **Figure 3**, structures along Sugar Creek would experience a 1-3 foot increase in flood depths with pockets of higher flood depths up to a maximum of 5 feet. This could create substantial increases in damage within existing structures, a hypothesis that is tested in the following HAZUS model runs.

FIGURE 3. Flood Depth Comparison (feet) Between Future and Existing Flood Grids for Mecklenburg County

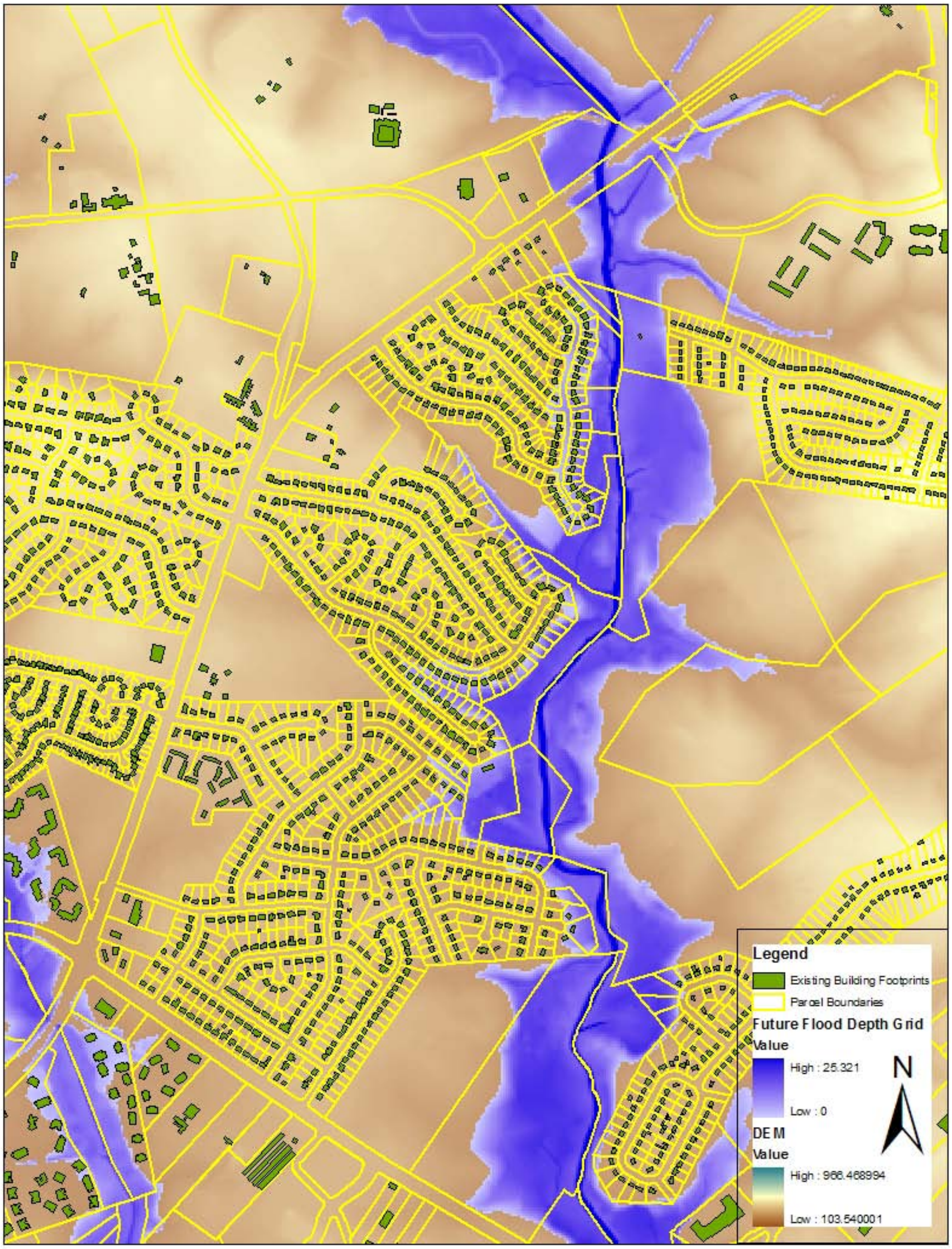


5.2.2 Inventory Data

Mecklenburg County also provided detailed county assessor's data. The data contained critical fields such as the total floor area of the structures, the occupancy class (in sufficient detail for easy mapping to the HAZUS occupancy classes), year built, assessed value, vacant parcel zoning, number of stories and the foundation type. In fact, Mecklenburg County was the only county to provide an assessor file that included this level of detailed data. Because the foundation type was provided, the project team chose to build a foundation distribution based on local data for application to the projected development of currently vacant parcels rather than using the HAZUS baseline foundation distribution, which is based on national level data. Mecklenburg County provided other data that proved useful to the analysis for their county. For many of the structures in the floodplain, Mecklenburg County was able to provide the master-elevation-certificate data in a digital format that could be merged with the assessor's dataset, providing very good information for the analysis.

Because Mecklenburg County also provided a GIS layer that included all of the building footprints in the county, the project team believed it would be more accurate to use the centroid of the building footprint rather than the centroid of the parcel when performing the loss estimation analysis for the existing buildings. However to determine the losses for the undeveloped parcels, the project team needed to revert to using the centroid of the parcel as the assumed location of the building. **Figure 4** below provides a view of some of the data provided by Mecklenburg County and the future condition 100-year flood inundation area. The figure shows the parcels with existing structures and several parcels where no development has occurred. It clearly indicates which structures are likely to get inundated (those footprints within the water). The figure also shows the extension of the parcels to the centerline of the river, as defined by the county in its plat maps.

FIGURE 4. Sample of Mecklenburg County Data Used in This Analysis



Some problems did arise with the data, including typical concerns related to multi-family apartments and condominium projects for such a research effort. Determining the total value for large multi-building projects in a parcel can be problematic. The value of multi-family dwellings was determined by dividing the total floor area and value in the assessor's data for the parcel and dividing it by the building footprints as seen on the parcel. Condominium units have individual parcel numbers but appear as single building footprints on the GIS data. However, since the assessor's database included latitude and longitude information, and the project team was able to merge and attach the condominium units to a given building footprint. Without the latitude and longitude, this would have been a much more complicated process.

For this analysis, the project team chose to perform the loss estimation modeling analysis at Sugar Creek. This stream was chosen because it is one of the longer rivers in Mecklenburg County and because nearly 37% of the parcels within the watershed are currently vacant, allowing for a significant increase in the total amount of impervious soils within the watershed when developed. For the loss estimation analysis, the project team added a 50-foot buffer to the 100-year future condition flood boundary and intersected this with the parcel boundaries to ensure that all parcels that might get flooded were selected (this was a conservative approach to ensure the entire exposure was captured). There are more than 1,115 parcels that intersect the floodplain boundary (including the 100-foot buffer) surrounding Sugar Creek. Some duplicate parcels were identified and reviewed. In all cases, these turned out to be parcel slivers in the GIS data, most likely right-of-ways that have been either returned to the parcel, or offers of dedication that were never acted upon. In all cases, for the purpose of this analysis, the slivers were merged back into the main parcel.

There are more than 1,115 parcels that intersect the floodplain boundary (including a 100-foot buffer) surrounding Sugar Creek. Of those 1,115 parcels, 416 (37%) were identified as "vacant", although 39 parcels had existing structures as seen in the building footprint file. Typically, these were large structures that physically covered more than one parcel. An additional six parcels had information in the "effective area" field in the county assessor's data, indicating that a structure should have been found on the parcel.

1,234 building footprints intersect the floodplain boundary. Of these, 216 could be assigned a first floor elevation and lowest adjacent grade from the survey data available. For the analysis, the six parcels without a building footprint that were identified as non-vacant based on the square footage in the assessors data were analyzed as single structures at the centroid of the parcel, for a total of 1,240 "buildings" in the floodplain (including the 100-foot buffer). Those structures without first floor elevation data were assigned a first floor elevation based on the HAZUS first floor elevations shown in Table 2 in Appendix 3.

The project team used the default depth-damage functions within HAZUS for the damage analysis. These functions can be found in the HAZUS-MH MR2 Technical Manual (NIBS, 2006) and within the model itself. These functions were used for every community analyzed for this project. For Mecklenburg County, the project team examined the existing buildings within the 1975 flood study depth grid, and the built-out condition within the future flood grid.

The results for buildings can be seen in **Table 4** below. The results are shown for each of the specific HAZUS occupancy classes found within the watershed, such as COM1 (retail sales sites). Definitions of the occupancy classes are available in Table 3 in Appendix 3. The table shows the damages associated with the current inventory and the 1975 100-year flood study inundation area (representing the current flood). The table then shows what would happen to the existing inventory with the future conditions 100-year flood. This is shown because it clearly demonstrates the increased damage within the current inventory caused by the changing flood conditions. Finally, the table shows the "built-out" or the future inventory with the associated future conditions 100-year flood.

The table shows that the overall damage can be expected to increase to nearly $33 million from $3 million should the 100-year flood occur in the future, built-out condition. Because of the increasing flood depths, and the relative constraining of the flooded area due to the steep terrain, the average dollar value damage within the affected structures is anticipated to increase from approximately $35,000 to nearly $130,000 after the area is built-out. The table also shows that the damage within the existing structures will double from $3 million to $6 million with the changing flood conditions and the average loss per structure will increase by nearly $13,000. This is an important finding in that it shows that the damage to existing structures represents an increase of 93% caused by the changing flood conditions.

TABLE 4. Mecklenburg County Structure Dollar Damage by HAZUS Occupancy Type by Floodplain Analysis

HAZUS Occupancy Code*	Current Inventory – Current Flood Conditions		Current Inventory – Future Flood Conditions		Future Inventory – Future Flood Conditions	
	Total ($)	**Average.($)**	**Total ($)**	**Average.($)**	**Total ($)**	**Average.($)**
COM1/COM4	17,869	17,869	17,869	17,869	2,383,879	170,277
COM2	78,085	19,521	299,022	59,804	1,108,184	184,697
COM3	10,031	3,344	16,488	4,122	16,488	4,122
COM4	1,317,996	146,444	2,272,909	227,291	6,187,158	412,477
COM7	0	0	9,193	9,193	9,193	9,193
COM8	0	0	0	0	162,225	162,225
GOV1	1,492	1,492	2,375	2,375	2,375	2,375
IND2/IND6	4,491	2,246	8,247	4,124	16,169,840	414,611
RES1A	708,186	16,862	1,295,099	18,770	3,967,198	31,238
RES1B	309,012	22,072	400,183	26,679	400,183	26,679
RES1D	48,455	12,114	69,048	17,262	69,048	17,262
RES1E	342,341	57,057	353,753	70,751	600,265	60,027
RES3	244,414	61,103	1,266,129	105,511	1,644,016	109,601
RES4	85,273	85,273	107,526	107,526	107,526	107,526
Total	**3,167,644**	**34,809**	**6,117,840**	**47,060**	**32,827,578**	**129,753**

* See Table 3-3 of Appendix 3 for definitions of HAZUS Occupancy Types

Table 5 presents the contents and inventory damage for the structures that are damaged in the same modeled flood. The pattern seen in Table 4 (above) is repeated here, where the contents damages are estimated to increase to nearly $35 million from the almost $3.5 million in the current conditions. The average building damage increases from $38,000 to $137,000. This is due to large increases in damage to commercial uses such as professional services/offices (COM4) and heavy and light industrial development (IND1 and IND2). These increases are driven in part by the changes in the inundation area (more buildings getting wet as seen in the COM7 numbers) and new structures being built in areas that get wet (as seen in the increases of IND2/IND4). Like Table 4, Table 5 also shows the increase in damage to the existing (current) building contents caused by the increased inundation of the future conditions flood. That is, the damage to the current inventory increases from nearly $3.5 million to $7 million as the flood conditions change.

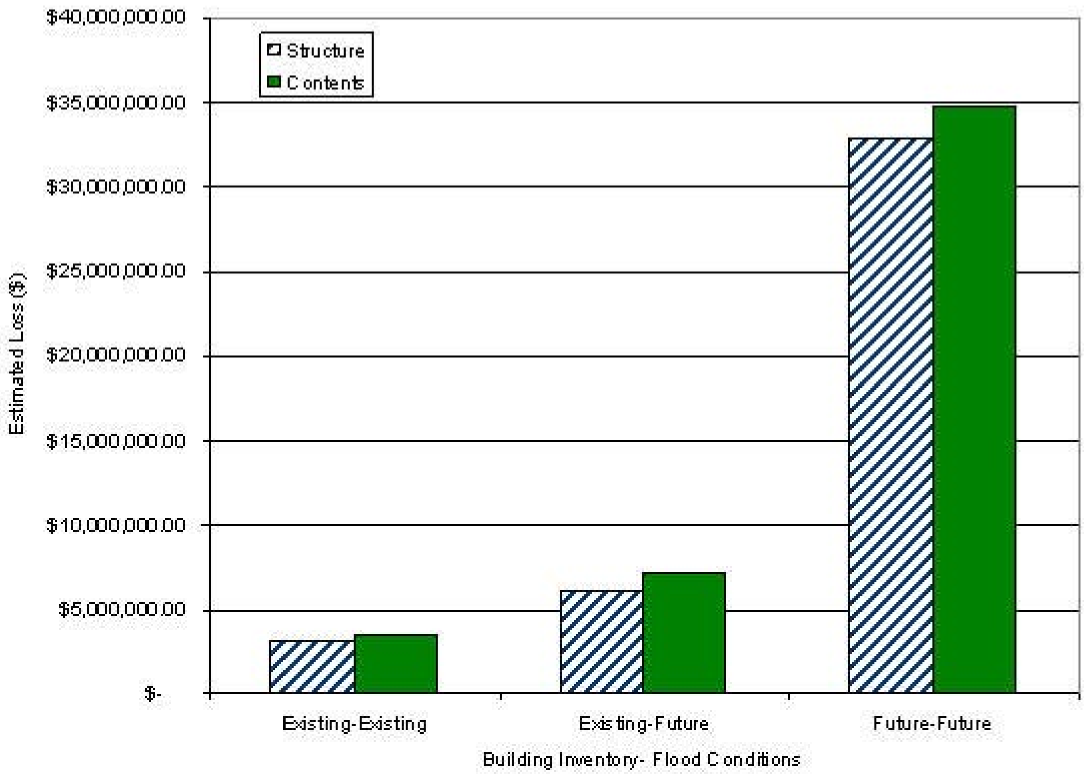
TABLE 5. Mecklenburg County Contents Dollar Damage by HAZUS Occupancy Type by Floodplain Analysis

HAZUS Occupancy Code*	Current Inventory – Current Flood Conditions		Current Inventory – Future Flood Conditions		Future Inventory – Future Flood Conditions	
	Total ($)	Average ($)	Total ($)	Average ($)	Total ($)	Average ($)
COM1/COM4	35,970	35,970	35,970	35,970	4,798,750	342,768
COM2	270,954	67,739	1,037,608	207,522	3,845,399	640,900
COM3	21,613	7,204	33,626	8,406	33,626	8,406
COM4	2,092,977	232,553	3,609,380	360,938	9,825,207	655,014
COM7	0	0	22,982	22,982	22,982	22,982
COM8	0	0	0	0	360,139	360,139
GOV1	56,200	56,200	67,841	67,841	67,841	67,841
IND2/IND6	3,498	1,749	5,532	2,766	11,504,545	294,988
RES1A	414,294	9,864	782,318	11,338	2,208,445	17,389
RES1B	197,261	14,090	271,847	18,123	271,847	18,123
RES1D	30,272	7,568	40,167	10,042	40,167	10,042
RES1E	78,504	13,084	85,758	17,152	218,376	21,838
RES3	116,134	29,033	903,858	75,321	1,341,746	89,450
RES4	180,097	180,097	227,095	227,095	227,095	227,095
Total	**3,497,774**	**38,437**	**7,123,981**	**54,800**	**34,766,164**	**137,416**

* See Table 3-3 of Appendix 3 for definitions of HAZUS Occupancy Types

Figure 5 shows that the difference in total losses (buildings plus contents) between the built-out conditions and the current conditions is nearly $61 million. The chart shows that most of the additional losses come from new development in the flood pone areas and that only $7 million of the additional losses come from older development that is affected by higher flood depths. It is important to caveat the future inventory damage estimates since the building was placed at the centroid of the parcel. It is anticipated that developers and the county's storm water management team will attempt to keep future development from being placed within the inundation areas. For this reason, the future-future bar may be considered an upper bound on the potential losses within this watershed.

FIGURE 5. Comparison of Flood Losses at Build-Out vs Flood Losses for the Existing Inventory, Mecklenburg County



The project team reviewed other available reports for Mecklenburg County (April 2003) and found this trend to be consistent throughout the other watersheds. In fact, for all watersheds, the future inventory losses varied between two and ten times those experienced by the existing inventory with the future conditions flood. This information leads the project team to infer that development within Mecklenburg County has traditionally been outside of the floodplain and is only now starting to encroach into higher risk areas.

5.3 Larimer County (Fort Collins), Colorado

The project team focused on Fort Collins, the largest city within Larimer County. Because of prior working relationships with the floodplain manager, the project team was able to obtain a significant amount of data that added value to the project. Fort Collins and Larimer County are pursuing the more common "No Adverse Impact" approach by requiring all future development to retain flood waters on site, and delay the discharge into the watershed over a period of time to prevent a large peak of flow and increased discharges. The concept asserts that if runoff up to the 100-year level is retained on site and discharged into the streams slowly, the hydrograph peak will have passed and downstream buildings will not see any increase in flood elevation from the upstream development. This means that any development will not have an adverse impact on the downstream structures until the 100-year retention capabilities have been exceeded.

Interestingly, if the development occurs according to plan, the current 100-year flood would remain unchanged as development progresses, since all additional discharge from the increased impervious soil would be contained on site and discharged slowly into the river thereby not increasing the 100-year flood. Naturally, there is always the chance that a greater event, such as the 500-year flood, would occur and exceed the capacity of the storage facilities, but that is beyond the scope of this project. In essence, the approach taken by the community would maintain the current discharge peak at the 100-year event, but the river would have a longer net discharge period.

