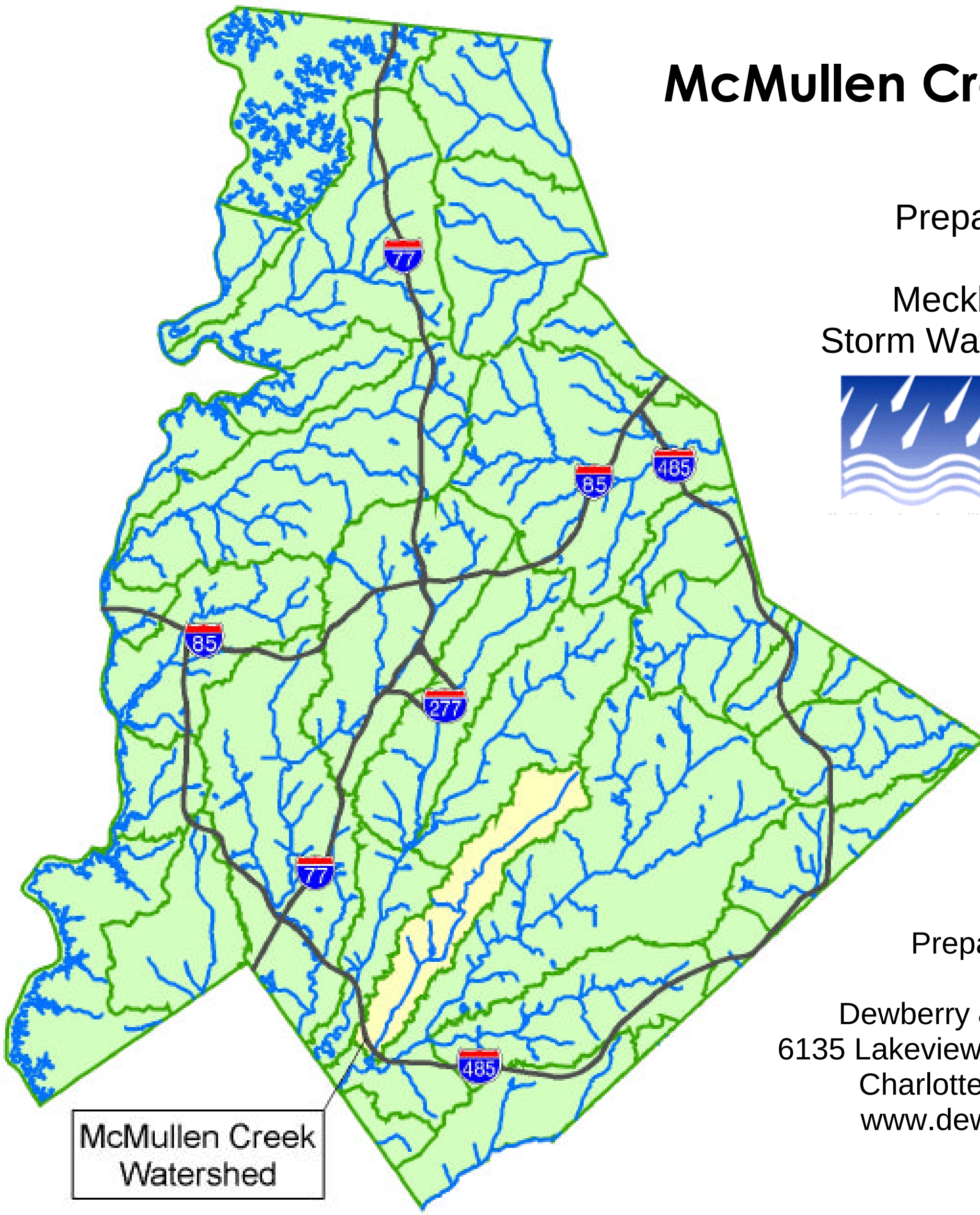
PRELIMINARY ENGINEERING FINAL REPORT

Watershed Study No. 9

McMullen Creek



Prepared for

Mecklenburg
Storm Water Services

Charlotte-Mecklenburg STORM WATER Services

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MECKLENBURG COUNTY
STORM WATER SERVICES

PRELIMINARY ENGINEERING REPORT FOR WATERSHED STUDY NO. 9

MCMULLEN CREEK WATERSHED

ACKNOWLEDGEMENT

The project staff of Dewberry would like to express our sincere appreciation to Mecklenburg County Storm Water Services (MCSWS) for its assistance and support during this project.

DISCLAIMER

This watershed-wide study is for planning purposes only. These study results and recommendations are preliminary and should not be used for construction without additional detailed engineering design analysis.

CERTIFICATION

I hereby certify that this Preliminary Engineering Report for Watershed Study No. 9, McMullen Creek Watershed, for Mecklenburg County was prepared by me or under my direct supervision.

Signed, sealed, and dated this _24_ day of October 2003.

By: Neal Banerjee

Neal Banerjee, PE
Project Engineer

(SEAL)

MECKLENBURG COUNTY
STORM WATER SERVICES
PRELIMINARY ENGINEERING REPORT
FOR
WATERSHED STUDY NO. 9

MCMULLEN CREEK WATERSHED

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GLOSSARY

Future Condition Floodplain (FCF):	Floodplain delineated for the 1% chance of flood event in any given year using future land use condition. It is currently defined as Floodplain Land Use Map (FLUM) in Mecklenburg County.
Existing Condition Floodplain:	Floodplain delineated for the 1% chance of flood event in any given year using current land use condition. It is defined as the same as within the Flood Insurance Rate Map (FIRM).
1% Annual Chance Flood:	The 1% annual chance flood is the flood that has a 1% chance of being equaled or exceeded in any given year, which is referred to as the “100-year flood,” in general.
Base Flood Elevation (BFE):	Water surface elevation based on the 1% annual chance flood (100-year flood).
FEMA	Federal Emergency Management Agency
MCSWS	Mecklenburg County Storm Water Services Department
WSE	Water surface elevation

EXECUTIVE SUMMARY

MCMULLEN CREEK WATERSHED

This Preliminary Engineering Report (PER) summarizes the methods, findings, and recommendations from a flood hazard mitigation and environmental restoration planning study for the McMullen Creek Watershed. The primary focus of this preliminary report was to conduct a review of pertinent stream/watershed information, assess flood damages, and investigate flood hazard mitigation alternatives within the regulated future condition floodplains (FCFs) in the McMullen Creek Watershed. A secondary focus was to provide a broad-level characterization of environmental quality in the Watershed and to offer general recommendations for environmental restoration. Per the context of this study, environmental restoration opportunities were typically only identified in conjunction with flood hazard mitigation improvement alternatives. It is important to note that the conclusions and recommendations provided in this report are based on broad planning level analysis, and thus should not be used for construction without additional detailed engineering analysis.

The McMullen Creek Watershed encompasses a 15.3 square mile urban area in the south-central portion of Mecklenburg County, North Carolina. The Watershed contains two County-regulated streams with FCFs that were included in this study - McMullen Creek and McMullen Creek Tributary.

Flood Hazard Mitigation

There are 309 structures within the FCF boundaries in the McMullen Creek Watershed. Comparison of flood information with building elevation certificates revealed that 74 of the 309 structures have their lowest finished floor below the predicted water surface elevation (WSE) of the FCF, and thus are considered "flooding" structures. Flood damages for these 74 buildings were estimated using the FEMA Full Riverine Benefit:Cost model (FEMA BC), and totaled to over $10 million (2003 dollars). Figure E-1 shows an overall map of the McMullen Creek Watershed and identifies problem areas discussed in the study.

Several alternatives were developed to mitigate flood damages for problem areas identified along the study streams. For general project ranking purposes, a benefit:cost (BC) economic analysis was performed to evaluate the cost-effectiveness of the alternatives at each problem area. The alternatives were then compared for their economic, technical, and social feasibility, from which a recommended mitigation strategy was developed for each problem area. If no improvement alternatives were identified as being cost effective or technically feasible, no action was recommended (i.e. leave building as-is).

The alternative evaluation indicated that it is cost-effective to provide flood protection for 16 of the 74 flooding buildings. The estimated benefits (i.e. damages reduced) and improvement costs are approximately $7.7 million and $2.5 million respectively. This indicates that a relatively number of the buildings are receiving the majority of the flood damages, and that focusing mitigation efforts on these buildings will provide the most return for mitigation dollars spent. Figures E-2 through E-8 show the recommended mitigation improvements within the McMullen Creek Watershed.

Environmental Characterization

The McMullen Creek Watershed is located in an established, highly urbanized area within the City of Charlotte. Land use is predominately residential (> 80%), but also includes limited commercial, industrial, vacant, and other uses. The streams in the Watershed have been modified (e.g. straightened, widened, armored, etc.) to accommodate urbanization, and thus do not exhibit natural, healthy stream characteristics. Reference to local water/biological monitoring data indicates overall "fair" conditions, however, benthic sample readings were classified as "poor" at several sites. The majority of environmental analysis included in this PER are broad in nature, however, several locations were identified for potential environmental restoration within the Watershed (Figure E-1). In addition, investigation of the GIS tax parcel database reveals that the County owns significant portions of vacant land adjacent to McMullen Creek. This land will likely be used for proposed greenways along the Creek, which in turn will likely incorporate water quality and/or environmental restoration features. It is recommended that more detailed analysis be conducted at a smaller scale level to investigate other environmental restoration opportunities.

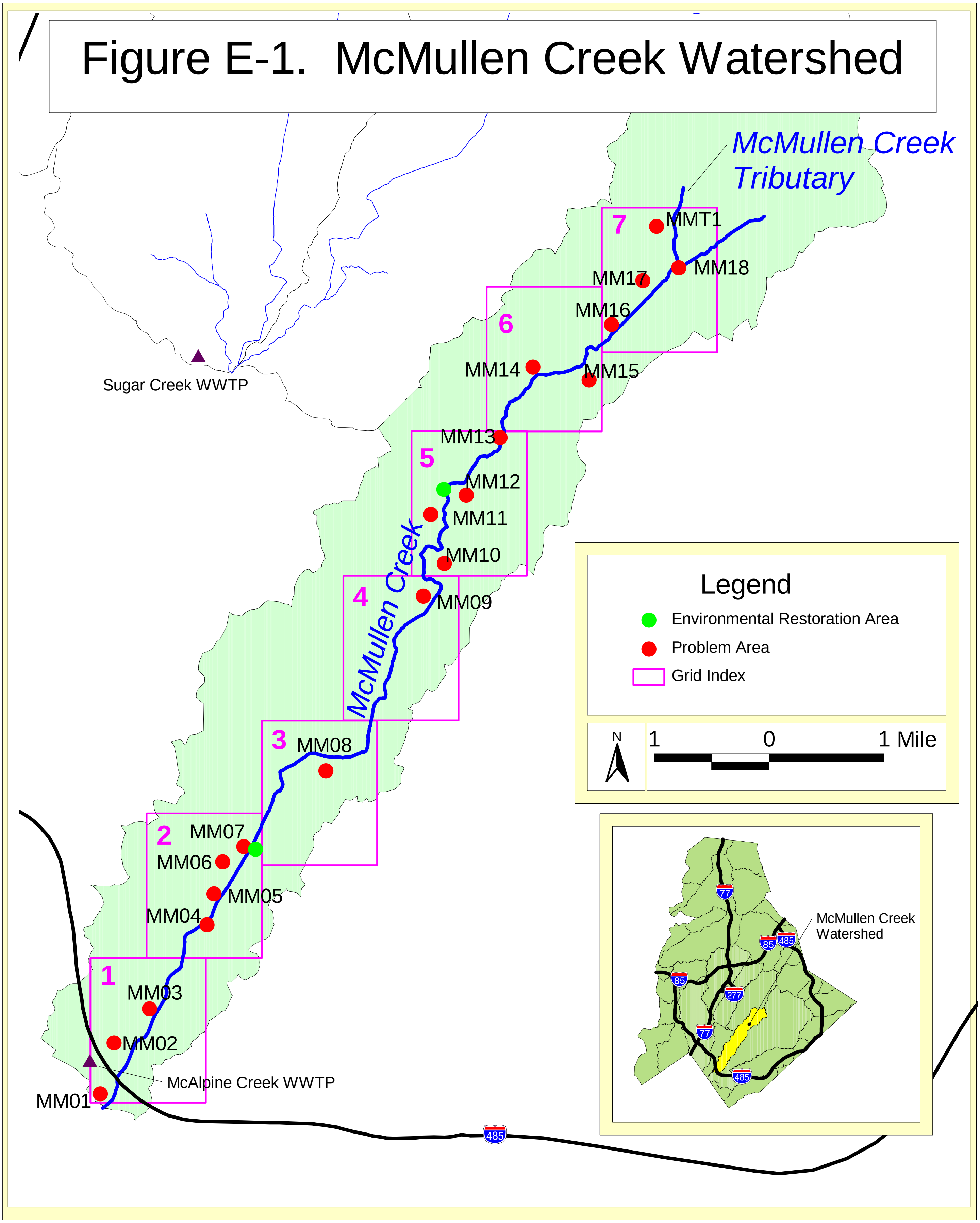


Figure E-1. McMullen Creek Watershed
McMullen Creek Tributary
McMullen Creek
Sugar Creek WWTP
McAlpine Creek WWTP
MMT1
MM18
MM17
MM16
MM15
MM14
MM13
MM12
MM11
MM10
MM09
MM08
MM07
MM06
MM05
MM04
MM03
MM02
MM01
1
2
3
4
5
6
7
Legend
Environmental Restoration Area
Problem Area
Grid Index
N
1
0
1 Mile
McMullen Creek Watershed
77
85
485
277