5.3.1 Flood Data

To examine the difference between the existing and future conditions, Fort Collins ran its hydrologic and hydraulic models to develop a projection of the future conditions flooding assuming that no on site storage occurred and the 100-year discharges resulting from the future development was entering the watershed unabated. This is essentially reflective of the future flood conditions seen in the Mecklenburg County analysis above. This approach was taken because this allows the analysis to determine the benefit associated with storing the water on-site and managing the 100-year discharge peak. Discussions with the city provided the project team with a river reach that provided the best opportunity to test the effectiveness of the floodplain management program. The selected area had a number of vacant parcels slated for development although the mix was predominantly residential in nature. This development pressure is the reason for the floodplain management program established by the city.

Fort Collins provided its flood data in a format that was easily readable in the Flood Information Tool (FIT) created for HAZUS. The data included a historic flood boundary, a digital elevation model for the region (the USGS 1/3 Arc-second data), and cross sections with flood elevations and discharges for the 100-year existing conditions flood and 100-year flood under future conditions (assuming no on-site storage). **Figure 6** and **Figure 7** on the next page show a side-by-side comparison of the two flood depth grids. Although it is difficult to observe visually, the future conditions flood depth grid does have areas where the inundation area is greater than the existing conditions grid. This generated a slight increase in the number of structures that were flooded.

FIGURE 6. Existing Conditions Flood Depth Grid for Fort Collins

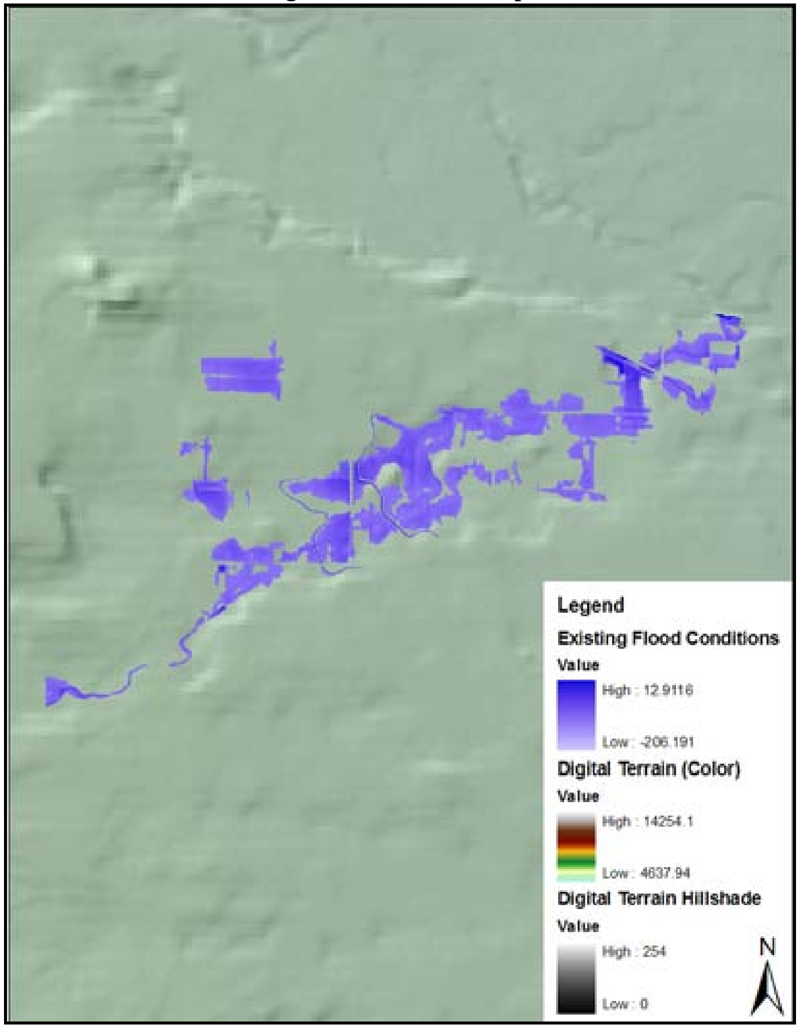


FIGURE 7. Future "Build-out" Flood Conditions for Fort Collins

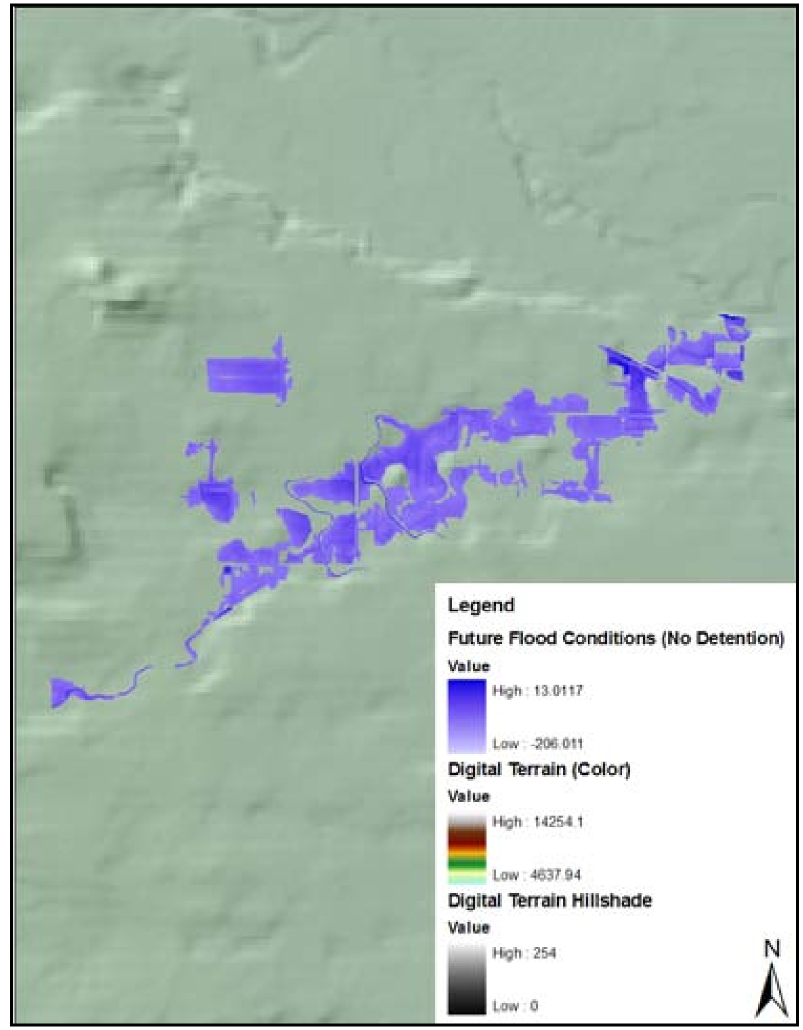
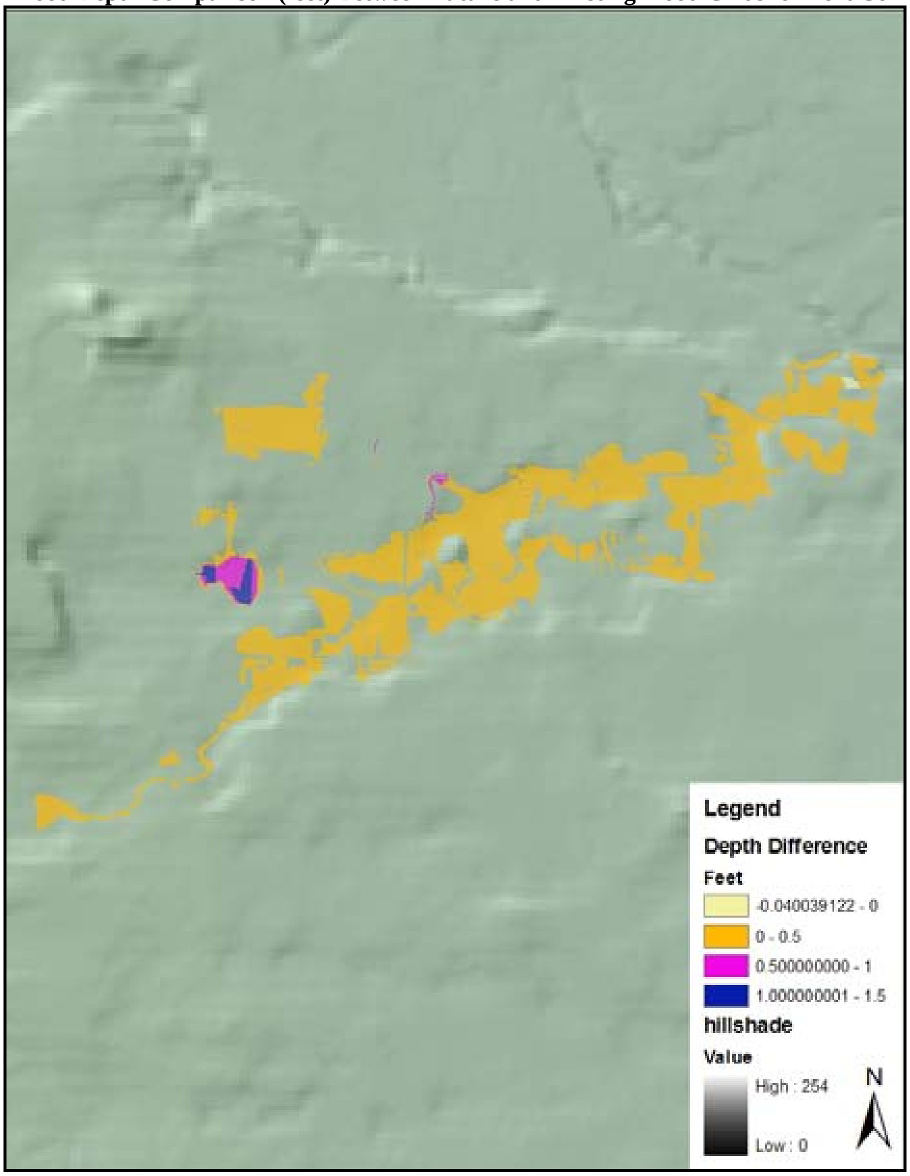


Figure 8 below shows the net difference between the existing conditions flood grid and the future conditions flood grid. Generally, it can be seen that the majority of the flood area would see a net increase of six inches or less. There are a few areas where the inundation would increase by slightly more than a foot. This nominal increase in flooding is reflected in the analysis results discussed below.

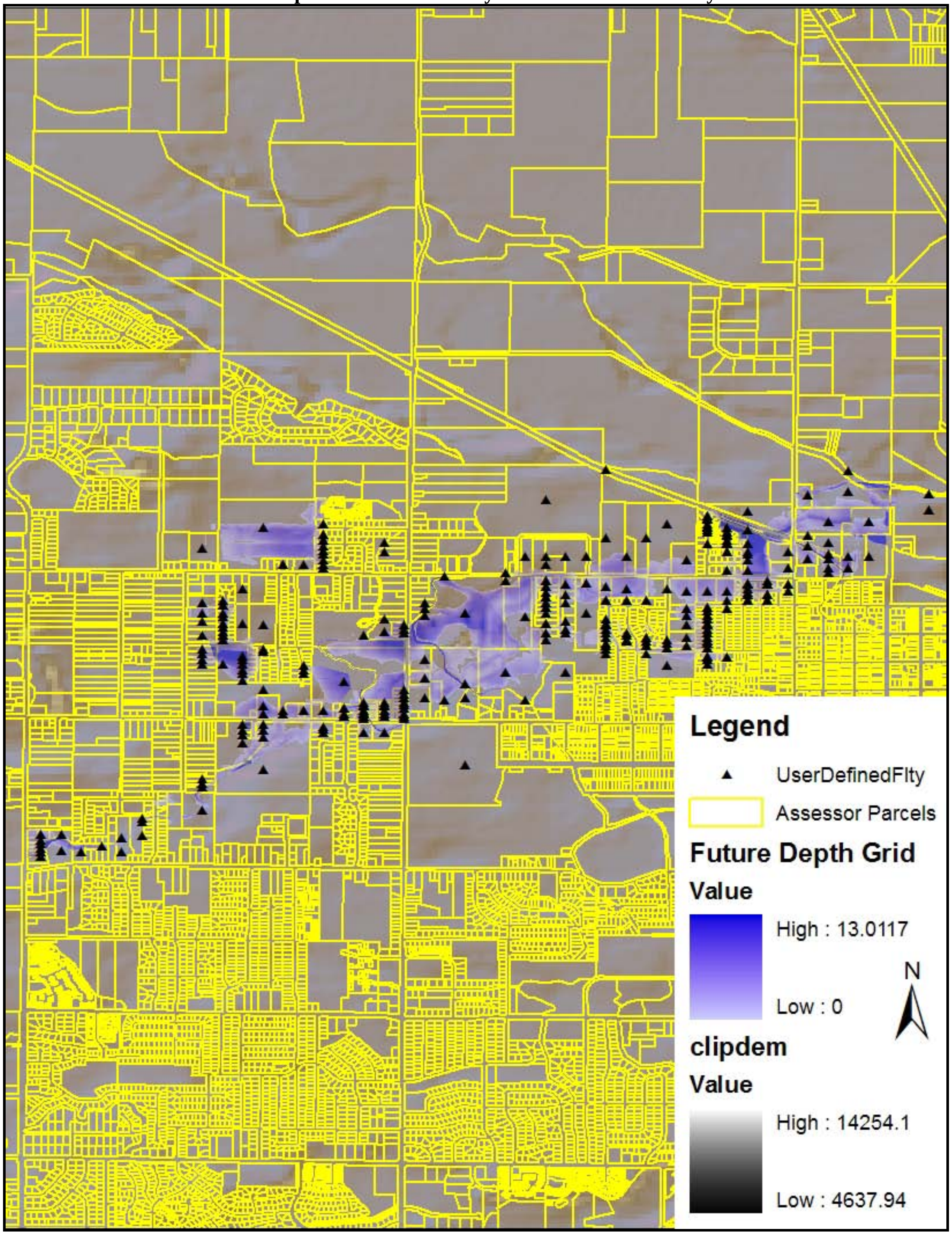
FIGURE 8. Flood Depth Comparison (feet) Between Future and Existing Flood Grids for Fort Collins



5.3.2 Inventory Data

County assessor data was purchased from a commercial site, the data included detailed information on the total floor area of the improvements, the value of the buildings, occupancy classifications that were easily mapped to the HAZUS occupancy classes, whether a structure had a basement, the number of stories for each structure, and the year built. With this information, the project team used the HAZUS foundation distributions to provide foundation types for those structures that did not have a basement. The project team also used the HAZUS distribution data to estimate the first floor heights for all of the structures, since that information could not otherwise be determined. **Figure 9** provides a graphic view of the data received by the project team with respect to the future conditions flooding.

FIGURE 9. Example of Larimer County Data Used in This Analysis



Fort Collins did provide the parcel boundaries with the corresponding parcel number, allowing the commercial dataset and the geographic parcel data to be joined. Of the total number of parcels in the dataset, 355 intersected the flood grids generated from the Fort Collins hazard data. Nearly all of the parcels were residential in nature, either single-family or multi-family, with one commercial retail parcel, two churches or other religious use parcels, one agricultural, and one industrial parcel. Of the 355 parcels, 306 of them had already been developed and 49, or 14%, were currently vacant. Again, because the city needed to perform work in developing the H & H analysis, and because the selected area is currently undergoing development, the project team and the city established this river reach as a reasonable test of potential increased losses within the city.

Since building footprints were not available, all of the structures were assumed to be located at the centroid of the parcels. This meant that the full value of the multi-family structures was applied at the centroid, whether there were multiple buildings or not. **Table 6** shows the results of the analysis of direct building damage. The table shows that the current conditions would result in nearly $2.4 million in damage to the buildings along the river. Should development have occurred without on-site storage, the damage would increase to $3.3 million at "build-out". The changing flood conditions would increase the losses to existing structures by about $450,000 from $ 2.4 million to $2.8 million. The average damage to an existing structure would increase by about $1,000. This stream is a good example of the risk in the city as it is likely to be representative of the small watersheds throughout the country and shows the incremental increase in damages that can occur.

TABLE 6. Larimer County (Fort Collins) Structure Dollar Damage by HAZUS Occupancy Type

HAZUS Occupancy*	Current Inventory - Current Flood Conditions		Current Inventory – Future Flood Conditions No Detention		Future Inventory – Future Flood Conditions No Detention	
	Total ($)	**Average ($)**	**Total ($)**	**Average ($)**	**Total ($)**	**Average ($)**
AGR1	0	0	223	223	223	223
COM1	21,694	21,694	23,054	23,054	23,054	23,054
IND2	11,185	11,185	11,633	11,633	11,633	11,633
REL1	60,285	30,142	60,757	30,379	60,757	30,379
RES1	1,892,741	15,264	2,221,473	16,025	2,660,677	19,421
RES2	281,604	93,868	301,926	75,482	301,926	75,481
RES3A	63,501	12,700	142,903	20,415	142,903	20,415
RES3C	81,758	27,253	104,279	34,760	104,279	34,760
Total	**2,412,767**	**17,234**	**2,856,248**	**18,193**	**3,305,451**	**21,054**

* See Table 3-3 of Appendix 3 for definitions of HAZUS Occupancy Types

Table 7 shows similar results for the contents and inventory (goods for resale) for the structures within the study. An existing conditions flood could be expected to create nearly $1.7 million in content and inventory damage, but this would increase to nearly $2.2 million if the regulatory requirement was not in place. Similar to the building damage, the changing flood conditions will increase the damage to existing contents and inventory by about $250,000. As this watershed is primarily residential, this means increased damage to personal property for the residents.