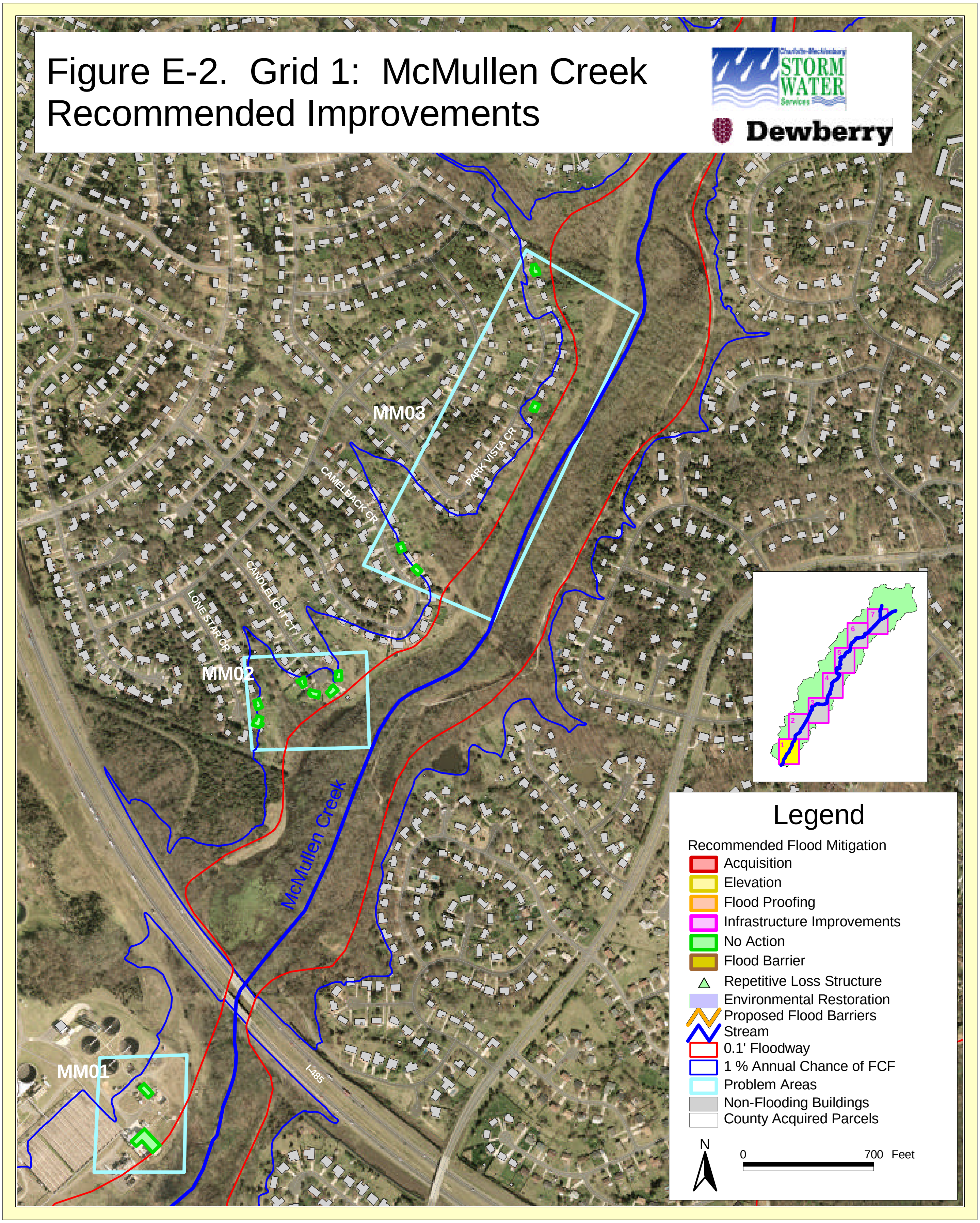
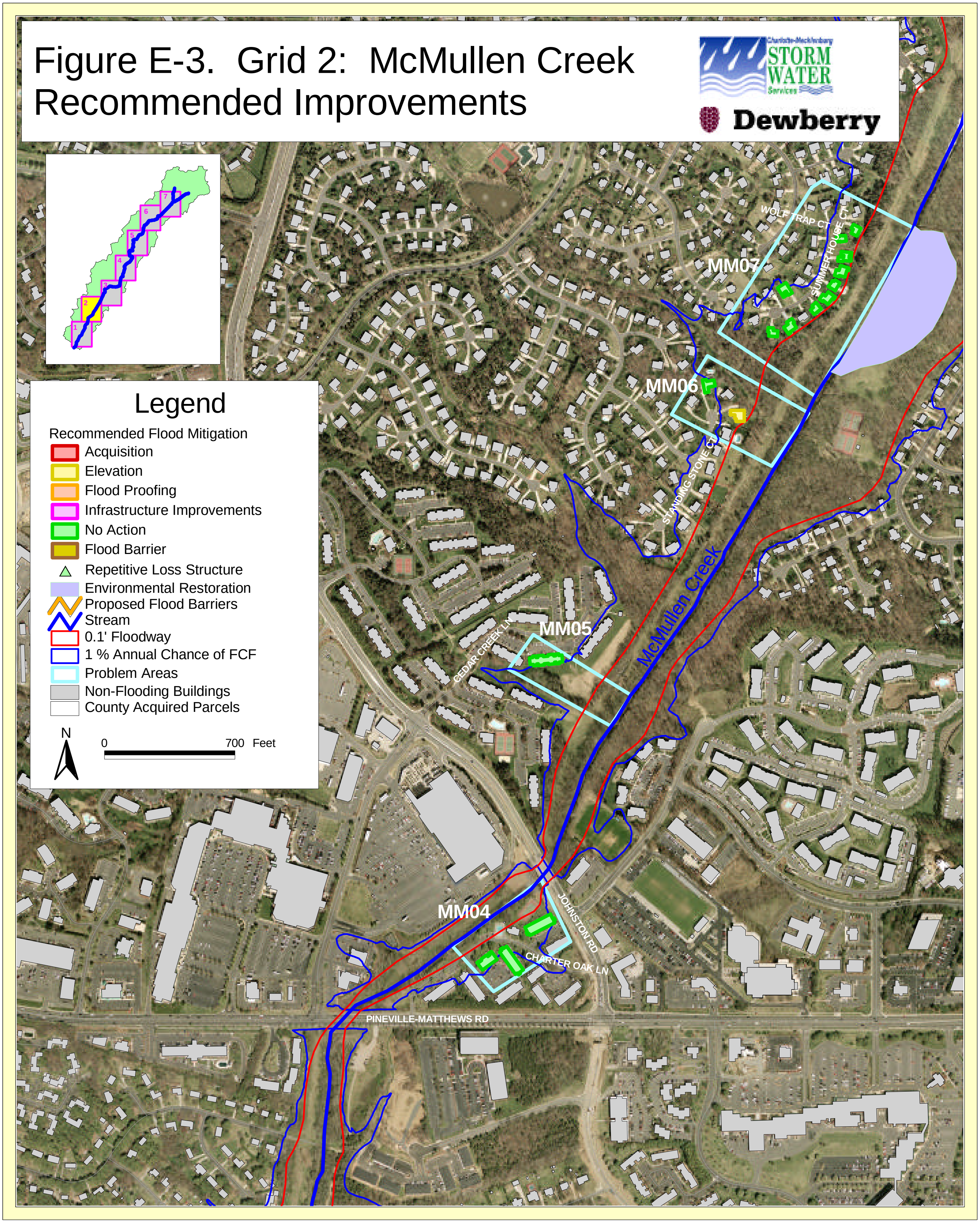


Figure E-2. Grid 1: McMullen Creek
Recommended Improvements
STORM WATER
Dewberry
MM03
MM02
MM01
PARK VISTA CR
CAMELBACK CR
CANDLELIGHT CT
LONE STAR CR
McMullen Creek
I-485
Legend
Recommended Flood Mitigation
Acquisition
Elevation
Flood Proofing
Infrastructure Improvements
No Action
Flood Barrier
Repetitive Loss Structure
Environmental Restoration
Proposed Flood Barriers
Stream
0.1' Floodway
1 % Annual Chance of FCF
Problem Areas
Non-Flooding Buildings
County Acquired Parcels
N
0
700 Feet