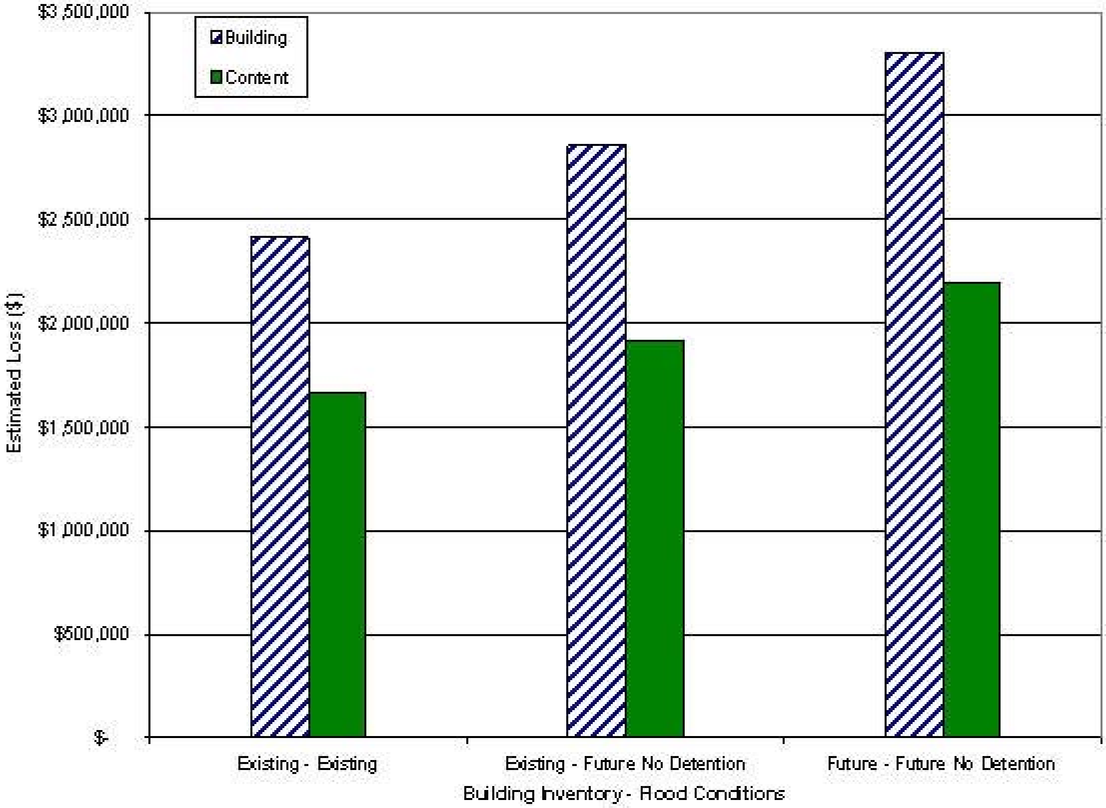
TABLE 7. Larimer County (Fort Collins) Contents Dollar Damage by HAZUS Occupancy Type

HAZUS Occupancy*	Current Inventory - Current Flood Conditions		Current Inventory – Future Flood Conditions No Detention		Future Inventory – Future Flood Conditions No Detention	
	Total ($)	Average ($)	Total ($)	Average ($)	Total ($)	Average ($)
AGR1	0	0	2,388	2,388	2,387	2,387
COM1	137,022	137,022	145,687	145,687	145,688	145,688
IND2	45,338	45,338	48,922	48,922	48,922	48,922
REL1	436,290	218,145	445,732	222,866	445,732	222,866
RES1	887,046	7,154	1,060,862	7,687	1,336,497	9,755
RES2	88,873	29,624	97,292	24,323	97,292	24,323
RES3A	25,400	5,080	60,754	8,679	60,754	8,679
RES3C	45,265	15,088	56,301	18,767	56,301	18,767
Total	**1,665,234**	**11,895**	**1,917,938**	**12,216**	**2,193,572**	**13,972**

* See Table 3-3 of Appendix 3 for definitions of HAZUS Occupancy Types

Looking at the results graphically, **Figure 10** shows the difference in total losses for both buildings and contents. The difference between the built out conditions and the current conditions is nearly $1.5 million. The relatively small savings is not surprising because of the overall minor increase in flood depths (as seen in Figure 8), and the fact that the area examined would have primarily residential development and the number of total parcels is smaller than the Mecklenburg County example. Because this analysis examines what would happen if there were no retention when new development occurred, it is assumed that the $1.5 million is the losses avoided should a 100-year event happen at build-out with detention, and assuming that none of the zoning changes as development expands.

FIGURE 10. Comparison of Flood Losses at Build-out vs Flood Losses With the Existing Inventory, Fort Collins



5.4 Harris County, Texas

Like Larimer County, Harris County and the City of Houston have also adopted the approach of requiring on-site detention of storm waters. The regulations require developers to store the equivalent amount of excess flow from their property in some form of on-site storage, and the release of the water must be over a period of several days. Because of the similarity to Larimer County, the project chose the same approach in analyzing the benefit of the management approach. As in Larimer County, the project team and the county chose an area where development pressure is relatively high and has enough vacant parcels whose development without on-site storage could lead to sufficient changes in the discharge of the watershed.

While the smaller analysis area might limit the generalization across all the watersheds in the nation, the planning approach (i.e. development pressure in small planning areas) is typical of that seen in many cities so the analysis is actually relevant to the manner in which other cities might perform the assessment.

When selecting the river reaches, the availability of data drove the number of reaches and the area within the community analyzed. In order for the project team to perform the analysis in Harris County, additional data development was needed. It was agreed that the analysis area would be limited. Additionally, Harris County was also very concerned about potential political consequences and wanted to keep the analysis area very constrained.

5.4.1 Flood Data

The project team received data for a portion of Dry Creek for the existing 100-year flood and for the 100-year flood that would potentially occur when "build-out" was achieved, assuming that there is no detention. The data included cross sections for the study reach, attributed with both the 100-year existing conditions elevation and the "future" condition 100-year flood assuming no detention. A sample floodplain boundary was provided. Harris County provided sufficient terrain data for the FIT analysis. Once the data was processed through the FIT, it was imported into the Flood Model for subsequent damage analysis.

Figure 11 and **Figure 12** provide a direct side-by-side comparison of the two grids produced by the analysis of the county supplied data. The most obvious conclusion is that the future conditions flood would inundate a significantly larger area than the current condition flooding. This may be due in part to the age of the current condition data (approximately 1975), the relatively flat terrain, and the large amount of development that has occurred and can still occur within very close proximity to the river.

FIGURE 11. Existing Conditions Flood Depth Grid for Harris County

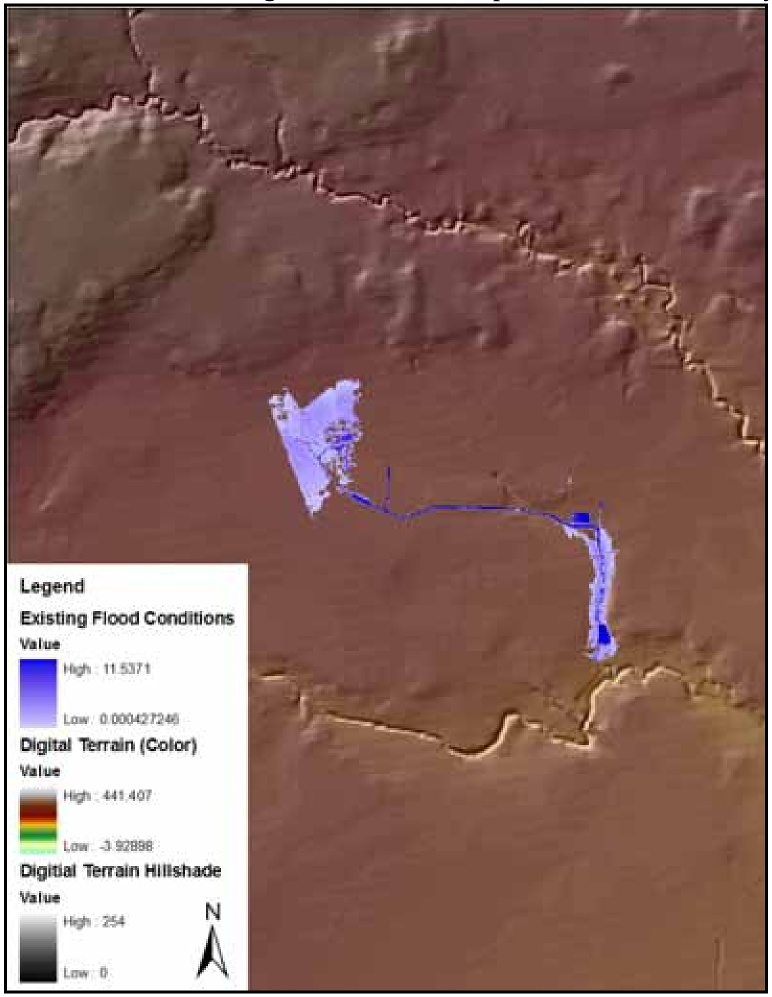
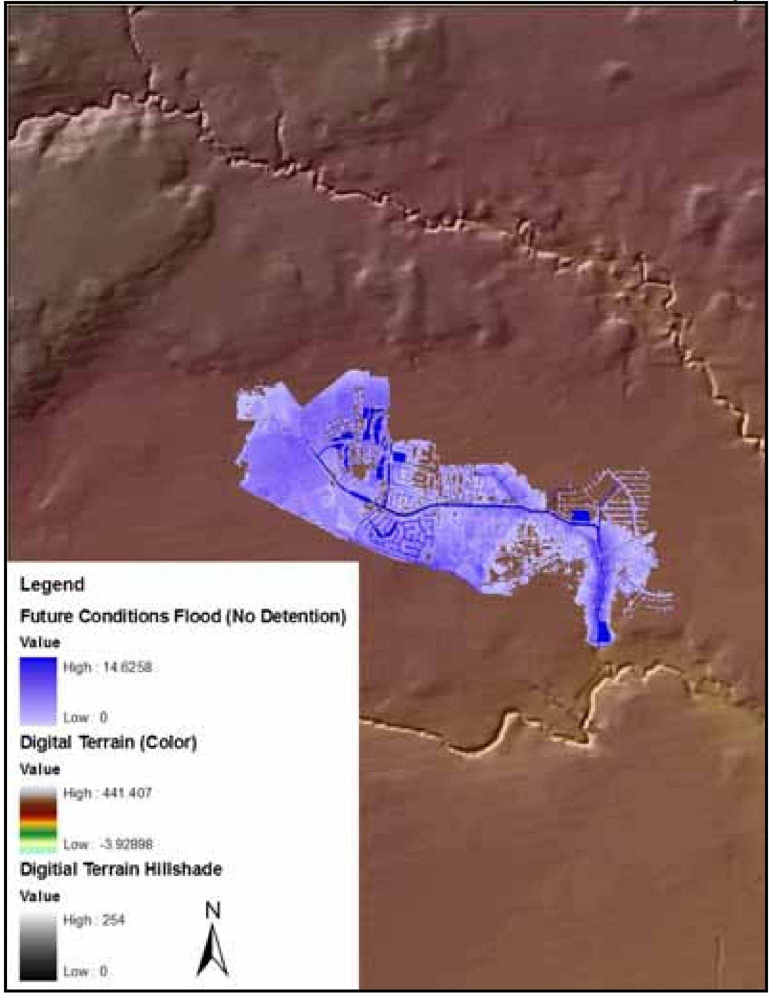
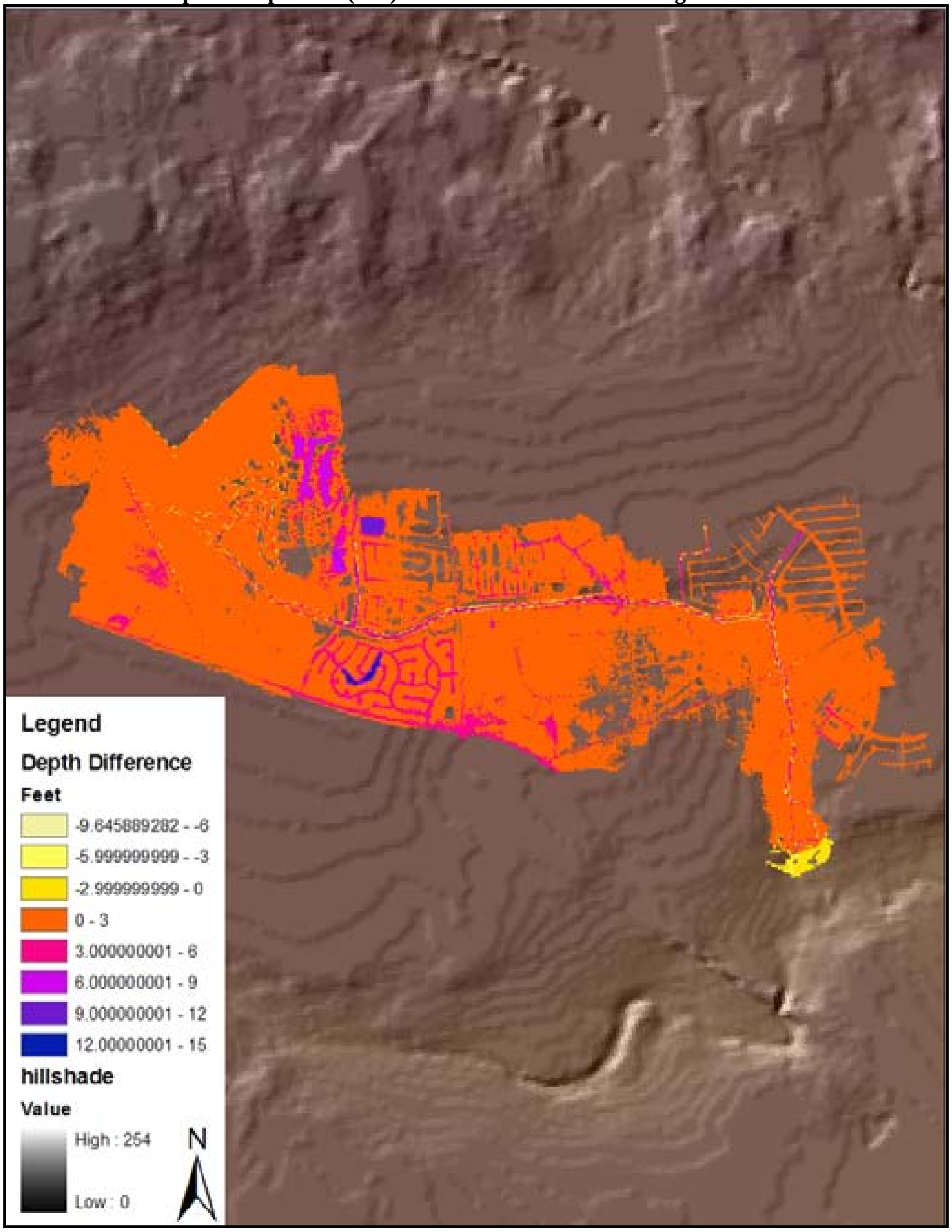


FIGURE 12. Future "Build-out" Flood Conditions for Harris County



Further comparison of the two depth grids by directly subtracting one from the other, **Figure 13** shows the difference between the existing conditions flooding and the future flooding assuming no on-site detention. Overall, the majority of the area would be subjected to 0-3 feet of additional flooding, with pockets of areas that could experience between 3 to 6 feet or more increased flooding.

FIGURE 13. Flood Depth Comparison (feet) Between Future and Existing Flood Grids for Harris County

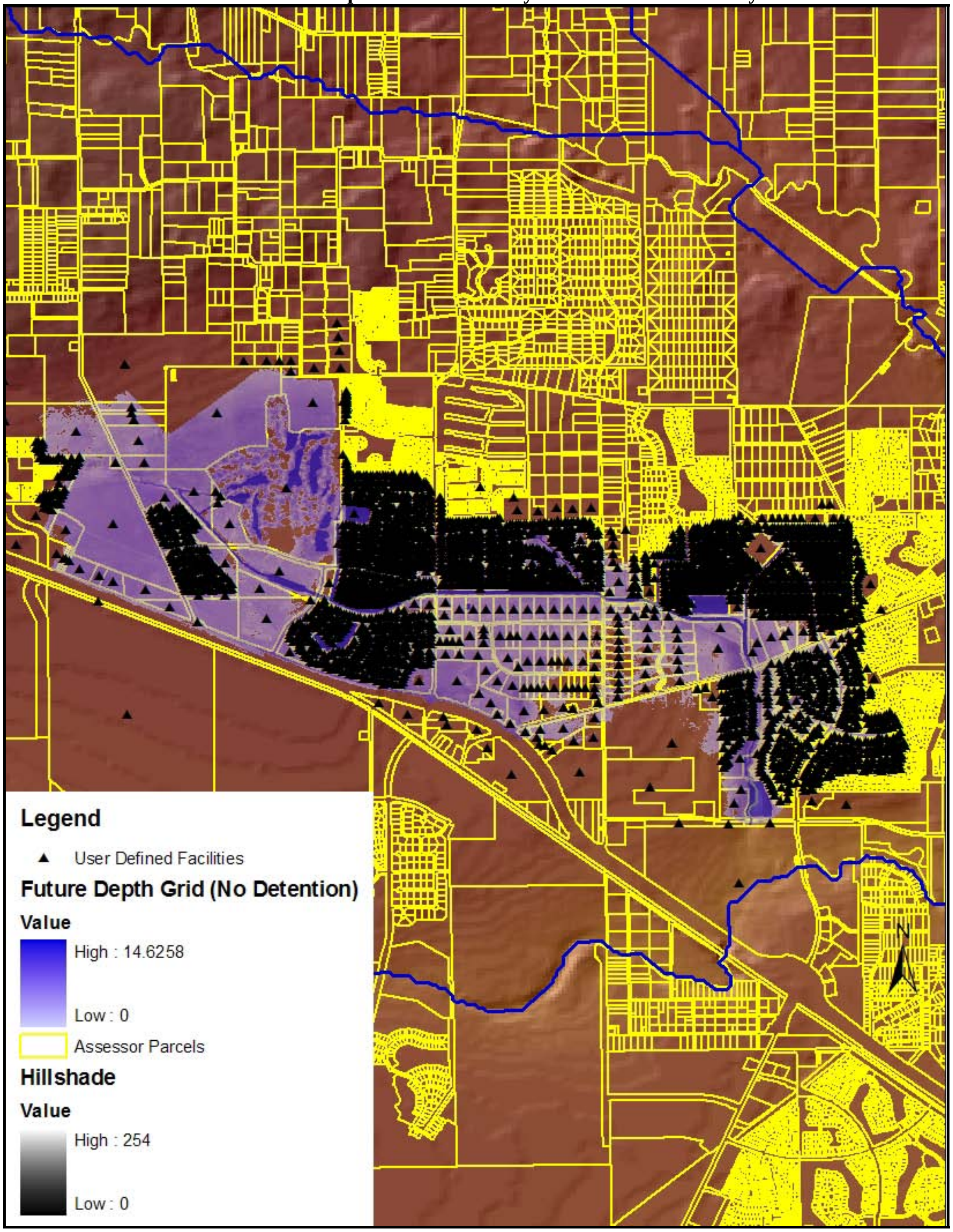


5.4.2 Inventory Data

County assessor data was purchased from the same commercial data source that provided the data on Larimer County. The purchased data included detailed information on the total floor area of the improvements, the value of the buildings, occupancy classifications that were easily mapped to the HAZUS occupancy classes, and number of stories and year built. The database did not include any information that would assist with determining the foundation type. These values were supplemented with the HAZUS regional averages by occupancy and this was assigned in a semi-random fashion ensuring that the percentages were maintained as closely as possible. The project team used the HAZUS default assumption of first floor height for each foundation type to estimate first floor heights for all of the structures.

Figure 14 provides a graphical view of the data collected for the project with respect to the future conditions flood depth grid. The assessor's data, stored in the "User Defined Facilities" table within HAZUS and shown as black triangles in the image, readily demonstrates why the resulting damage increases so significantly in the Harris County analysis. The expansion of the flooded area and the increased depth of flooding, as well as the heavy concentration of structures in the area, greatly increase the overall exposure and the resulting damage.

FIGURE 14. Example of Harris County Data Used in This Analysis



Again, as for Larimer County, GIS data showing the parcel boundaries for Harris County was obtained, and all structures were assumed to be at the centroid of the parcel. Of the total dataset for Harris County (over 1.1 million parcels), 3,835 parcels intersected the floodplain boundaries developed by the Flood Information Tool, with 735 or 21% defined as currently vacant. The assessor's file did provided approved zoning for the parcels, allowing the project team to assume the typical HAZUS configuration for projected future development for the occupancies as seen in Appendix 3, Table 3. **Table 8** shows the estimated structural damage to the buildings in the study area. The estimated damage for the future conditions is estimated to be approximately $62 million, up from the current conditions of slightly over $3.3 million. Most of the increase is seen in the agricultural (AGR1), government (GOV1), and single-family residential (RES1) occupancies. In this analysis, the impact to the existing structures is significant representing over a 1,300% increase. As seen in Figure 11 and Figure 12 without the use of on-site storage, a number of structures that are currently outside of the floodplain would be affected. The changing flood conditions with the future development would increase damage to existing buildings from $3.3 million to over $46 million. This increase represents nearly 75% of the total increased losses that potentially could occur after build-out if on site storage was not mandated.

TABLE 8. Harris County Structure Dollar Damage by HAZUS Occupancy Type

HAZUS Occupancy*	**Current Inventory - Current Flood Conditions**		**Current Inventory – Future Flood Conditions No Detention**		**Future Inventory – Future Flood Conditions No Detention**	
	Total ($)	**Average ($)**	**Total ($)**	**Average ($)**	**Total ($)**	**Average ($)**
AGR1	954,174	95,417	18,129,716	142,754	18,129,716	141,638
COM1	4,348	4,348	2,860,952	286,095	7,152,675	246,644
COM2	0	0	236,834	236,834	236,834	236,834
COM3	0	0	29,612	29,612	29,612	29,612
COM5	0	0	82,551	82,551	82,551	82,551
COM8	0	0	241,020	120,510	241,020	120,510
GOV1	5,389	5,389	1,942,885	242,861	6,187,602	309,380
IND1	2,050,121	227,791	6,854,242	263,625	6,854,242	274,170
IND2	0	0	26,539	2,413	26,539	2,654
REL1	0	0	0	0	370,439	123,480
RES1	290,777	10,770	16,379,057	13,559	22,634,263	10,924
RES2	0	0	18,464	18,464	18,464	18,464
Total	**3,304,808**	**70,246**	**46,801,872**	**33,526**	**61,963,956**	**27,023**

* See Table 3-3 of Appendix 3 for definitions of HAZUS Occupancy Types

The content and inventory damage for the analyzed portion of Harris County is shown in **Table 9** below and the results shows that changes in the flood grids causes the estimate to soar. The future conditions estimation for the contents is anticipated to approach $289 million, up from the current conditions of under $18 million. This is driven by large increases in content damages to the agriculture occupancy (AGR1), retail commercial uses (COM1), government (GOV1), and single-family residential (RES1) occupancies. While the overall damage increases dramatically, the average content damage estimated per structure actually decreases by a third indicating a large increase in the number of flooded structures, many of which have lower average losses thus lowering the overall average. The content losses reflect the losses associated with the buildings with nearly 78% of the $289 million in losses coming from existing structures that are affected by the future flood conditions assuming no detention.

TABLE 9. Harris County Contents Dollar Damage by HAZUS Occupancy Type

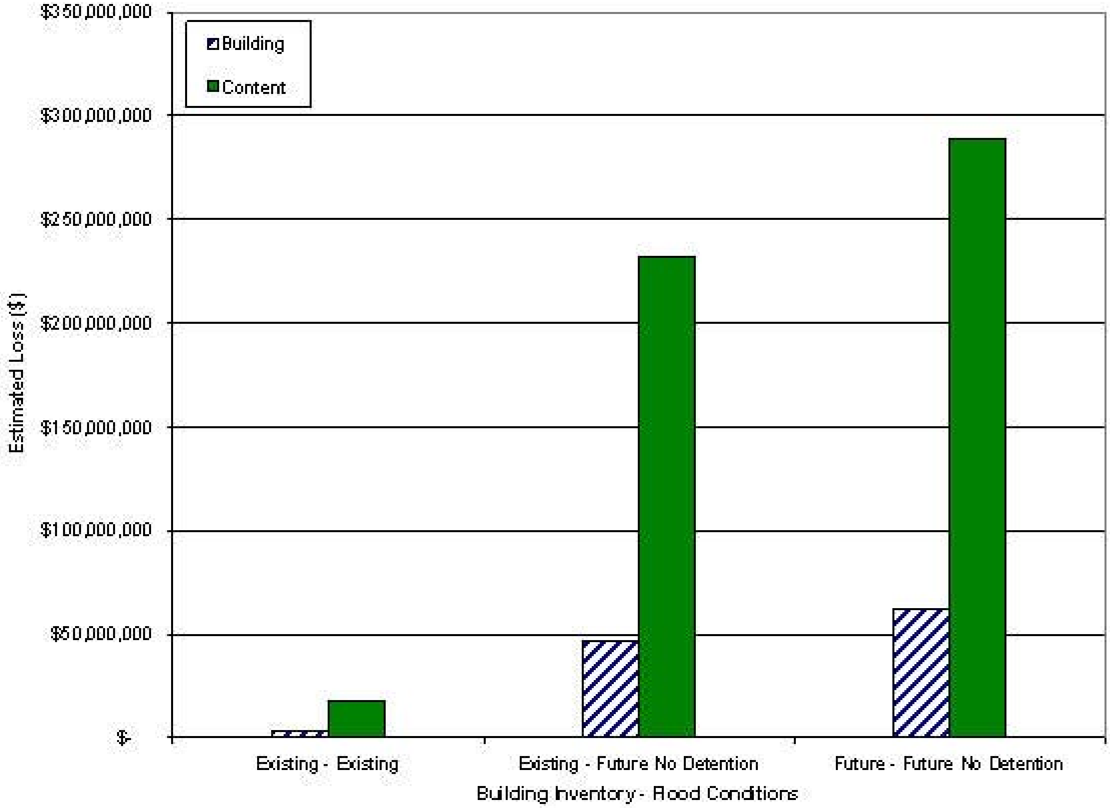
HAZUS Occupancy*	Current Inventory - Current Flood Conditions		Current Inventory – Future Flood Conditions No Detention		Future Inventory – Future Flood Conditions No Detention	
	Total ($)	Average ($)	Total ($)	Average ($)	Total ($)	Average ($)
AGR1	7,817,077	781,708	151,772,027	1,195,055	151,772,027	1,185,719
COM1	30,052	30,052	20,519,469	2,051,947	50,172,683	1,730,093
COM2	0	0	1,760,908	1,760,908	1,760,908	1,760,908
COM3	0	0	104,734	104,734	104,734	104,734
COM5	0	0	394,039	394,039	394,039	394,039
COM8	0	0	1,276,635	638,318	1,276,635	638,317
GOV1	32,332	32,332	11,896,421	1,487,053	34,261,767	1,713,088
IND1	9,961,296	1,106,811	36,621,135	1,408,505	36,621,135	1,464,845
IND2	0	0	64,728	5,884	6,699	6,470
REL1	0	0	0	0	2,214,086	738,029
RES1	105,985	3,925	7,276,741	6,024	10,678,623	5,154
RES2	0	0	7,147	7,147	7,147	7,147
Total	**17,946,743**	**390,147**	**231,693,984**	**165,970**	**289,328,482**	**195,624**

* See Table 3-3 of Appendix 3 for definitions of HAZUS Occupancy Types

Looking at the results graphically, **Figure 15** present the difference in total losses, for both buildings and contents. The difference in loss between the built-out conditions and the current conditions is nearly $330 million. There are several reasons for the very large difference. The difference between the two flood grids probably has the most profound affect. The analysis performed with the current conditions flood grid inundates the centroid of 51 parcels, while that performed with the future conditions and no-detention flood grid inundates approximately 1,560 parcels or an increase of 300% in total parcels effected. The other principle reason is the content damage on the parcels that are flooded. Many of the additional parcels in the floodplain are non-residential parcels that are zoned for agricultural, commercial, industrial, and government uses. By definition the content value of such parcels is greater than that of the structures housing the contents (Table 4 in Appendix 3). This is because the structures themselves are typically pretty simple structures with limited internal finishes or ‘beautification" compared to that seen in residential structures, and because the contents are generally either expensive equipment or a commodity that may be for sale.

The project team noted that the greatest content damage is occurs on agricultural parcels. The project team believes there is a strong possibility that the agriculture zoning will be changed to support residential or commercial development, as is typical when development expands. Such a change would impact the net results by shifting damage from a few structures with high value contents to a larger number of residential structures and the associated contents. The exact impact would be hard to determine since the project team cannot know the number of homes or types of home (luxury, custom, average, or economy) that might be developed. Therefore the project assumed that the current zoning dictates the future development. Because this analysis looks at what would happen if there is no retention when the new development takes place, it may be safe to assume that the $330 million represents the losses avoided should a 100-year event happen at build-out with detention, assuming that none of the zoning changes as development expands.

FIGURE 15. Comparison of Flood Losses at Build-out vs Flood Losses With the Existing Inventory, Harris County



5.5 DuPage County, Illinois

Like Larimer County and Harris County, DuPage County and the cities within that county have adopted the approach of requiring on-site detention of storm water. The regulations require developers to store the equivalent amount of excess flow from their property in some form of on-site storage and then release it over a period of several days. Because of the similarity to Larimer and Harris counties, the project chose the same approach in analyzed the benefit of the management approach in the same manner. The county staff recommended a series of reaches for the analysis based on the quality of the flood data and the number of vacant parcels. The parcels within the study area are a mix of residential and non-residential uses, and the non-residential uses vary from commercial to government uses.

When selecting the river reaches, the availability of data drove the number of reaches and the area within the community analyzed. In order for the project team to perform the analysis in DuPage County, additional data needed to be developed, therefore it was agreed that the analysis area would be limited.

5.5.1 Flood Data

Unlike the other communities researched for this report, DuPage County provided the H&H model for a historic storm and the associated discharges that were widely considered a close approximation of the 100-year event. For this historic event, the project team received flood related data for the reaches for the current development and for the built out conditions assuming that there is no detention. This data included cross sections and discharges assuming the same level of rainfall and differing soil conditions to account for development. The county provided the data assuming the current conditions of development, the future development with detention per code and without any detention for all future development. The data also included a floodplain boundary. DuPage County also provided the terrain data for the FIT analysis. The riverine hazard data was processed through the FIT for subsequent import into the Flood Model, where the loss estimation was performed.

Figure 16 and **Figure 17** provide a direct side-by-side comparison of the resulting depth grids. Like Mecklenburg County and Larimer County, the difference in the two grids is not readily apparent when presented in this fashion, as there appears to be relatively small increases in the overall inundated area. There are a few specific pockets of inundation in the future conditions depth grid that are not flooded in the existing conditions grid.

FIGURE 16. Existing Conditions Flood Depth Grid for DuPage County

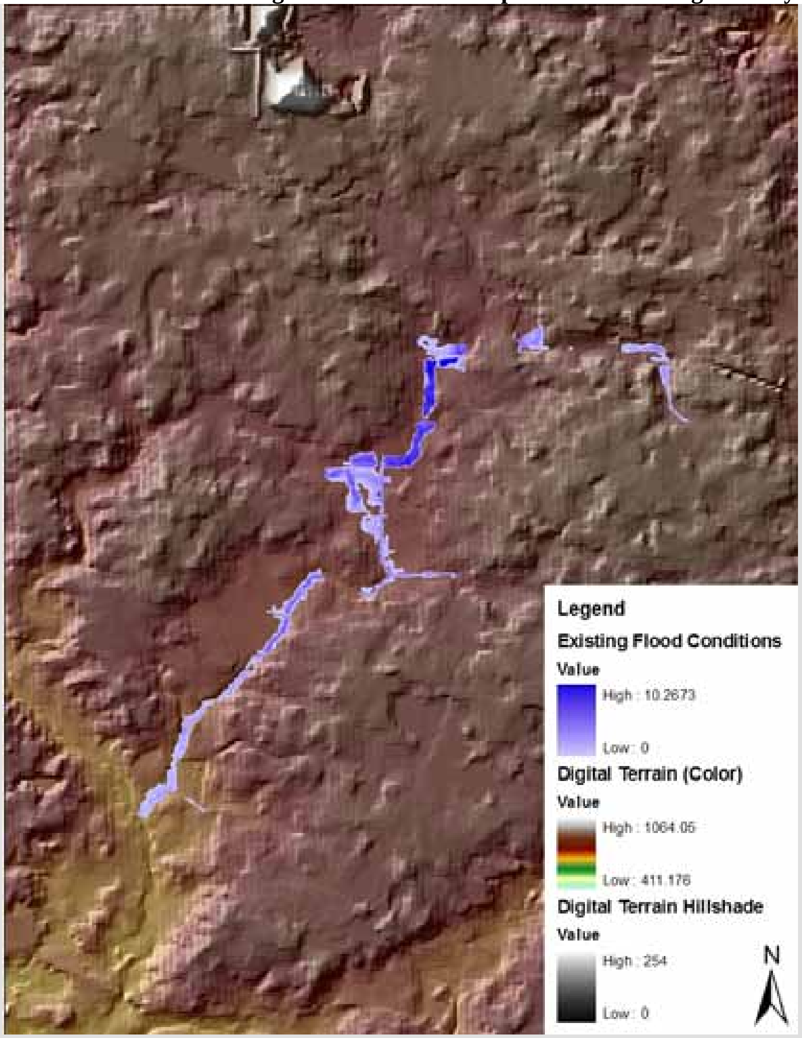
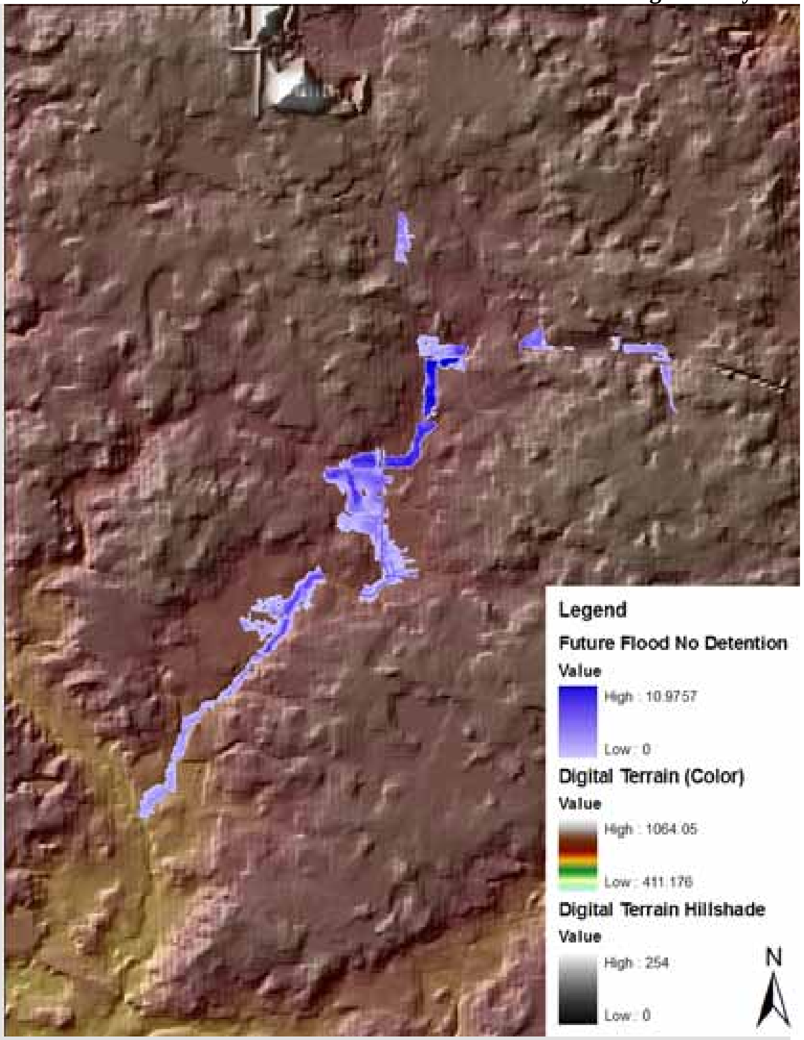
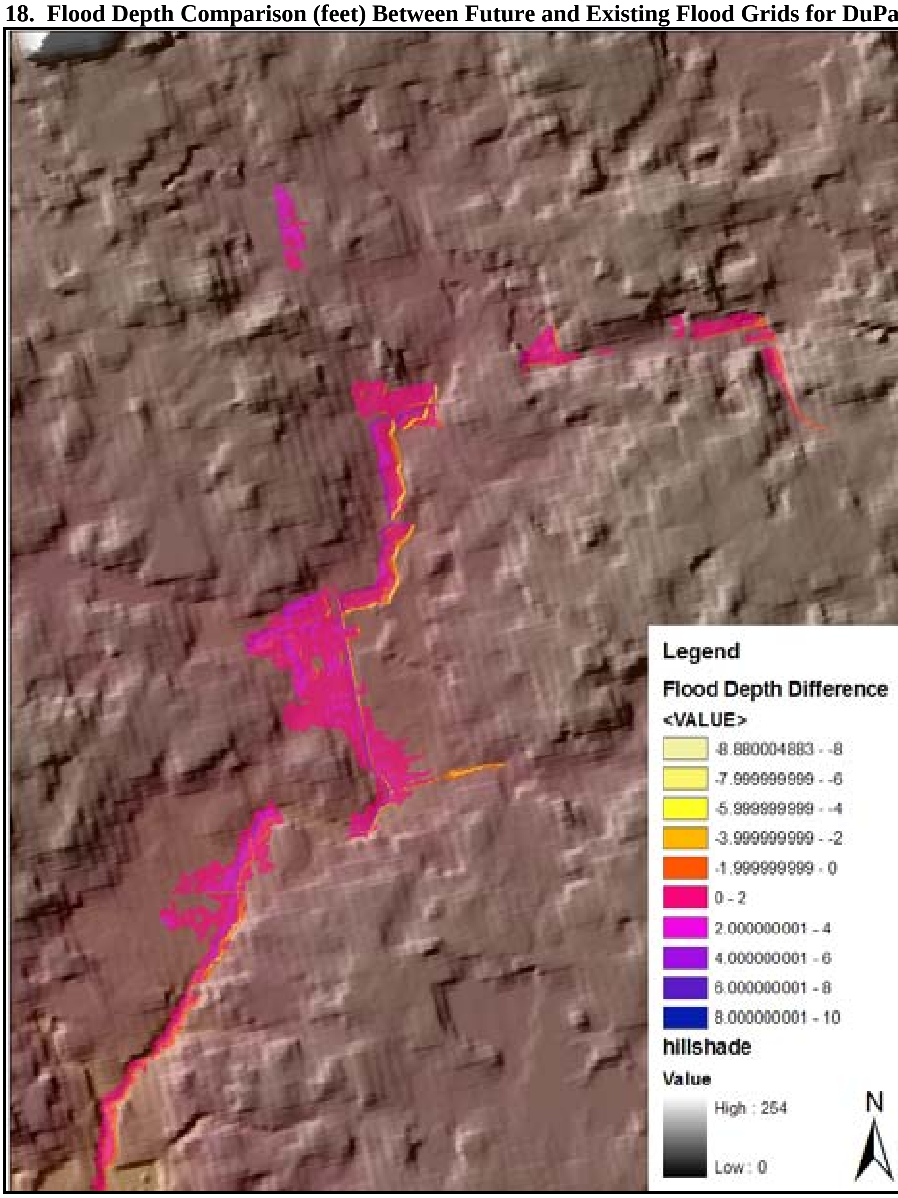