Figure E-3. Grid 2: McMullen Creek Recommended Improvements



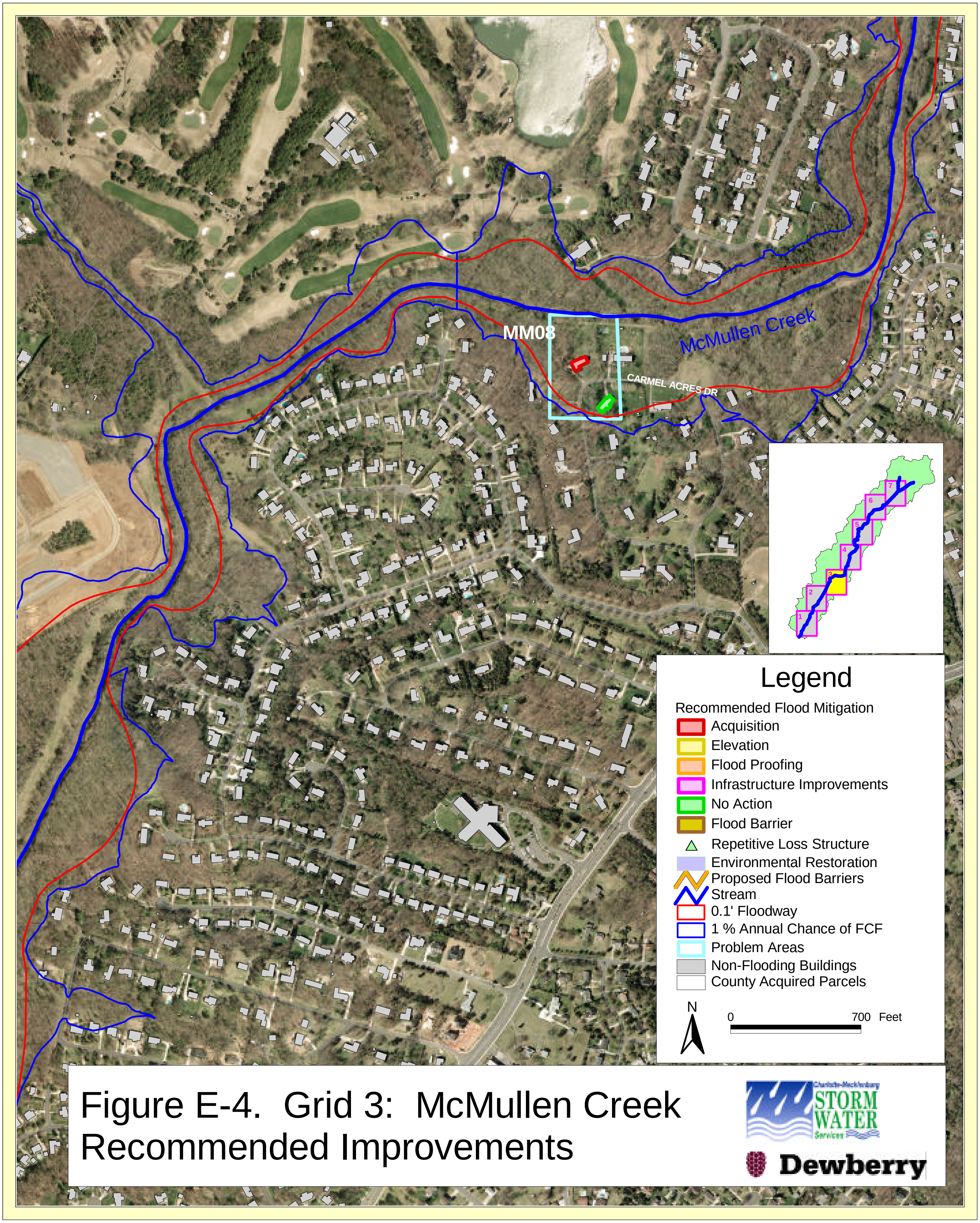


Figure E-4. Grid 3: McMullen Creek Recommended Improvements