FIGURE 17. Future "Build-out" Flood Conditions for DuPage County



Direct comparison of the existing conditions flooding and the future conditions flooding (**Figure 18**), shows an increase of 0 to 4 feet over most of the inundated. There are some areas where the flood conditions are expected to improve, although this may be due to the modeling techniques used to develop. Overall, the rather sharp terrain constrains the storm waters into tightly defined inundation zones.

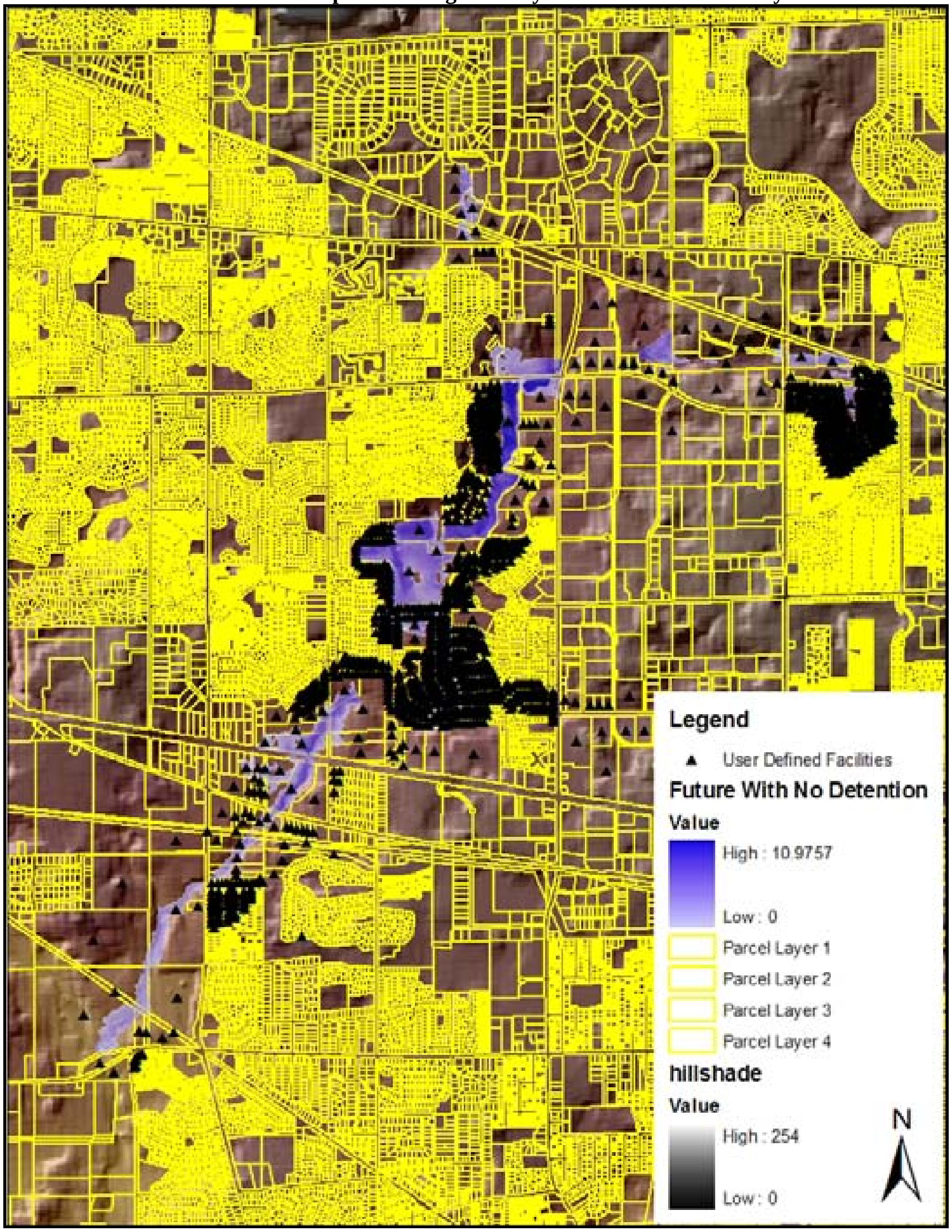
FIGURE 18. Flood Depth Comparison (feet) Between Future and Existing Flood Grids for DuPage County



5.5.2 Inventory Data

The DuPage County assessor provided data from which the occupancies could be determined and mapped to the HAZUS occupancy classes as well as detailed parcel boundaries for the county, from which the centroids for the analysis could be determined. The county assessor could not provide the total floor area for the parcels but did provide the valuations for all developed parcels. Although the project team needed to assume a floor area for each of the parcels to ensure that the flood model would operate correctly, the assumption is not expected to have an effect on resulting losses, because damage is determined as a percent of exposed value, not relative to exposed square footage. If the zoning was unknown, as was the case in DuPage County, the project team looked at the development patterns surrounding the parcel to identify the likely approved use. This was the exception rather than the rule. The project team also needed to assign the regional HAZUS foundation distribution, number of stories, and first floor elevations to all of the developed parcels as this information was missing from the assessor's files. **Figure 19** contains data collected by the project team with respect to the future flood conditions.

FIGURE 19. Example of DuPage County Data Used in This Analysis



For the undeveloped parcels, the project team once again assumed that a typically configured building of the identified occupancy would be located at the centroid of the parcel, and estimated the valuation using the HAZUS parameters (see Table 3 in Appendix 3). Depending on the occupancy class, the project team also assigned the distribution of foundation types, number of stories, and first floor elevations. The assignments were semi-random in the sense that the project team attempted to ensure that the regional distribution as seen in Appendix 3, Table 1 was maintained.

GIS data showing the parcel boundaries for DuPage County was obtained. Nearly 2,318 parcels intersected the floodplain boundaries developed by the Flood Information Tool, with 42 or 2% of those defined as currently vacant. The assessor's file did provide approved zoning for the parcels, allowing the project team to assume the typical HAZUS configuration for projected future development for the occupancies as seen in Appendix 3, Table 3.

Table 10 shows the estimated structural damage to buildings within the study area. The Current Inventory is based on the assessor's data file provided by the county and reflects the conditions as of 2005. The Future Inventory in the table assumes that all of the vacant parcels are developed to their current zoning, as defined in the assessor's file. The table shows that the overall structural damage will increase by nearly $3 million, but the average damage to each structure will be approximately half of the current conditions flooding. This is due primarily to the fact that more structures are damaged and many of additional structures are not as heavily flooded. Of the $5.8 million in estimated losses for the future conditions flooding, 84% of the increased losses are in the existing building stock.

TABLE 10. DuPage County Structure Dollar Damage by HAZUS Occupancy Type

HAZUS Occupancy*	Current Inventory - Current Flood Conditions		Current Inventory – Future Flood Conditions No Detention		Future Inventory - Flood Conditions No Detention	
	Total ($)	Average ($)	Total ($)	Average ($)	Total ($)	Average ($)
AGR1	0	0	385,751	192,876	385,751	192,875
COM1	0	0	165,634	82,817	165,634	82,817
GOV1	2,382,447	340,350	4,289,567	225,767	4,289,567	285,971
IND1	0	0	0	0	379,229	189,615
IND2	0	0	0	0	143,324	143,324
REL1	0	0	338,423	169,212	338,423	169,211
RES1	12,317	1,760	112,360	775	112,360	2,247
Total	**2,394,764**	**149,673**	**5,291,735**	**31,128**	**5,814,288**	**78,571**

* See Table 3-3 of Appendix 3 for definitions of HAZUS Occupancy Types

Table 11 provides the estimated damage to the contents and commercial inventory of the structures analyzed above. Like the structural damage above, the overall content and inventory damage increases yet the average content damage per structure drops by half. This usually indicates an increase in the overall number of structures being damaged at lower depths of flooding. Significant increases in content damage can be seen in nearly all occupancy classes, but predominantly government (GOV1). Reflective of the building damage, the content damage for the existing structures, when subjected to the future conditions flooding represents nearly 88% of the potential losses at build-out.

TABLE 11. DuPage County Contents Dollar Damage by HAZUS Occupancy Type

HAZUS Occupancy*	Current Inventory - Current Flood Conditions		Current Inventory – Future Flood Conditions No Detention		Future Inventory - Flood Conditions No Detention	
	Total ($)	**Average ($)**	**Total ($)**	**Average ($)**	**Total ($)**	**Average ($)**
AGR1	28,077	28,077	3,259,610	1,629,805	3,259,611	1,629,805
COM1	0	0	1,044,320	522,160	1,044,320	522,160
GOV1	14,960,004	2,137,143	26,234,895	1,380,784	26,234,895	1,748,993
IND1	0	0	0	0	1,795,791	897,895
IND2	0	0	0	0	428,832	428,832
REL1	4,261	4,261	1,851,232	925,616	1,851,232	925,616
RES1	8,217	1,174	56,576	390	56,576	1,132
Total	**15,000,559**	**937,535**	**32,446,633**	**190,863**	**34,671,257**	**468,530**

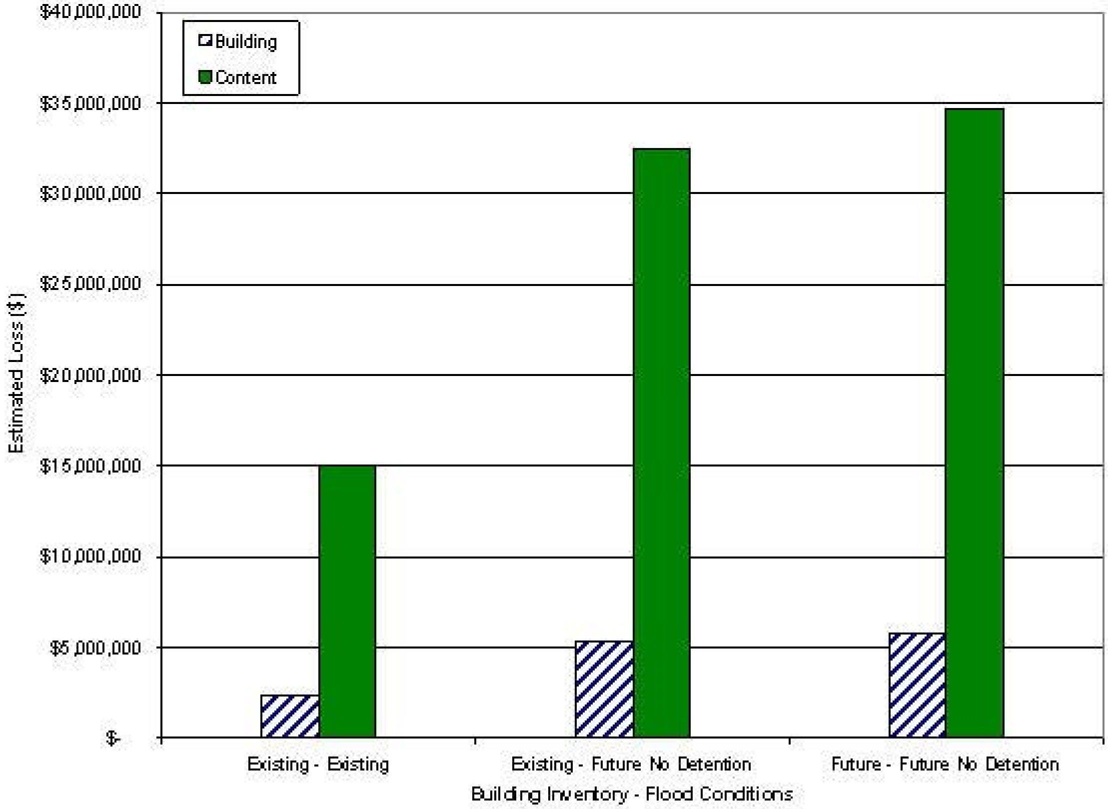
* See Table 3-3 of Appendix 3 for definitions of HAZUS Occupancy Types

Looking at the results graphically, **Figure 20** shows the net difference between the existing flooding with the existing inventory, and the future flooding with no detention for the historic rainfall for buildings and contents. The net difference between the results of the current inventory / current flood conditions and the future inventory / flood conditions is nearly $23 million. The majority of the difference is in the estimation of content damage. Because this analysis is looking at what would happen if there is no retention when the new development occurs, it may be safe to assume that the $23 million represents the losses avoided should a 100-year event happen at build-out with detention, and assuming that none of the zoning changes as development expands.

Like Harris County, this is driven by estimated damage to non-residential buildings that will be developed in the future. Key drivers for the increased losses include the current zoning that identifies agricultural and industrial uses. There are also a number of parcels that are zoned government use that also contributes to the estimated loss increase.

The project team believes that most of the parcels currently zoned for agricultural production are likely to be rezoned to other uses such as commercial, residential or industrial, as the development pressure increases on those parcels. Exactly what those parcels would become is unknown. Another question arises as to whether all of the parcels designated as government would actually be developed as such, or if they may be converted to other uses or kept as open space.

FIGURE 20. Comparison of Flood Losses at Build-out vs Flood Losses With the Existing Inventory, DuPage County



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6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

As previously stated, the goal of this project was to determine the consequence (cost and benefits) of managing future conditions in the watershed. The intent of the interviews is to provide a qualitative sampling which could be used to demonstrate first hand experience with costs associated with managing future conditions in the watershed. The benefits of managing future conditions were demonstrated by using HAZUS to quantify the avoided losses between 1) Current Inventory with Current Flood Conditions; 2) Current Inventory with Future Flood Conditions; and, 3) Anticipated Inventory with Future Flood Conditions.

6.1.1 Interviews

For this study, the project team interviewed community officials, developers, floodplain managers, insurance agents, mortgage lenders, federal officials, and state officials. The results from the interviews suggested that the costs associated with compliance with the regulations are negligible. Many interviewees felt that other market forces have a more predominant effect on the value of property other than the cost of floodplain regulation compliance. This conclusion is also supported by "*Evaluation of the National Flood Insurance Program's Building Standards*" report (Jones *et al*, 2006). The interviewees indicated that aside from the potential cost of performing hydrologic and hydraulic (H & H) studies to demonstrate potential changes in the inundation areas, the cost for future conditions floodplain management are primarily the cost of implementing new regulations.

As for cost associated with the implementation of the regulations, many of the interviewees indicated that they too are negligible. While some interviewees discussed law suits associated with floodplain management, there was no indication that the number of law suits have increased because of the implementation of the regulations. The types of issues that they have encountered are called takings. This study cannot extrapolate the legal activity to other communities, but these communities did not experience a major increase in legal activity. This study cannot predict what might happen should the final build-out conditions not match the assumed build-out conditions used in the models.

The NFIP has provided communities a backbone to regulate floodplain areas. There was agreement that because of the implementation of the NFIP and other watershed programs, they have a foundation on which they can negotiate with developers who do not have the long-range interest in mind. The location and building of a structure is more carefully planned. If a building has the potential to be flooded, extra flood proofing measures have been taken to mitigate the flood hazard. This has allowed for development in higher risk areas, which is beneficial to communities that have little land outside the floodplain. Thus the health and safety of the people in the communities is better protected.

6.1.2 Computational Analysis

Using HAZUS and HAZUS-type methodologies, the computational analysis for this project was accomplished by comparing the results from the 100-year flood for: 1) Current Inventory with Current Flood Conditions; 2) Current Inventory with Future Flood Conditions; and, 3) Anticipated Inventory with Future Flood Conditions.

An obvious observation is that building in the watershed does change the flood conditions and can greatly increase the damage to structures. Increasing the flood conditions will change the design level base flood elevation (BFE) and/or alter the 100-year floodplain. This in turn can expose more buildings, especially existing buildings, to damage. As this study demonstrates the increased damage to buildings can be multiple orders of magnitude depending on the flood conditions. Even in the areas with only minor differences in the flood elevations and subsequent flood depth, estimated savings could easily be in the millions of dollars. This is consistent with the "No Adverse Impact" thinking currently espoused by the Association of State Floodplain Managers.

In Mecklenburg County, for example, the future conditions flooding represents a nearly 440% increase from the existing conditions flooding. Even in Fort Collins (Larimer County), where the increased flooding is relatively minor, the future conditions flooding may result in a 37% increase in flood damages from the 100-year event.

The analysis shows that in most cases, the existing buildings will suffer increasing damage as the watershed is built out unless the floodplain management program includes on site storage.

6.2 Recommendations

The primary recommendation of this study is that communities should be encouraged to manage future conditions of the watershed. As previously mentioned, this study identified two (2) approaches to managing future conditions: 1) managing the watershed to the anticipated 100-year build-out flood conditions; and, 2) attempting to avoid or delay the flood waters from entering the stream system thereby reducing or preventing an increase in the hydrograph. This study is not making a recommendation or distinction between the two (2) approaches; but it does recommend that communities should manage future conditions in the watershed using the approach that best suits their needs.

Below is a brief description of other recommendations suggested by the project team. This list of recommendations is a direct result of the analysis performed for this project. These recommendations will aid in the implementation, maintenance, and enforcement of watershed management programs.

Flood Studies

The project team recommends that detailed flood studies, such as those currently being conducted with the Map Modernization program, should examine multiple return periods besides just the 100-year event. Three (3) return periods (e.g. 50-, 100-, and 500-year) are the minimum necessary to develop a loss curve that can be integrated to estimate the average annual loss. This provides a number of benefits. Current FEMA guidelines and specifications state the FIS's should include 10-, 50-, 100- and 500-year return periods. Most FIS's include those return periods for the existing conditions flooding.

First the community could use the multiple return periods to perform an annualized assessment on their flood areas which leads to an improved picture of the potential benefits and costs associated with their floodplain management strategy. Second, improving people's understanding that the 100-year flood event is simply a line drawn on a map and not a limitation in nature may cause more consumers to consider purchasing flood insurance even if they are outside the regulatory floodplain. Recent events have demonstrated that nature can always surpass the "worst event we ever have experienced" with another storm or flood.

Establishing and Maintaining Flood Maps

Determining how communities can effectively maintain their maps and keep them up to date is crucial to developing an effective management program. Approval of the use of HAZUS at the Level 1[10] analysis for communities that cannot afford detailed flood studies may be a good start to achieving 100% flood mapping throughout the United States. That is, use HAZUS to develop non-engineered floodplains for communities with no flood maps or where flood studies do not exist.

Promote loss estimation along with mapping efforts. Whenever a Draft Flood Insurance Rate Map (DFIRM) has been completed, perform the loss estimation to determine the overall flood risk. Programs such as HAZUS provide an opportunity for the floodplain manager and building and safety officials to present scientifically based information to the elected officials to help them in the decision making process. This was the process used in Mecklenburg County to help generate the political will.

Floodplain Management Programs

The analysis suggests that the "No Adverse Impact" initiative launched by ASFPM and FEMA should continue to be supported with credits in the Community Rating System since these activities are an excellent way to reduce future losses and analysis efforts such as this can assist in promoting such initiatives.

As noted above, loss estimation can help develop political will and can aid public outreach. This is complicated by the fact that capturing the necessary data is a complicated process that takes significant time and resources. It is recommended that FEMA consider encouraging these efforts within the Hazard Mitigation Grant Program (HMGP) or other FEMA mitigation grant activities.

[10] HAZUS allows three levels of analysis. Level 1 uses primarily baseline data provided with the program, Level 2 analysis occurs when users replace the baseline data with improved local data (such as was done in this report), and Level 3 analysis occurs when outside experts are used to modify components such as damage functions, mapping schemes, and other crucial analysis parameters.

The project team believes that the concept of on-site storage may need further research and analysis to demonstrate that the concept not only reduces the 100-year flood losses as seen in this analysis, but that it is effective in reducing the average annual losses. It is recommended that the communities using on-site storage in this project might be given grants to develop sufficient flood data to perform an annualized assessment for their current and future flood conditions. This will allow the communities and FEMA to determine how effective this approach really is.

Data Collection Guidelines

The project team recommends that FEMA develop a guide for local governments to provide outreach and training to local governments discussing potential data sources and data collection activities that can help the community define its overall risk. Assuming the communities in the study are typical, the project team believes there is a large amount of data available in most communities, but much of it is not coordinated, contains inaccuracies, is incomplete, and/or may be difficult to obtain.

These guidelines are necessary to inform communities of the data needs. With this knowledge communities can assess the effort needed to complete this type of work. Without these guidelines communities may underestimate the cost to perform such an effort and may get discouraged as assumptions need to be made.

Further, given the proper guidelines, communities throughout the U.S. could use the tools applied by the project team to determine the most effective floodplain management approach for their community.

Lack of Knowledge

The interviewees felt that lack of knowledge was a major barrier in the implementation of the NFIP and future floodplain condition programs. There are many reasons that this barrier has not been able to be overcome. Below is a sample of the reasons provided by the interviewees:

- Community (elected) officials only stay in office for a few years, so they do not necessarily familiarize themselves with the details of the NFIP.
- Developers only know the regulations of what they can or cannot do when building a structure. They see it as an annoyance because they do not have free reign in their designs and they believe that their engineers do not know what flood proofing is.
- The floodplain managers know all about the NFIP, but they have not been able to completely educate the community, due to what they perceive as a lack of interest.

In order for the project team to define the losses avoided and completely understand the potential impacts and subsequent savings, each community had to obtain additional hydrologic and hydraulic (H & H) modeling assuming that on-site storage would not be effective. Preserving the baseline H & H analysis for built-out conditions could be useful to communities in educating their elected officials, developers, and public regarding the reasoning behind floodplain management for future conditions.

Special Flood Hazard Area (SFHA)

The interviewees believe that the flood insurance maps create a false sense of security amongst the general population caused in part by the line on the map being called the 100-year floodplain (also know as the SFHA). They felt that the public interprets it as the chance of getting flooded once every 100 years. However, this is misleading because they do not understand that the 100-year floodplain is the area that is affected should such a storm occur. Although difficult, the project team recommends using the available tools to educate communities on total flood risk and not just the 100-year flood.

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7. APPENDICES

Appendix 1: Community Data

1.1 DuPage County, Illinois

Date of Incorporation	1833
Population	
County	904,161
Municipalities	
Cities	40
Annual Budget	$632 million
Number of Policy Holders	
FEMA Report	5,335
Site Reports	642
CRS	Not participating

1.2 Escambia County, Florida

Date of Incorporation	March 13, 1824
Population	
City of Pensacola	56,255
County	294,410
Municipalities	
Cities	8
Annual Budget	$350 million
Number of Policy Holders	
FEMA Report	638
Site Reports	647
CRS (County)	7

1.3 Grand Forks County, North Dakota

Date of Incorporation	February 22, 1881
Population	
City of Grand Forks	49,366
County	66,109
Municipalities	
Townships	41
Cities	12
Districts	9
Annual Budget	$133 million
Number of Policy Holders	
FEMA Report	1,917
Site Reports	2,017
CRS (City)	5

1.4 Harris County, Texas

Date of Incorporation	1836
Population	
City of Houston	1,953,631
County	3,400,578
Municipalities	
Cities	38
Annual Budget	$2.623 billion
Number of Policy Holders	
FEMA Report	99,505
Site Reports	98,138
CRS (County)	8

1.5 Larimer County, Colorado

Date of Incorporation	1873
Population	
City of Fort Collins	126,848
County	273,965
Municipalities	9
Annual Budget	$438.4 million
Number of Policy Holders	
FEMA Report	361
Site Reports	361
CRS (City)	4

1.6 Mecklenburg County, North Carolina

Date of Incorporation	December 11, 1762
Population	
City of Charlotte	540,828
County	746,427
Municipalities	
Cities	7
Annual Budget	$1.1 billion
Number of Policy Holders	
FEMA Report	26,509
Site Reports	1,618
CRS (County)	6

Appendix 2: Interview Discussion Guide

I. RESPONDENT-RELATED INFORMATION

A. Respondent's professional background and job position
B. Respondent's self-perceived level of knowledge of NFIP
C. How respondent's job relates to or is part of NFIP

II. COMMUNITY HISTORY

Discuss your knowledge of major flooding in your community, the history and impacts, problematic areas?

III. COMMUNITY IMPACTS OF THE NATIONAL FLOOD INSURANCE PROGRAM

Since your community has enacted ordinances managing flood conditions, discuss your impression of the impacts on land use, development trends, and cost.

IV. FUTURE CONDITIONS PROGRAM IMPLEMENTATION

A. Are you aware of any legal issues that have arisen related to higher level of floodplain regulations?
B. What do you perceive are the benefits of managing to future conditions?
C. What are some of the barriers?

V. BUILDING STANDARDS

A. How well do you think current standards will meet anticipated/future needs in your community?

VI. OVERALL OPINION OF NFIP

A. What do you perceive as the benefits to your community because of NFIP?
B. What do you perceive as barriers to implementing and/or benefiting from NFIP?

Appendix 3: HAZUS®MH Flood Model Distribution Tables

TABLE-1. HAZUS Distribution of Foundation Types for Single Family and Multi-Family Residences

US Census Region	States within the Region	Foundation Types						
		Pile	**Solid Wall**	**Pier/ post**	**Basement/ Garden Level**	**Crawl-space**	**Fill**	**Slab-on-Grade**
Northeast – New England	CT, MA, ME, NH, RI, VT	0	0	0	81	10	0	9
Northeast – Mid Atlantic	NJ, NY, PA	0	0	0	76	10	0	14
Midwest – East North Central	IL, IN, MI, OH, WI	0	0	0	68	21	0	11
Midwest – West North Central	IA, KS, MN, MO, NE, ND, SD	0	0	0	75	13	0	12
South – South Atlantic	DE, DC, FL, GA, MD, NC, SC, VA, WV	0	0	0	23	35	0	42
South – East South Central	AL, KY, MS, TN	0	0	0	25	49	0	26
South – West South Central	AR, LA, OK, TX,	0	0	0	5	38	0	57
West- Mountain	AZ, CO, ID, MT, NV, NM, UT, WY	0	0	0	32	29	0	39
West – Pacific	AK, CA, HI, OR, WA	0	0	0	13	45	0	42

TABLE-2. HAZUS Default Floor Heights Above Grade to Top of Finished Floor (Riverine)

Foundation Type	Pre-Firm	Post-FIRM
Slab	1 ft	1 ft[1]
Fill	2 ft	2 ft
Crawlspace	3 ft	4 ft
Basement (or Garden Level)	4ft	4 ft[1]
Pier (or post and beam)	5 ft	6 ft
Solid Wall	7 ft	8 ft
Pile	7 ft	8 ft

SOURCE: Expert Opinion

Notes:

1 Typically not allowed, but may exist

TABLE-3. HAZUS Default Full Replacement Cost Models (Means, 2002)

HAZUS Occupancy Class Description		Sub-category	Means Model Description (Means Model Number)	Means Cost/SF (2002)
RES1	Single Family Dwelling	See Table 14.2	SFR Avg 1 story 1,600 SF	$79.88
RES2	Manufactured Housing	Manufactured Housing	Manufactured Housing (N/A)[1]	$30.90
RES3	Multi Family Dwelling – small	Duplex	SFR Avg 2 St., MF adj, 3000 SF	$67.24
		Triplex/Quads	SFR Avg 2 St., MF adj, 3000 SF	$73.08
	Multi Family Dwelling – medium	5-9 units	Apt, 1-3 st, 8,000 SF (M.010)	$125.63
		10-19 units	Apt., 1-3 st., 12,000 SF (M.010)	$112.73
	Multi Family Dwelling – large	20-49 units	Apt., 4-7 st., 40,000 SF (M.020)	$108.86
		50+ units	Apt., 4-7 st., 60,000 SF (M.020)	$106.13
			Apt., 8-24 st., *145,000 SF* (M.030)	$111.69
RES4	Temp. Lodging	Hotel, medium	Hotel, 4-7 st., 135,000 SF(M.350)	$104.63
		Hotel, large	Hotel, 8-24 st., 450,000 SF (M.360)	$93.47
		Motel, small	Motel, 1 st., 8,000 SF (M.420)	$94.13
		Motel, medium	Motel, 2-3 st., *49,000 SF* (M.430)	$110.03
RES5	Institutional Dormitory	Dorm, medium	College Dorm, 2-3 st, *25,000 SF* (M.130)	$118.82
		Dorm, large	College Dorm, 4-8 st, *85,000 SF* (M.140)	$113.31
		Dorm, small	Frat House, 2 st., 10,000 SF (M.240)	$99.50
RES6	Nursing Home	Nursing home	Nursing Home, 2 st., 25,000 SF (M.450)	$104.62
COM1	Retail Trade	Dept Store, 1 st	Store, Dept., 1 st., 110,000 SF (M.610)	$71.54
		Dept Store, 3 st	Store, Dept., 3 st., 95,000 SF (M.620)	$88.73
		Store, small	Store, retail, 8,000 SF (M.630)	$79.23
		Store, medium	Supermarket, *44,000 SF* (M.640)	$69.09
		Store, convenience	Store, Convenience, 4,000 SF (M.600)	$83.59
		Auto Sales	Garage, Auto Sales, 21,000 SF (M.260)	$70.84
COM2	Wholesale Trade	Warehouse, medium	Warehouse, 30,000 SF (M.690)	$61.91
		Warehouse, large	Warehouse, 60,000 SF (M.690)	$56.58
		Warehouse, small	Warehouse, 15,000 SF (M.690)	$70.43
COM3	Personal and Repair Services	Garage, Repair	Garage, Repair, *10,000 SF* (M.290)	$86.81
		Garage, Service sta.	Garage, Service sta., 1,400 SF (M.300)	$113.91
		Funeral Home	Funeral home, 10,000 SF (M.250)	$97.66
		Laundromat	Laundromat 3,000 SF (M.380)	$135.64
		Car Wash	Car Wash, 1 st., 800 SF (M.080)	$198.28
COM4	Prof./ Tech./Business Services	Office, Medium	Office, 5-10 st., *80,000 SF* (M.470)	$98.96
		Office, Small	Office, 2-4 st., *20,000 SF* (M.460)	$102.69
		Office, Large	Office, 11-20 st., *260,000 SF* (M.480)	$88.21
COM5	Banks	Bank	Bank, 1 st., 4100 SF (M.050)	$153.97

TABLE-3 (Continued). HAZUS Default Full Replacement Cost Models (Means, 2002)

HAZUS Occupancy Class Description		Sub-category	Means Model Description (Means Model Number)	Means Cost/SF (2002)
COM6	Hospital	Hospital, Medium	Hospital, 2-3 st., 55,000 SF (M.330)	$144.60
		Hospital, Large	Hospital, 4-8 st., 200,000 SF (M.340)	$125.60
COM7	Medical Office/Clinic	Med. Office, medium	Medical office, 2 st., 7,000 SF (M.410)	$129.82
		Med. Office, small	Medical office, 1 st., 7,000 SF (M.400)	$118.01
COM8	Entertainment & Recreation	Restaurant	Restaurant, 1 st., 5,000 SF (M.530)	$137.02
		Restaurant, Fast food	Restaurant, fast food, 4,000 SF (M.540)	$121.49
		Bowling Alley	Bowling Alley, 20,000 SF (M.060)	$72.31
		Country Club	Club, Country, 1 st., 6,000 SF (M.100)	$135.23
		Social Club	Club, Social, 1 st., 22,000 SF (M.110)	$95.39
		Racquetball Court	Racquetball Court, 30,000 SF (M.510)	$111.23
		Hockey Rink	Hockey Rink 30,000 SF (M.550)	$115.13
COM9	Theaters	Movie Theatre	Movie Theatre, 12,000 SF (M.440)	$102.35
		Auditorium	Auditorium, 1 st., 24,000 SF (M.040)	$109.60
COM10	Parking	Parking Garage	Garage, Pkg, 5 st., 145,000 SF (M.270)	$34.78
		Parking Garage, Underground	Garage, UG Pkg, 100,000 SF (M.280)	$49.20
IND1	Heavy	Factory, small	Factory, 1 st., 30,000 SF (M.200)	$73.82
		Factory, large	Factory, 3 st., 90,000 SF (M.210)	$78.61
IND2	Light	Warehouse, medium	Warehouse, 30,000 SF (M.690)	$61.91
		Factory, small	Factory, 1 st., 30,000 SF (M.200)	$73.82
		Factory, large	Factory, 3 st., 90,000 SF (M.210)	$78.61
IND3	Food/Drugs/Chemicals	College Laboratory	College Lab, 1 st., 45,000 SF (M.150)	$119.51
		Factory, small	Factory, 1 st., 30,000 SF (M.200)	$73.82
		Factory, large	Factory, 3 st., 90,000 SF (M.210)	$78.61
IND4	Metals/Minerals Processing	College Laboratory	College Lab, 1 st., 45,000 SF (M.150)	$119.51
		Factory, small	Factory, 1 st., 30,000 SF (M.200)	$73.82
		Factory, large	Factory, 3 st., 90,000 SF (M.210)	$78.61
IND5	High Technology	College Laboratory	College Lab, 1 st., 45,000 SF (M.150)	$119.51
		Factory, small	Factory, 1 st., 30,000 SF (M.200)	$73.82
		Factory, large	Factory, 3 st., 90,000 SF (M.210)	$78.61
IND6	Construction	Warehouse, medium	Warehouse, 30,000 SF (M.690)	$61.91
		Warehouse, large	Warehouse, 60,000 SF (M.690)	$56.58
		Warehouse, small	Warehouse, 15,000 SF (M.690)	$70.43
AGR1	Agriculture	Warehouse, medium	Warehouse, 30,000 SF (M.690)	$61.91
		Warehouse, large	Warehouse, 60,000 SF (M.690)	$56.58
		Warehouse, small	Warehouse, 15,000 SF (M.690)	$70.43
REL1	Church	Church	Church, 1 st., 17,000 SF (M.090)	$114.08