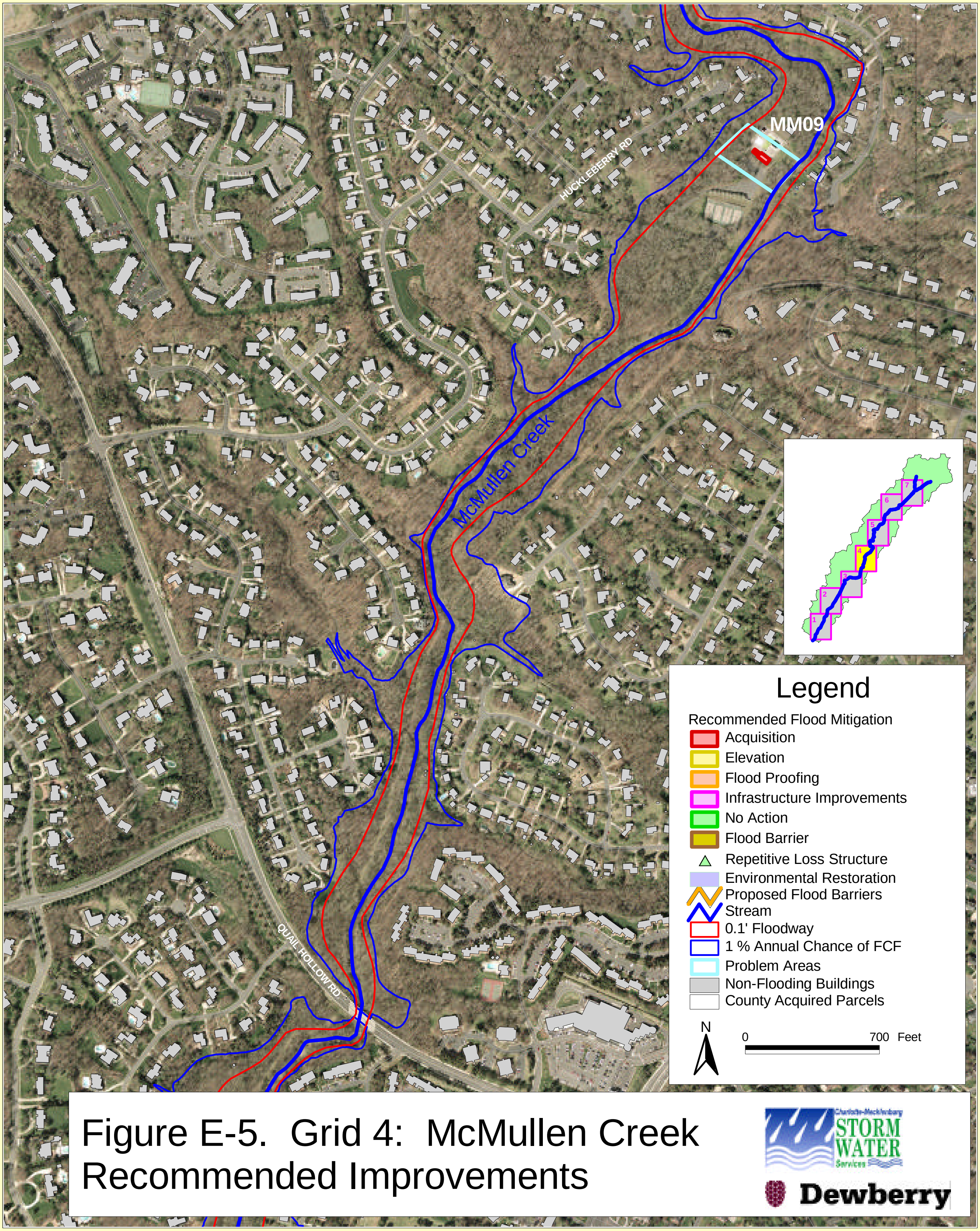


Figure E-5. Grid 4: McMullen Creek Recommended Improvements

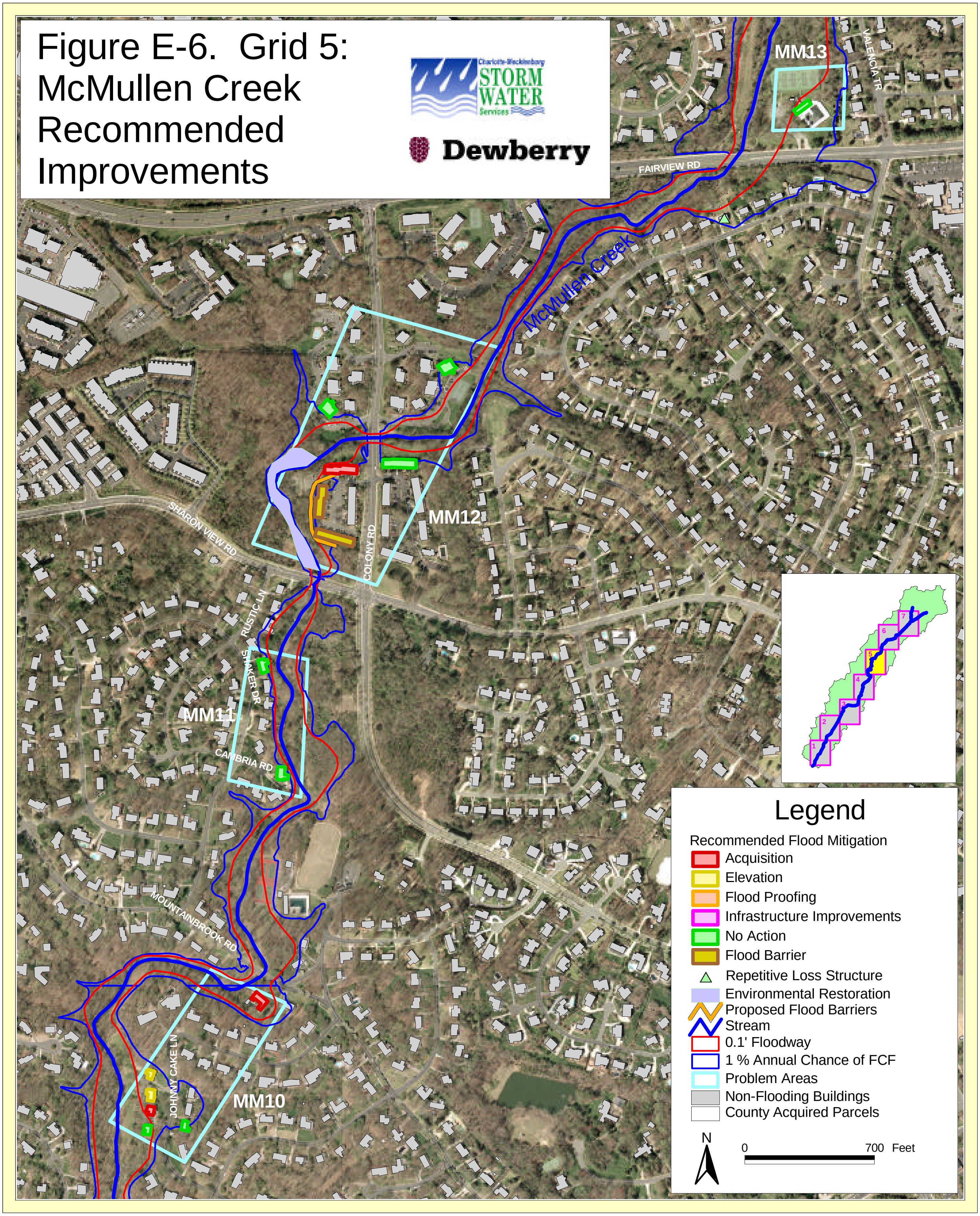
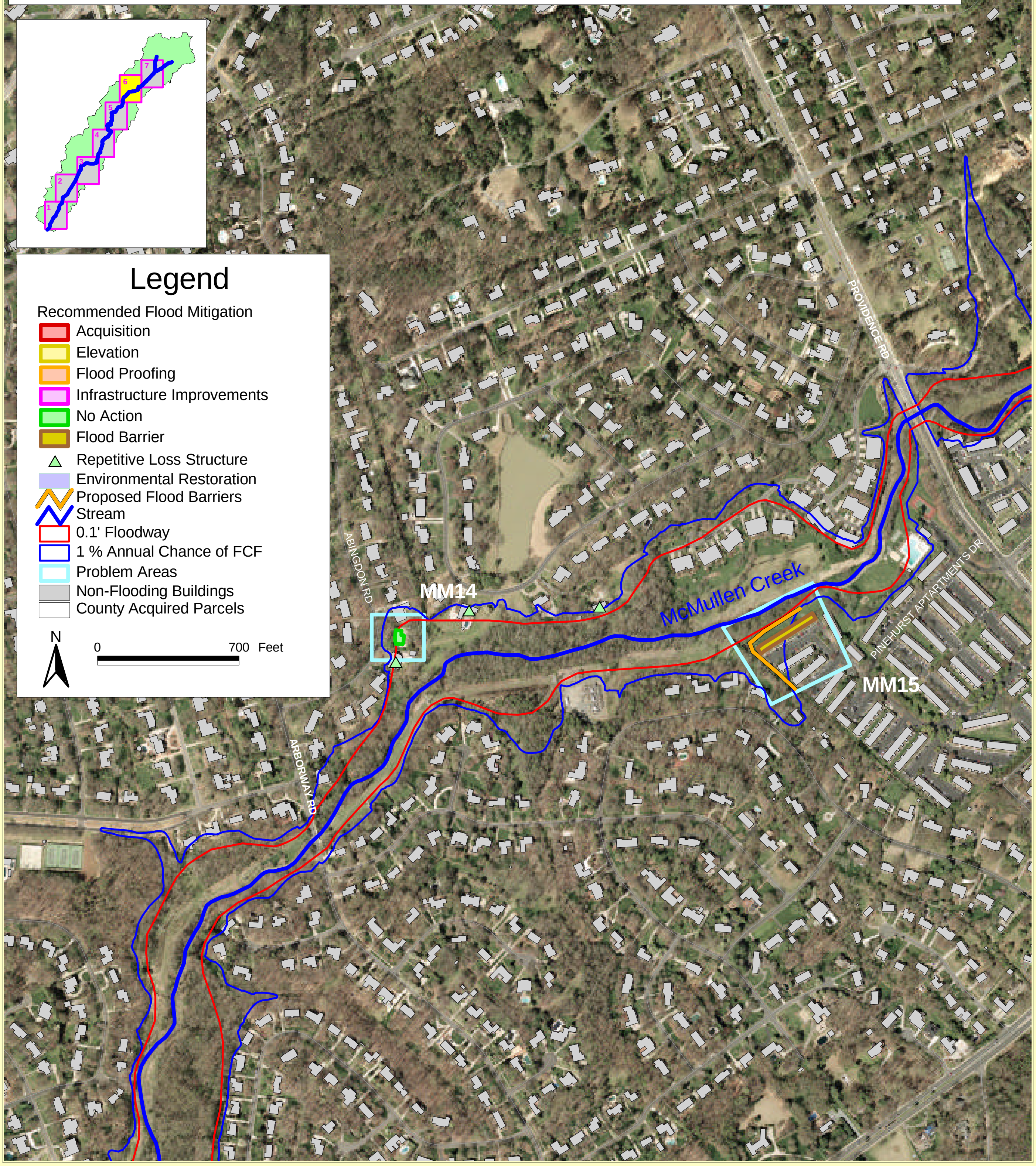