TABLE-3 (Continued). HAZUS Default Full Replacement Cost Models (Means, 2002)

HAZUS Occupancy Class Description		Sub-category	Means Model Description (Means Model Number)	Means Cost/SF (2002)
GOV1	General Services	Town Hall, small	Town Hall, 1 st., 11,000 SF (M.670)	$90.30
		Town Hall, medium	Town Hall, 2-3 st., 18,000 SF (M.680)	$112.94
		Courthouse, small	Courthouse, 1 st., 30,000 SF (M.180)	$130.71
		Courthouse, medium	Courthouse, 2-3 st., 60,000 SF (M.190)	$136.81
		Post Office	Post Office, 13,000 SF (M.500)	$86.83
GOV2	Emergency Response	Police Station	Police Station, 2 st., 11,000 SF (M.490)	$136.10
		Fire Station, small	Fire Station, 1 st., 6,000 SF (M.220)	$105.53
		Fire Station, medium	Fire Station, 2 st., 10,000 SF (M.230)	$110.34
EDU1	Schools/Libraries	High School	School, High, 130,000 SF (M.570)	$92.80
		Elementary School	School, Elementary, 45,000 SF (M.560)	$90.22
		Jr. High School	School, Jr. High, 110,000 SF (M.580)	$95.21
		Library	Library, 2 st., 22,000 SF (M.390)	$103.94
		Religious School	Religious Educ, 1 st., 10,000 SF (M.520)	$112.19
EDU2	Colleges/Universities	College Classroom	College Class. 2-3 st, *50,000 SF* (M.120)	$114.68
		College Laboratory	College Lab, 1 st., 45,000 SF (M.150)	$119.51
		Vocational school	School, Vocational, 40,000 SF (M.590)	$93.96

Notes:

1 Manufactured Housing Institute, 2000 cost for new manufactured home

TABLE-4. Default HAZUS Contents Value Percent of Structure Value

No.	Label	Occupancy Class	Contents Value (%)
		Residential	
1	RES1	Single Family Dwelling	50
2	RES2	Mobile Home	50
3	RES3	Multi Family Dwelling	50
4	RES4	Temporary Lodging	50
5	RES5	Institutional Dormitory	50
6	RES6	Nursing Home	50
		Commercial	
7	COM1	Retail Trade	100
8	COM2	Wholesale Trade	100
9	COM3	Personal and Repair Services	100
10	COM4	Professional/Technical/ Business Services	100
11	COM5	Banks	100
12	COM6	Hospital	150
13	COM7	Medical Office/Clinic	150
14	COM8	Entertainment & Recreation	100
15	COM9	Theaters	100
16	COM10	Parking	50
		Industrial	
17	IND1	Heavy	150
18	IND2	Light	150
19	IND3	Food/Drugs/Chemicals	150
20	IND4	Metals/Minerals Processing	150
21	IND5	High Technology	150
22	IND6	Construction	100
		Agriculture	
23	AGR1	Agriculture	100
		Religion/Non/Profit	
24	REL1	Church/Membership Organization	100
		Government	
25	GOV1	General Services	100
26	GOV2	Emergency Response	150
		Education	
27	EDU1	Schools/Libraries	100
28	EDU2	Colleges/Universities	150

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8. DATA DICTIONARY

8.1 Inventory Data

DuPage County, Illinois

Field	Source	Format	Description	Used in Analysis (Y or N)
PARCEL_	Boundary Solutions Inc.	Number	Parcel Number	N
PARCEL_ID	Boundary Solutions Inc.	Number	Parcel Number	N
PIN	Boundary Solutions Inc.	Number	Parcel Identification Number	Y – UDEF
MUNZCODE	Boundary Solutions Inc.	Number	Municipal Code	N
USE00	Boundary Solutions Inc.	Number	Land Use Code	Y – UDEF
LUP97	Boundary Solutions Inc.	Number	Land Use Plan 97	Y – UDEF
ACRES	Boundary Solutions Inc.	Number	Parcel Acreage	Y – UDEF
BILLNAME	Boundary Solutions Inc.	Text	Billing data	Y – UDEF
BILLSTNUM	Boundary Solutions Inc.	Text	Billing data	Y – UDEF
BILLSTDIR	Boundary Solutions Inc.	Text	Billing data	Y – UDEF
BILLSTNAME	Boundary Solutions Inc.	Text	Billing data	Y – UDEF
BILLAPT	Boundary Solutions Inc.	Text	Billing data	Y – UDEF
BILLCITY	Boundary Solutions Inc.	Text	Billing data	Y – UDEF
BILLSTATE	Boundary Solutions Inc.	Text	Billing data	Y – UDEF
BILLZIP	Boundary Solutions Inc.	Text	Billing data	Y – UDEF
PROPNAME	Boundary Solutions Inc.	Text	Property data	N
PROPSTNUM	Boundary Solutions Inc.	Text	Property data	N

Field	Source	Format	Description	Used in Analysis (Y or N)
PROPSTDIR	Boundary Solutions Inc.	Text	Property data	N
PROPSTNAME	Boundary Solutions Inc.	Text	Property data	N
PROPAPT	Boundary Solutions Inc.	Text	Property data	N
PROPCITY	Boundary Solutions Inc.	Text	Property data	N
PROPZIP	Boundary Solutions Inc.	Text	Property data	N
BILLVALUE	Boundary Solutions Inc.	Number	Bill Value	N
TAXAMOUNT	Boundary Solutions Inc.	Number	Tax Amount	N
FCVLAND	Boundary Solutions Inc.	Number	2005 fair-cash assessed value of land	N
FCVIMP	Boundary Solutions Inc.	Number	2005 fair-cash assessed value of improvements	Y – UDEF
FCVTOTAL	Boundary Solutions Inc.	Number	2005 fair-cash assessed value of land and improvements	N
TAXCODE	Boundary Solutions Inc.	Text	Tax Identification Number	N
EXEMPTCODE	Boundary Solutions Inc.	Text	Exempt Code	N
PROPCLASS	Boundary Solutions Inc.	Text	Class of Property Tax	N
X_COORD	Boundary Solutions Inc.	Number	X-Coordinate	Y – UDEF
Y_COORD	Boundary Solutions Inc.	Number	Y-Coordinate	Y – UDEF

Escambia County, Florida

Field	Source	Format	Description	Used in Analysis (Y or N)
AREA	Boundary Solutions Inc.	Number	Area of Parcel	Y – UDEF
PERIMETER	Boundary Solutions Inc.	Number	Perimeter of Parcel	N
PARCEL_	Boundary Solutions Inc.	Number	Parcel	N
PARCEL_ID	Boundary Solutions Inc.	Number	Parcel Identification	N
PARCEL_NUM	Boundary Solutions Inc.	Text	Parcel Identification Number	N
APN	Boundary Solutions Inc.	Text	Parcel Identification Number	N
ACCOUNT	Boundary Solutions Inc.	Number	Account	N
LOCATION	Boundary Solutions Inc.	Text	Property data	Y – UDEF
NAME1	Boundary Solutions Inc.	Text	Billing data	Y – UDEF
NAME2	Boundary Solutions Inc.	Text	Billing data	Y – UDEF
NAME3	Boundary Solutions Inc.	Text	Billing data	Y – UDEF
NAME4	Boundary Solutions Inc.	Text	Billing data	Y – UDEF
NAME5	Boundary Solutions Inc.	Text	Billing data	Y – UDEF
NAME6	Boundary Solutions Inc.	Text	Billing data	Y – UDEF
ZIPCODE	Boundary Solutions Inc.	Text	Billing data	Y – UDEF
LEGAL1	Boundary Solutions Inc.	Text	Property data	N
LEGAL2	Boundary Solutions Inc.	Text	Property data	N
LEGAL3	Boundary Solutions Inc.	Text	Property data	N

Field	Source	Format	Description	Used in Analysis (Y or N)
LEGAL4	Boundary Solutions Inc.	Text	Property data	N
LEGAL5	Boundary Solutions Inc.	Text	Property data	N
LEGAL6	Boundary Solutions Inc.	Text	Property data	N
CITY_CODE	Boundary Solutions Inc.	Text	City Code	N
USE_CODE	Boundary Solutions Inc.	Text	Land Use Code	Y – UDEF
TOTAL_ASSM	Boundary Solutions Inc.	Number	Assessed Value of Building and Land	N
BUILDING_A	Boundary Solutions Inc.	Number	Assessed Building Value	Y – UDEF
LAND_ASSMN	Boundary Solutions Inc.	Number	Assessed Land Value	N
SALEMONTH	Boundary Solutions Inc.	Number	Month of Sale	N
SALEYEAR	Boundary Solutions Inc.	Number	Year of Sale	N
SALEPRICE	Boundary Solutions Inc.	Number	Price of Sale	N
ACTUAL_YEA	Boundary Solutions Inc.	Number	Year Built	Y – UDEF
EFFECTIVE_	Boundary Solutions Inc.	Number	Year Sold	Y – UDEF
BATH_COUNT	Boundary Solutions Inc.	Number	Number of Bathrooms	N
BEDROOM_CO	Boundary Solutions Inc.	Number	Number of Bedrooms	N
ROOM_COUNT	Boundary Solutions Inc.	Number	Number of Rooms	N
NUMBER_STO	Boundary Solutions Inc.	Number	Number of Stories	Y – UDEF
NOTE1	Boundary Solutions Inc.	Text	Misc. data	N
NOTE2	Boundary Solutions Inc.	Text	Misc. data	N

Field	Source	Format	Description	Used in Analysis (Y or N)
NOTE3	Boundary Solutions Inc.	Text	Misc. data	N
NOTE4	Boundary Solutions Inc.	Text	Misc. data	N
NOTE5	Boundary Solutions Inc.	Text	Misc. data	N
NOTE6	Boundary Solutions Inc.	Text	Misc. data	N

Grand Forks County, North Dakota

Field	Source	Format	Description	Used in Analysis (Y or N)
AREA	Boundary Solutions Inc.	Number	Area of Parcel	Y – UDEF
PERIMETER	Boundary Solutions Inc.	Number	Perimeter of Parcel	N
PIN	Boundary Solutions Inc.	Text	Parcel Identification Number	N
PARCEL	Boundary Solutions Inc.	Text	Parcel Number	N
ASSESSOR	Boundary Solutions Inc.	Text	Assessor	N
PCODE2	Boundary Solutions Inc.	Text	Parcel Number	N
BASE_ZONIN	Boundary Solutions Inc.	Text	Base Zoning	N
ZONING_TEX	Boundary Solutions Inc.	Text	Zoning Description	N
LANDUSE_CO	Boundary Solutions Inc.	Number	Land Use Code	Y – UDEF
LU_DESIGNA	Boundary Solutions Inc.	Text	Land Use Designation	Y – UDEF
APN	Boundary Solutions Inc.	Text	Parcel Identification Number	N
HOUSE	Boundary Solutions Inc.	Text	Property Data	Y – UDEF
STREET	Boundary Solutions Inc.	Text	Property Data	Y – UDEF
MISC	Boundary Solutions Inc.	Text	Property Data	Y – UDEF
YEARBLT	Boundary Solutions Inc.	Text	Year Built	Y – UDEF
AREA_1	Boundary Solutions Inc.	Text	Square Footage of Building	Y – UDEF
HEIGHT	Boundary Solutions Inc.	Text	Number of Stories	Y – UDEF
CONST	Boundary Solutions Inc.	Text	Construction Type	Y – UDEF

Harris County, Texas

Field	Source	Format	Description	Used in Analysis (Y or N)
AREA	Boundary Solutions Inc.	Number	Area of Parcel	Y - UDEF
PERIMETER	Boundary Solutions Inc.	Number	Perimeter of Parcel	N
PARCEL_	Boundary Solutions Inc.	Number	Parcel	N
PARCEL_ID	Boundary Solutions Inc.	Number	Parcel Identification	N
HCAD_NUM	Boundary Solutions Inc.	Text	HCAD Account Number	N
HCAD_ACCOU	Boundary Solutions Inc.	Text	HCAD Account Number	N
REGION_NUM	Boundary Solutions Inc.	Text	Region Number	N
PARCEL_I_1	Boundary Solutions Inc.	Text		N
TAX_YEAR	Boundary Solutions Inc.	Number	Tax Year	N
OWNER_NAME	Boundary Solutions Inc.	Text	Billing Data	Y – UDEF
OWNER_MAIL	Boundary Solutions Inc.	Text	Billing Data	Y – UDEF
OWNER_MA_1	Boundary Solutions Inc.	Text	Billing Data	Y – UDEF
OWNER_MA_2	Boundary Solutions Inc.	Text	Billing Data	Y – UDEF
MAIL_CITY_	Boundary Solutions Inc.	Text	Billing Data	Y – UDEF
MAIL_ZIP_C	Boundary Solutions Inc.	Text	Billing Data	Y – UDEF
MAIL_ZIP_1	Boundary Solutions Inc.	Text	Billing Data	Y - UDEF
OWNER_PUR_	Boundary Solutions Inc.	Number	Owner Purchasing	N
OWNER_PUR1	Boundary Solutions Inc.	Number	Owner Purchasing (Owner 2)	N
OWNER_PU_1	Boundary Solutions Inc.	Number	Owner Purchasing (Owner 1)	N

Field	Source	Format	Description	Used in Analysis (Y or N)
PROPERTY_D	Boundary Solutions Inc.	Text	Property Data	N
PROPERTY_1	Boundary Solutions Inc.	Text	Property Data	N
PROPERTY_2	Boundary Solutions Inc.	Text	Property Data	N
PROPERTY_3	Boundary Solutions Inc.	Text	Property Data	N
PROPERTY_R	Boundary Solutions Inc.	Text	Property Data	N
ACREAGE	Boundary Solutions Inc.	Number	Acreage of Parcel	N
CURRENT_LA	Boundary Solutions Inc.	Number	Current Land Value	N
CURRENT_IM	Boundary Solutions Inc.	Number	Current Improvement Value	N
CURRENT_PR	Boundary Solutions Inc.	Number	Current Market Price	N
PREVIOUS_L	Boundary Solutions Inc.	Number	Previous Land Value	N
PREVIOUS_I	Boundary Solutions Inc.	Number	Previous Improvement Value	N
PREVIOUS_P	Boundary Solutions Inc.	Number	Previous Market Price	N
PRODUCTIVI	Boundary Solutions Inc.	Text	Productivity	N
STATE_REPO	Boundary Solutions Inc.	Text	State Report	N
EXEMPTION_	Boundary Solutions Inc.	Text	Exemption	N
VET_DISABI	Boundary Solutions Inc.	Number	Veteran’s Disability Code	N
VET_DISA_1	Boundary Solutions Inc.	Number	Veteran’s Disability Code	N
AGENT_CODE	Boundary Solutions Inc.	Text	Agent Code	N
AGENT_ADDR	Boundary Solutions Inc.	Text	Agent Data	N

Field	Source	Format	Description	Used in Analysis (Y or N)
AGENT_AD_1	Boundary Solutions Inc.	Text	Agent Data	N
AGENT_AD_2	Boundary Solutions Inc.	Text	Agent Data	N
AGENT_AD_3	Boundary Solutions Inc.	Text	Agent Data	N
AGENT_CITY	Boundary Solutions Inc.	Text	Agent Data	N
AGENT_ZIP_	Boundary Solutions Inc.	Text	Agent Data	N
AGENT_ZIP1	Boundary Solutions Inc.	Text	Agent Data	N
AGENT_TEL_	Boundary Solutions Inc.	Text	Agent Data	N
AGENT_TEL1	Boundary Solutions Inc.	Text	Agent Data	N
LOCATION_S	Boundary Solutions Inc.	Text	Property Data	N
LOCATION_1	Boundary Solutions Inc.	Text	Property Data	N
LOCATION_C	Boundary Solutions Inc.	Text	Property Data	N
LOCATION_Z	Boundary Solutions Inc.	Text	Property Data	N
LOCATION_2	Boundary Solutions Inc.	Text	Property Data	N
MAP_FACET	Boundary Solutions Inc.	Text	Map Grid Location	N
PARCEL_KEY	Boundary Solutions Inc.	Text	Parcel Key	N
STORY_HEIG	Boundary Solutions Inc.	Text	Number of Stories	Y – UDEF
BLD_YEAR_B	Boundary Solutions Inc.	Text	Year Built	Y – UDEF
CAMA_Commo	Boundary Solutions Inc.	Text	(same as Parcel_I_1)	N
BLDG_SQFT	Boundary Solutions Inc.	Text	Building Square Footage	Y – UDEF

Field	Source	Format	Description	Used in Analysis (Y or N)
TOT_LAND_V	Boundary Solutions Inc.	Text	Total Land Value	N
TOT_IMPR_V	Boundary Solutions Inc.	Text	Total Improvement Value	Y – UDEF
FIN_VAL	Boundary Solutions Inc.	Text	Total Value of Land and Improvement	N
VALUE_TYPE	Boundary Solutions Inc.	Text	Value Type	N
LAND_USE	Boundary Solutions Inc.	Text	Land Use Code	Y – UDEF
STREET_NO	Boundary Solutions Inc.	Text	Property Data	N
STREET_DIR	Boundary Solutions Inc.	Text	Property Data	N
STREET_NAM	Boundary Solutions Inc.	Text	Property Data	N
CAMA_Resid	Boundary Solutions Inc.	Text	(same as Parcel_I_1)	N
STORY_HE_1	Boundary Solutions Inc.	Text	Number of Stories	Y - UDEF
STYLE	Boundary Solutions Inc.	Text	Style	N
EXTERIOR_W	Boundary Solutions Inc.	Text	Exterior Wall	N
DATE_ERECT	Boundary Solutions Inc.	Text	Date Building Erected	N
SALE_YEAR_	Boundary Solutions Inc.	Text	Sale Year	N
SALE_TYPE_	Boundary Solutions Inc.	Text	Sale Type	N
SALE_PRICE	Boundary Solutions Inc.	Text	Sale Price	N
SALE_YEAR1	Boundary Solutions Inc.	Text	Sale Year (Owner 2)	N
SALE_TYPE1	Boundary Solutions Inc.	Text	Sale Type (Owner 2)	N
SALE_PRI_1	Boundary Solutions Inc.	Text	Sale Price (Owner 2)	N