Figure E-6. Grid 5: McMullen Creek Recommended Improvements

Figure E-7. Grid 6: McMullen Creek Recommended Improvements



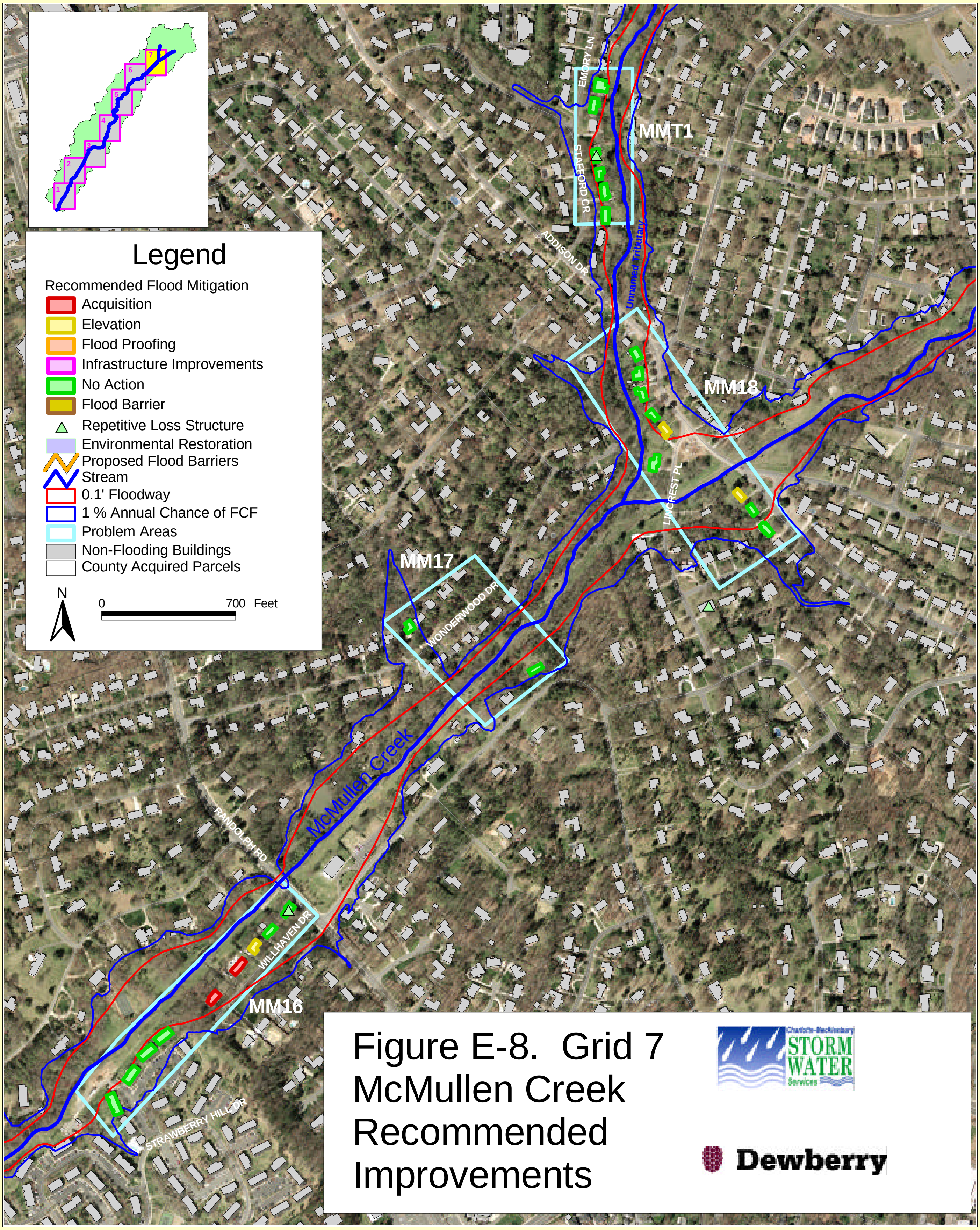


Figure E-8. Grid 7 McMullen Creek Recommended Improvements

GENERAL WATERSHED CONDITIONS

1.1. Watershed Characteristics

McMullen Creek Watershed encompasses a 15.3 square mile urban area in the south-central portion of Mecklenburg County, North Carolina. The Watershed is one of thirty-three (33) major watersheds in the County and drains in a southwestern direction towards the Catawba River. McMullen Creek Watershed is located entirely within the City of Charlotte municipal limits, and is generally bounded by I-485 to the southwest, Independence Boulevard to the northeast, Sharon Road to the northwest, and Carmel Road/Sardis Road to the southeast.

The topography of the McMullen Creek Watershed is generally characterized by relatively steep upland slopes and well-defined drainage features, as are typical of Piedmont areas. The Watershed is relatively narrow and uniform in shape, which is indicative of the fact that there are no major named tributaries to the main stem of McMullen Creek. Soils in the Watershed are predominately NRCS Hydrologic Group B soils, which have relatively low runoff potential.

The McMullen Creek Watershed contains two streams that have mapped, County-regulated, future condition floodplains (FCFs, also referred to as FLUM floodplains) - McMullen Creek and an unnamed tributary to McMullen Creek, hereafter referred to as McMullen Creek Tributary. These streams were considered in this Preliminary Engineering Report (PER) for potential flood hazard mitigation and environmental restoration alternatives, and are described below.

McMullen Creek

The McMullen Creek study reach flows southwest from just downstream of Erinshire Road, to its outlet at the confluence with McAlpine Creek - a distance of approximately 10.9 miles. The Creek runs through highly residential areas for almost its entire length, crossing thirteen roadways, and outlets into McAlpine Creek at the McAlpine Creek Waste Water Treatment Plant (WWTP).

Figure 1. McMullen Creek – Looking downstream from Mountainbrook Road.

The McMullen Creek main channel exhibits different characteristics along its length, but can be generally described as a straight, relatively wide, trapezoidal channel with steep banks, and a relatively shallow normal flow depth. The upper reaches tend to exhibit narrower banks and steeper channel slopes, whereas, the lower reaches have wider banks, milder slopes and finer bed materials. The width of the main channel typically ranges from 25 to 40 feet wide in the upper stream reaches, and transitions to widths of 45 to 60 feet around the Sharon View Road crossing (River Station 36094).

The channel banks are generally heavily vegetated as an established riparian zone lines much of the creek. The channel bed is generally comprised of sand, gravel, and cobble in the upper reaches, but is almost entirely sand and silt in the reaches downstream of Johnston Road (River Station 10271). There are a several rock outcrops, most notably in the area near Mountainbrook Road and Quail Hollow Road.

McMullen Creek Tributary

The McMullen Creek Tributary study reach is located in the upper portion of the McMullen Creek Watershed. It flows in a southern direction from upstream of North Sharon Amity Road to its confluence with McMullen Creek, for a distance of approximately 0.7 miles. The tributary runs through almost all residential land use, with the exception of some institutional and vacant land uses near North Sharon Amity Road. There are three roadway crossings along the on the tributary.

The McMullen Creek Tributary channel is similar in shape to the upper portions of the McMullen Creek channel, having an average top width of approximately 30 feet. The channel is grassed with a silt-rock bed and armored with riprap for much of its length.

Figure 2. McMullen Creek Tributary – Looking downstream from North Sharon Amity Road.

1.2. Development in the Watershed

Identifying existing and future development conditions and activities is an important part of watershed-wide planning. Many of these issues can have a direct or indirect impact in evaluating the feasibility of potential flood mitigation and environmental restoration measures. Examples of pertinent development issues include: land development patterns, land use characteristics, proposed new development, existing and proposed utilities, proposed capital improvement projects (CIPs). These issues are further discussed in the following paragraphs.

As noted in the previous section, the McMullen Watershed is located in an urbanized area within Mecklenburg County, thus much of the Watershed has been developed. Tax parcel information indicates that on a watershed-wide basis, new development and re-development peaked in the 1970’s and has steadily decreased over the last several decades. However, significant localized development is still occurring. Mecklenburg County GIS (2002) shows preliminary plans for new development at two locations within the McMullen Creek Watershed:

- a 186 lot single family residential development located along McMullen Creek in the lower third of the Watershed, off of Smithfield Church Road
- a 25 lot multi-family residential development located in the western-central headwaters of the Watershed, near the intersection of Sharon View Road and Sharon Woods Lane.

Land use in the McMullen Creek Watershed is predominately residential (approximately 90%), with scattered pockets of commercial, office, industrial, and open/vacant land. The majority of residential land use is medium density (i.e. 1/3 – 1/2 acre lot size), single-family properties. Commercial/Industrial land uses are generally concentrated along the major thoroughfares – Sharon Amity Road, Monroe Road, Sharon Road, Fairview Road, and Park Road. Open/vacant areas such as parks, undisturbed parcels, and school lands are scattered throughout the Watershed. A summary of development patterns and current land use conditions is provided in Table 1 below.

Table 1. Development in the McMullen Creek Watershed

	Year Developed					Vacant/	
	Before 1961	**1961-1970**	**1971-1980**	**1981-1990**	**1991-2000**	**Unclassified**	**Total**
Parcels	2,256	2,718	5,084	4,161	1,776	700	16,695
Percentage	13.5%	16.3%	30.5%	24.9%	10.6%	4.2%	100.0%

	Land Use as of 2002				
	Single Family	**Other Residential**	**Non-Residential**	**Vacant/ Unclassified**	**Total**
Parcels	10,243	4,780	972	700	16,695
Percentage	61.4%	28.6%	5.8%	4.2%	100.0%

Note: Includes entire McMullen Creek Watershed within Mecklenburg County, including all tributaries (15.2 sq. miles)

Being an urbanized area, infrastructure utilities are present throughout the McMullen Creek Watershed. Sanitary sewers are typically the most pertinent utility in relation to stream projects since they often run adjacent to stream channels and may have several crossings. Sanitary sewers are present along McMullen Creek and several small tributaries. A major interceptor generally runs along the northwest overbank of McMullen Creek. The interceptor collects sewage from the smaller system components and transports it to the McAlpine Creek WWTP, just downstream of Interstate 485 (I-485). The Charlotte-Mecklenburg Utilities (CMU) 5-year capital improvement project map does not indicate any proposed sanitary sewer capital improvements in the McMullen Creek Watershed, although several projects are proposed for the McAlpine Creek Wastewater Treatment Plant (which is partially in the Watershed).