Field	Source	Format	Description	Used in Analysis (Y or N)
SALE_YEA_1	Boundary Solutions Inc.	Text	Sale Year (Owner 1)	N
SALE_TYP_1	Boundary Solutions Inc.	Text	Sale Type (Owner 1)	N
SALE_PRI_2	Boundary Solutions Inc.	Text	Sale Price (Owner 1)	N
HAZUSOCCUP	Boundary Solutions Inc.	Text	HAZUS Occupancy Code	Y - UDEF

Larimer County, Colorado

Field	Source	Format	Description	Used in Analysis (Y or N)
LINK_ID	County	Number	Link Identification	N
PARCELNO	County	Text	Parcel Number	
APN	County	Text	Parcel Number	
PARCELNB	County	Number	Parcel Number	
ACCOUNTNO	County	Text	Account Number	N
SCHEDULENU	County	Number	Schedule Number	N
IMPACTUALV	County	Number	Improvement Actual Value	Y – UDEF
BLDGID	County	Number	Building Identification Number	N
PROPTYPE	County	Text	Property Type	N
OCCCODE	County	Number	Occupancy Code	Y – UDEF
OCCDESCR	County	Text	Occupancy Description	Y – UDEF
BLTASID	County	Number	Built As Identification	N
BLTASDESCR	County	Text	Built As Description	N
SF	County	Number	Square Footage	Y – UDEF
CONDOSF	County	Number	Condo Square Footage	N
BSMNTSF	County	Number	Basement Square Footage	N
BSMNTSFFIN	County	Number	Basement Finished Square Footage	N
GARAGESF	County	Number	Garage Square Footage	N
CARPORTSF	County	Number	Carport Square Footage	N
BALCONYSF	County	Number	Balcony Square Footage	N
PORCHSF	County	Number	Porch Square Footage	N
PERIM	County	Number	Perimeter	N
PERCCOMP	County	Number	Percent Complete	N
CONDITION	County	Text	Condition	N
QUALITY	County	Text	Quality	N

Field	Source	Format	Description	Used in Analysis (Y or N)
HVACID	County	Number	HVAC Identification	N
HVACDESCR	County	Text	HVAC Description	N
EXTERIOR	County	Text	Exterior	N
INTERIOR	County	Text	Interior	N
UNITTYPE	County	Text	Unit Type	N
STORIES	County	Number	Number of Stories	Y – UDEF
SPRINKLERS	County	Number	Sprinkler Square Footage	N
ROOFTYPE	County	Text	Roof Type	N
ROOFCOVER	County	Text	Roof Cover	N
FLOORCOVER	County	Text	Floor Cover	N
FOUNDATION	County	Text	Foundation	Y – UDEF
ROOMS	County	Number	Number of Rooms	N
BEDROOMS	County	Number	Number of Bedrooms	N
BATHS	County	Number	Number of Baths	N
UNITS	County	Number	Number of Units	N
CLASSID	County	Text	Class Identification	Y – UDEF
CLASSDESCR	County	Text	Class Description	Y – UDEF
YRBLT	County	Number	Year Built	Y – UDEF
YRREM	County	Number	Year Remodeled	N
PERCREM	County	Number	Percent Remodeled	N
ADJYRBLT	County	Number	Adjusted Year Built	N
AGE	County	Number	Age	N
MHTITLENO	County	Text	Mobile Home Title Number	N
MHSERIALNO	County	Text	Mobile Home Serial Number	N
MHLENGTH	County	Number	Mobile Home Length	N
MHWIDTH	County	Number	Mobile Home Width	N
MHMAKE	County	Text	Mobile Home Make	N

Mecklenburg County, North Carolina

Field	Source	Format	Description	Used in Analysis (Y or N)
PID	County	Text	Parcel Identification	Y – UDEF
ALPHA_EXT	County	Text	Alpha Extension	N
CARD_NO	County	Text	Card Number	N
USE_CODE	County	Text	Use Code	Y – UDEF
STYLE	County	Text	Style	N
MODEL	County	Text	Model	N
HEATED_ARE	County	Number	Heated Area	N
EFFECTIVE_	County	Number	Effective Area	N
YEAR_BUILT	County	Number	Year Built	Y – UDEF
BEDROOMS	County	Number	Number of Bedrooms	N
BATHROOMS	County	Number	Number of Bathrooms	N
RESTROOMS	County	Number	Number of Restrooms	N
BASEMENT	County	Text	Basement	N
GARAGE	County	Text	Garage	N
FIREPLACE	County	Text	Fireplace	N
AC	County	Text	Air Conditioning	N
EXT_WALL	County	Text	Exterior Wall	N
HEATING_TY	County	Text	Heating Type	N
NET_BLDG_V	County	Number	Total Building Value	N
NET_OBXF_V	County	Number	Total Out Building Value	N
UNITS	County	Number	Number of Units	N
QUALITY	County	Number	Quality	N
MRK_DESIGN	County	Number	Market Design	N
ABLDG_KEY	County	Text	Building Identification	N
PID_EXT	County	Text	Parcel Identification	Y – UDEF
OWNER_NAME	County	Text	Billing Data	Y – UDEF
NAME_OVERF	County	Text	Billing Data	Y – UDEF

Field	Source	Format	Description	Used in Analysis (Y or N)
MAILADDR1	County	Text	Billing Data	Y – UDEF
MAILADDR2	County	Text	Billing Data	Y – UDEF
CITY	County	Text	Billing Data	Y – UDEF
STATE	County	Text	Billing Data	Y – UDEF
ZIP_CODE	County	Text	Billing Data	Y – UDEF
PERCENT_IN	County	Number	Billing Data	N
CAMA_ACREA	County	Number	Parcel Acreage	N
LEGAL_ACRE	County	Number	Legal Acreage	Y – UDEF
CAMA_ACRE_	County	Text	Parcel Acreage Description	N
LGLACSRC	County	Text	Legal Acreage	N
LEGAL_DESC	County	Text	Legal Description	N
ACCOUNT_TY	County	Text	Account Type	N
FARM_FLAG	County	Text	Farm Flag	N
HIST_FLAG	County	Text	Historical Flag	N
MUNIC_CODE	County	Text	Municipality Code	N
TOWNSHIP	County	Text	Township Code	N
FIRE_DIST	County	Text	Fire District	N
SP_DIST	County	Text	Special District	N
DEED_BOOK	County	Text	Deed Book	N
DEED_PAGE	County	Text	Deed Page	N
FILE_DATE	County	Date/Time	File Date	N
QUALIFIED_	County	Text	Qualified	N
SALES_PRIC	County	Number	Sales Price	N
SALE_DATE	County	Date/Time	Sale Date	N
HOUSE_NO	County	Text	Property Data	N
HOUSE_NO_num	County	Number	Property Data	N
HOUSE_UNIT	County	Text	Property Data	N
HOUSEUNDES	County	Text	Property Data	N
ST_DIR	County	Text	Property Data	N
ST_NAME	County	Text	Property Data	N
ST_TYPE	County	Text	Property Data	N
ST_SUFFIX	County	Text	Property Data	N

Field	Source	Format	Description	Used in Analysis (Y or N)
NEIGHBORHO	County	Text	Property Data	N
NEIGHBRHD_	County	Text	Property Data	N
USE_CODE_T	County	Text	Use Code	Y – UDEF
AC_TYPE	County	Text	Air Conditioning Type	N
EXT_WALL_T	County	Text	Exterior Wall Type	N
FIREPLACE	County	Text	Fireplace	N
HEATINGTYP	County	Text	Heating Type	N
MODEL_TYPE	County	Text	Model Type	N
STYLE_TYPE	County	Text	Number of Stories	Y – UDEF
MUNIC	County	Text	Municipality	N
NEWPID	County	Text	New Parcel Identification	N
ZONING	County	Text	Zoning	N
LAND_VALUE	County	Number	Land Value	N
DEF_VALUE	County	Number	Unknown	N
TOT_IMP_VA	County	Number	Total Improvement Value	Y – UDEF
TOT_MRK_VA	County	Number	Total Market Value	N
SALES98	County	Number	Sales 98	N

8.2 Hazard Data

DuPage County, Illinois

Name of the file	Source	Format	Feature Class Type	Description	Used?
98MrSID_County27	County	MrSID		1998 Dupage County, IL 0.5 pixel res, Ortho imagery - MrSID - NAD27	No
03MrSID_County27.sid	County	MrSID		2002_2003 Dupage county, IL, 0.5 pix, Orthoimagery - MrSID NAD27	No
cs_af_grad_y.e00	County	Interchange		1 story masonry commercial building finished floor plan	No
cs_gk_grad_y.e00	County	Interchange		Grading and erosion control plan	No
cs_gke_grad_y.e00	County	Interchange		Grading and erosion control plan	No
cs_gks_grad_y.e00	County	Interchange		Grading and erosion control plan	No
cs_gla_grad_y.e00	County	Interchange		Grading and erosion control plan	No
cs_ip_grad_y.e00	County	Interchange		Grading and erosion control plan	No
cs_kcbus_y.e00	County	Interchange		Grading plan	No
cs_ke_det_y.e00	County	Interchange		Pond elevations overflow cross sections 450 kchoc boulevard, Carol stream, Illinois	No
cs_nh_topo_y.e00	County	Interchange		Topology	No
cs_rand_y.e00	County	Interchange			No
cs_satdet_y.e00	County	Interchange		Building floor elevation	No
cs_sf_grad_y.e00	County	Interchange		Building floor plan	No
cs_shire_y.e00	County	Interchange			No
cs_tc_grad_y.e00	County	Interchange		Village of Carol stream	No
hydrocl.e00	County	Interchange		Stream network	No
lclrdan_blm.e00	County	Interchange		Street names	No
lclrdan_mil.e00	County	Interchange		Street names	No
lclrdan_way.e00	County	Interchange		Street names	No
lclrdan_win.e00	County	Interchange		Street names	No
lomc_ud_xtnts.e00	County	Interchange			No
munic04.e00	County	Interchange		Municipality – Towns	No
topo_ud_xtnts.e00	County	Interchange		Municipality - Places	No
wbkc_1b.e00	County	Interchange		Riverine cross sections	Yes – FIT data
wbkc_2b.e00	County	Interchange		Riverine cross sections	Yes - FIT data

Name of the file	Source	Format	Feature Class Type	Description	Used?
wbkc_3b.e00	County	Interchange		Riverine cross sections	Yes - FIT data
wbkc_5b.e00	County	Interchange		Riverine cross sections	Yes - FIT data
wbkc_6b.e00	County	Interchange		Riverine cross sections	Yes - FIT data
wbkc_bdy.e00	County	Interchange		Riverine area buffer region	Yes - Reference
wbkc_c100_rfm.e00	County	Interchange		Riverine cross sections	Yes - Reference
wbkc_fw_rfm.e00	County	Interchange		Riverine mainstream polygon	No
wbkc_m100_rfm.e00	County	Interchange		Riverine cross sections	Yes – Reference
wbkc_p100_rfm.e00	County	Interchange		Riverine stream polygon	Yes – Reference
wbkc_p500_rfm.e00	County	Interchange		Riverine stream polygon	Yes - Reference
wbkc_rte.e00	County	Interchange		Riverine stream network	Yes – Reference
wbkc_topo.e00	County	Interchange		Topology	Yes – Reference
wbkc_xs_rfm.e00	County	Interchange		Riverine cross sections	Yes – Reference
wtrsheds.e00	County	Interchange		Watersheds polygon	No
lclrdln_blm_shp	County	Shapefile	Polygon	Streets name	No
lclrdln_mil_shp	County	Shapefile	Polygon	Streets name	No
lclrdln_way_shp	County	Shapefile	Polygon	Streets name	No
lclrdln_win_shp	County	Shapefile	Polygon	Streets name	No
pclpy_blm_shp	County	Shapefile	Polygon	Parcels	Yes - Presentation layer/ Centroid of parcel
pclpy_mil_shp	County	Shapefile	Polygon	Parcels	Yes - Presentation layer/ Centroid of parcel
pclpy_way_shp	County	Shapefile	Polygon	Parcels	Yes - Presentation layer/ Centroid of parcel
pclpy_win_shp	County	Shapefile	Polygon	Parcels	Yes - Presentation layer/ Centroid of parcel
Klein creek DEM	County	DEM		Klein creek DEM	No

Escambia County, Florida

Name of the file	Source	Format	Feature Class Type	Description	Used?
County.shp	County	Shapefile	Polygon	County	No
Parcels.shp	County	Shapefile	Polygon	Parcels	Yes - Presentation layer/ Centroid of parcel
Roads.shp	County	Shapefile	Polyline	Roads	No

Grand Forks County, North Dakota

Name of the file	Source	Format	Feature Class Type	Description	Used?
County.shp	County	Shapefile	Polygon	County	No
Parcels.shp	County	Shapefile	Polygon	Parcels	Yes - Presentation layer/ Centroid of parcel
Roads.shp	County	Shapefile	Polyline	Roads	No
Road.shp	County	Shapefile	Polyline	Roads – Whatcom county	No

Harris County, Texas

Name of the file	Source	Format	Feature Class Type	Description	Used?
County.shp	County	Shapefile	Polygon	County polygon	No
Parcels.shp	County	Shapefile	Polygon	Parcels	Yes - Presentation layer/ Centroid of parcel
Roads.shp	County	Shapefile	Polyline	Roads	No
Exist	County	Raster		Existing conditions depth grid	Yes - As depthgrid RPD_100 in HAZUS
Future	County	Raster		Future conditions depth grid	Yes - As depthgrid RPD_100 in HAZUS
FloodAreaWithParcels.mxd	County	Arcmap document		Zoomed view of the area	Yes - Reference

Larimer County, Colorado

Name of the file	Source	Format	Feature Class Type	Description	Used?
county.shp	County	Shapefile	Polygon	County polygon	No
Flooded_Parcels.shp	ABS	Shapefile	Polygon	Flooded parcels	Yes
parcels.shp	County	Shapefile	Polygon	Parcels	Yes - Presentation layer/ Centroid of parcel
Parcels_Existing.shp	ABS	Shapefile	Polygon	Existing parcels	Yes
Roads.shp	County	Shapefile	Polyline	Roads	No
Depth100	HAZUS-MH - FIT	Raster		Existing conditions depth grid	Yes - As depthgrid RPD_100 in HAZUS
Depth101	HAZUS-MH - FIT	Raster		Future conditions depth grid	Yes - As depthgrid RPD_100 in HAZUS
Elev100	County	Raster		Existing conditions elevation grid	Yes – Reference
Elev101	County	raster		Future conditions elevation grid	Yes - Reference

Mecklenburg County, North Carolina

Name of the file	Source	Format	Feature Class Type	Description	Used?
County.shp	County	Shapefile	Polygon	County	No
FloodedParcels.shp	County	Shapefile	Polygon	Flooded parcels	Yes
Mecklenburg.mxd	County	Arcmap document			Yes - Reference
Parcels.shp	County	Shapefile	Polygon	Parcels	Yes - Presentation layer/ Centroid of parcel
Roads.shp	County	Shapefile	Polyline	Roads	No
Trainingparcels.shp	County	Shapefile	Polygon	Training parcels	Yes - Presentation layer/ Centroid of parcel
sugar_parcels.shp	County	Shapefile	Polygon	Parcels	Yes - Presentation layer/ Centroid of parcel
sugar_footprints.shp	County	Shapefile	Polygon	Foot prints	Yes
Futuredepth	County	Raster		Future conditions depth grid	Yes - As depthgrid RPD_100 in HAZUS
Existdepth	County	Raster		Existing conditions depth grid	Yes - As depthgrid RPD_100 in HAZUS
footprints_over500sqft.shp	County	Shapefile	Polygon	Footprints	Yes – Reference
gpsbfe.shp	County	Shapefile	Point		Yes
master.shp	County	Shapefile	Point	Elevation points	Yes
master_elev_certs.shp	County	Shapefile	Point	Elevation points	Yes
xsects.shp	County	Shapefile	Polyline	Stream intersections	Yes
future100yr_combined.shp	County	Shapefile	Polygon		Yes
flum_stream_centerline.shp	County	Shapefile	Polyline	Stream centerline	Yes
floodway_oldareas.shp	County	Shapefile	Polygon	Floodway	Yes
floodplain_oldareas.shp	County	Shapefile	Polygon	Flood plain	Yes
existing100yr.shp	County	Shapefile	Polygon	Existing conditions - 100 year flood streams	Yes – Reference
parcels_withpid.shp	County	Shapefile	Polygon	Parcels	Yes - Presentation layer/ Centroid of parcel
masteraddress.shp	County	Shapefile	Point	Address data for elevation points	Yes

9. ACRONYMS

AGR1	Agriculture Occupancy
AIR	American Institutes for Research
ASFPM	Association of Floodplain Mangers
BFE	Base Flood Elevation
COM1	Retail Commercial Uses
CRS	Community Rating System
DEM	Digital Elevation Model
DFIRM	Draft Flood Insurance Rate Map
DHS	Department of Homeland Security
FEMA	Federal Emergency Management Agency
FIMA	Federal Insurance and Mitigation Administration
FIRM	Flood Insurance Rate Maps
FIT	Flood Information Tool
GIS	Geographical Information Systems
GOV1	Government
HAZUS	HAZUS-MH Flood Model
HMGP	Hazard Mitigation Grant Program
LIDAR	Laser Imaging Detection and Ranging
NFIP	National Flood Insurance Program
NIBS	National Institute for Building Sciences
RES1	Single-family Residential
RUNUP	Wave Run-up Computation
SFHA	Special Flood Hazard Areas
WHAFIS	Wave Height Analysis for Flood Insurance Studies

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10. REFERENCES

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Heinz Center. April 2000. *Evaluation of Erosion Hazards*.

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