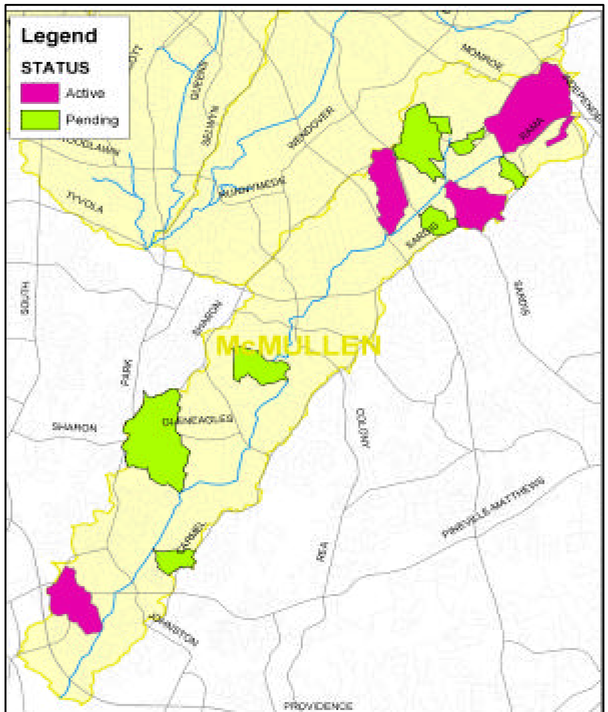


Figure 3. City of Charlotte Storm Water Services Capital Improvement Projects (CIPs)

Storm sewers are another significant feature in flood mitigation, since they exist throughout the McMullen Creek Watershed, and discharge to the study creeks at numerous locations. The City of Charlotte Storm Water Services currently has two active design CIP projects in the McMullen Creek Watershed, as well as several pending planning/design projects (Figure 3). A summary of recent MCSWS CIP projects is shown in Figure 5 at the end of this section.

Other utilities (storm, water, power, phone, etc.) are scattered throughout the McMullen Creek Watershed, as well. Waterlines and gas lines cross the creeks in the Watershed along several of the thoroughfares. Mecklenburg County GIS indicates major transmission lines along two reaches of McMullen Creek – between I-485 and Pineville-Mathews Road, and between Quail Hollow Road and Providence Road. In addition, power lines and utility poles are present at many locations.

Greenways are multi-purpose systems that can be used to assist in floodplain management and environmental restoration/protection, as well as, provide recreational and other benefits. Similarly, flood mitigation and environmental restoration improvements (e.g. acquisition, wetland creation, etc.) are often coordinated with greenway development to maximize overall benefits.

The existing Mecklenburg County greenway system includes only one section of greenway in the McMullen Creek Watershed. The existing greenway runs along McMullen Creek from the confluence with McAlpine Creek to Pineville-Matthews Road. However, the 1999 Mecklenburg County Greenway Master Plan recommends that the greenway be extended northeast along McMullen Creek up to Independence Boulevard – a distance of approximately 10.3 miles. Figure 4 depicts the existing and future greenway systems outlined in the Master Plan within the McMullen Creek Watershed. Upon inspection of the GIS tax parcel database, it appears that the County has already acquired significant portions of property along McMullen Creek that will likely be used for the greenway in the future.

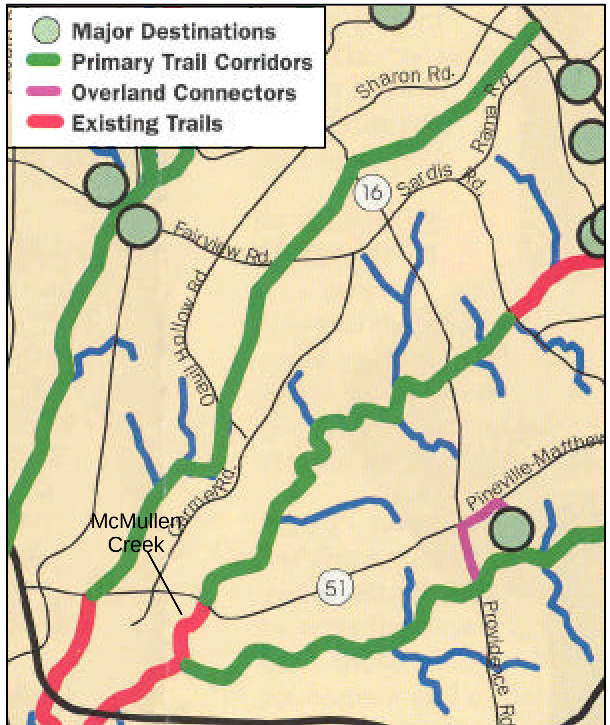


Figure 4. Existing/Proposed Greenway System in McMullen Creek Watershed (from 1999 Greenway Master Plan).

1.3. Aquatic Habitat and Environmental Monitoring

When available, monitoring data can be one of the best sources of information for evaluating site environmental conditions in a watershed. In addition to providing specific information on existing conditions, monitoring data may provide insight to patterns over time. Patterns identified in the monitoring data can be coupled with records of development and/or other activities to help develop a cause-effect relationship between activities in the watershed and environmental stressors (problems) that currently exist, or are likely to develop, based on current watershed patterns. Although a full environmental watershed assessment and data analysis is beyond the scope of this planning project, available monitoring data is identified and summarized below.

Mecklenburg County has a water quality program which maintains a system of approximately 49 water quality monitoring stations throughout the County. There are three basic types of environmental monitoring conducted at the stations:
1) Benthic macroinvertebrate sampling (i.e. taxa richness (EPT method))
2) Fish sampling (i.e. North Carolina Index of Biotic Integrity (NCIBI))
3) Ambient sampling (e.g. dissolved oxygen, nitrates, metals, oils, etc. – reported as composite Water Quality Index (WQI)).

Biological (fish and macroinvertebrate) sampling is used to assess a streams ability to support abundant and diverse populations of aquatic life, and thus, is a direct measure of the aquatic health of a stream. Generally biological sampling protocols are based on the presence or non-presence of indicator species sensitive to pollutants or environmental stressors. A principal advantage of biological sampling is that it is generally less sensitive to short-term environmental changes, and represents a more composite, longer-term view of aquatic health. A limitation of biological sampling is that although it answers the direct question of “how/what” is the aquatic health of the stream, it does not indicate “why” it is such.

Ambient sampling is used to assess the chemical and physical properties of the stream flow, and to indirectly assess the aquatic health of a stream. When coupled with the biological sampling, ambient data can help answer the question to as “why” the aquatic health of a stream is the status that it is. Ambient sampling is also helpful in evaluating whether the water meets water quality standards (e.g. enough dissolved oxygen, appropriate temperature, etc.), as well as, identifying the presence of potential pollutants that may hinder healthy conditions (e.g. excess metals, oil, etc.). One limitation of ambient sampling is that since it is representative of in-stream conditions at a given point(s) in time, it is highly variable – constituent levels are often sensitive and are affected by changes in environmental conditions (e.g. diurnal and seasonal patterns, wet versus dry weather, etc.). To help assess the data from the many sampled constituents, Mecklenburg County uses a “Water Quality Index” (WQI). The WQI integrates samples from the individual constituent samples to provide a composite or overall rating of the ambient water quality.

Organized monitoring of the stations began in the late 1980’s and continues today. The frequency of monitoring at each station is dependent on purpose of the station (i.e. project specific or general) and the type of information collected (i.e. chemical versus biological). Ambient chemical water quality data is generally collected every quarter, whereas macroinvertebrate is sampled annually. Fish sampling for the entire County was collected on a “one-time” basis between 1995 and 1999. However, the County is planning on conducting a new round of fish sampling in the near future.

The Mecklenburg County Water Quality Program (MCWQP) maintains two monitoring stations in the McMullen Creek Watershed – stations MC42 and MC43. Both stations are located on McMullen Creek, at Sharon View Road and Johnston Road, respectively. A third station (MC42B) previously existed, but was discontinued in 1994.

Macroinvertebrate/Benthic sampling over the last six years has consistently produced "Poor" ratings at both monitoring stations along McMullen Creek. Fish sampling in 1995 and 1996 indicate "Fair" ratings at both monitoring stations along McMullen Creek. Although, there are only two sites, these consistently low rankings indicate unhealthy aquatic habitat on McMullen Creek.

Conversely, ambient water quality sampling of McMullen Creek has consistently provided "Good" or better water quality rankings. Detailed analysis (beyond the scope of this study) is needed to better assess the reason for the conflicting water quality ratings. One possible hypothesis is that although the WQI, which is a composite ambient water quality rating, is good, one or more ambient constituents that are important for healthy aquatic life are at unsuitable levels. Table 2 summarizes the MCWQP monitoring data.

Table 2. MCDEP Water Quality Monitoring Summary

NC Piedmont Macroinvertebrate Taxa Richness		Jul-95		Jul-96		Aug-99		Aug-00		Jul-01	
Site	Location	S_{EPT}	WQ Rating	S_{EPT}	WQ Rating	S_{EPT}	WQ Rating	S_{EPT}	WQ Rating	S_{EPT}	WQ Rating
MC42	McMullen Creek - Sharon View Rd	3	Poor	-	-	2	Poor	5	Poor	5	Poor
MC43	McMullen Creek - Johnston Road	-	-	5	Poor	3	Poor	4	Poor	-	-

Fish Bioassessment		Oct-95		Sep-96		Aug-99		Aug-00		Jul-01	
Site	Location	NCIBI	WQ Rating	NCIBI	WQ Rating	NCIBI	WQ Rating	NCIBI	WQ Rating	NCIBI	WQ Rating
MC42	McMullen Creek - Sharon View Rd	40	Fair	-	-	-	-	-	-	-	-
MC43	McMullen Creek - Johnston Road	-	-	42	Fair	-	-	-	-	-	-

Water Quality Index		Oct-95		Jun-96		Apr-99		Jun-00		May-01	
Site	Location	WQI	WQI Rating	WQI	WQI Rating	WQI	WQI Rating	WQI	WQI Rating	WQI	WQI Rating
MC42	McMullen Creek - Sharon View Road	76.3	Good/Exc.	68.8	Good	73.4	Good	69.6	Good	66.9	Good
MC43	McMullen Creek - Johnston Road	-	-	69.9	Good	76.5	Good/Exc.	80.4	Good/Exc.	73.9	Good

In additional to the MCWQP monitoring stations, there are two USGS flow stations and two rain gages within the McMullen Creek Watershed. A list of these stations and gages are provided below for general reference.

Table 3. USGS Stations and Mecklenburg County Rain Gages

Station/Gage ID	Type	Location
02146750	USGS (flow,rainfall)	McMullen Creek/McAlpine Creek confluence
02146700	USGS (flow)	McMullen Creek at Sharon View Road
351032080475245	County (rainfall)	Fire Station #14 at Sharon Amity
350635080513245	County (rainfall)	South Mecklenburg High School

1.4. Rosgen Stream Morphology Assessment

Stream classification is a process where subject streams are analyzed and are grouped into discrete categories based on similar characteristics. Classification is beneficial and often used in stream restoration projects since it provides a consistent baseline for organizing, comparing, and managing streams. In addition, classification can offer insight on existing behavior and future trends of the stream.

There are several types of stream classification systems that categorize streams using different parameters (e.g. channel stability, sediment transport, etc.). This study utilized the Rosgen Stream Classification System, which is a hierarchical classification system (Levels I – IV) based on increasingly detailed morphological information. For the purposes of watershed-wide planning, the Level I (i.e. the most generalized classification) classification is appropriate. Detailed planning and/or design generally merit a Level II assessment or above.

A Rosgen Level I Assessment was conducted on the study streams within the McMullen Creek Watershed to obtain a course geomorphic characterization for each study stream. The Rosgen Assessment qualitatively classifies a stream based on broad-scale quantitative assessments of basin relief, landform, and valley morphology characteristics. For this Level I analysis, topographic data, aerial photos, and HEC-RAS models were used to calculate stream sinuosity (i.e. a measure of how much a stream meanders) and channel slope for each study stream. These calculated values are presented below in the table.

Table 4. Rosgen Level 1 Assessment: Geomorphic Characterization

	Channel Length (mi)	Valley Length (mi)	Channel Sinuosity	Channel Slope (percent)
McMullen Creek	10.88	8.97	1.21	0.28
McMullen Creek Tributary	0.7	0.65	1.08	0.54

The information presented above indicates that both McMullen Creek and McMullen Creek Tributary are best classified as a Type G channel (although less steep and sinuous). Type G channels are generally characterized by a low sinuosity, mild slopes, and a low bankfull width/depth ratio. These conditions often lend to undesirable high bank erosion rates, and channel instability. This is consistent with the fact that the creek bank has been armored along numerous sections with riprap to reduce bank erosion.

It is important to note that the urban development of Charlotte has significantly altered the natural stream system (i.e. straightening, widening, armoring, etc), which has diminished the influence that the general geomorphic information (used in a Level 1 analysis) has on channel morphology. In addition, stream morphology can vary considerably between different reaches, especially in urban areas. These factors can complicate classifying streams, since the calculated numbers may not fit perfectly into any one distinct category (as was the case for both study streams). In this situation, judgment and/or further study is used to approximate the "best fit".

1.5. Bank Stability Problem Identification

Channel bank stability is an important issue in urban floodplain/stormwater management, since it can have a significant impact on the quality of a stream for both localized areas and as a whole. Unstable channels with eroding banks destroy valuable property, expose and/or weaken existing infrastructure (e.g. utilities), and lessen the efficiency of ponds and reservoirs. In addition, the increased sedimentation can cause significant water quality problems. Sediment in streams negatively impacts aquatic life by burying and suffocating aquatic habitat, and providing a host for harmful bacteria and other pollutants to attach to.

Channel instability problems typically fall into two general categories: isolated areas of bank erosion and long-term equilibrium adjustments to changes in the watershed and stream system. The former may be caused by rapid inflow from tributaries, unstable banks, or encroachment of development. The latter is related to larger scale changes in the land use of the watershed and flows in the stream, which manifest in the form of changes to the channel bottom level.

Channel bank stability problems were investigated during field visits to road crossings. Both localized scour and the presence of mid-channel sand bars (which indicate long-term equilibrium adjustments) were observed. Other problem areas may exist at areas not visible from road crossings. However, since much of the channel is heavily vegetated and/or armored, it is not anticipated that stream bank stability is a major problem in the study streams within the McMullen Creek Watershed.

2. BENEFIT:COST ECONOMIC ANALYSIS

2.1. Benefit:Cost Analysis Overview

The benefit:cost (B:C) analysis is an economic based analysis that is commonly used in mitigation projects to evaluate the cost-effectiveness of one or more proposed improvement alternatives. The B:C analysis compares the benefits (in dollars) obtained by a proposed improvement versus the cost to implement the improvement.

In the context of flood hazard mitigation, the benefits are primarily comprised of the estimated flood damages that are avoided by implementing an improvement. For example, if a proposed improvement project (e.g. elevating a building above the floodplain) protects (i.e. eliminates flood damages) a floodprone building that incurs an average of $1,000/yr in flood damages, the $1,000/yr is considered the benefit. The cost equals the cost to implement (and maintain) the alternative.

The results of the B:C analysis is typically expressed in a simple ratio of the benefits over the costs – referred to as the B:C ratio. A B:C ratio of greater than 1.0 implies that the benefit of implementing a proposed project is greater than the cost to implement the project. Thus, the given alternative is considered an economically feasible solution. Subsequently, a B:C ratio of less than 1.0 indicates that the costs associated with a proposed alternative are more than its benefits, so the alternative is not cost-effective. It should be noted that the B:C ratio is based solely on economic considerations, whereas in reality, there are often many other considerations that cannot be directly quantified (for both benefits and costs). Examples of other considerations include: water quality benefit, aesthetic benefit, public safety issues, political environment, disruptions in traffic patterns, and others. For this reason, it can be acceptable to implement an alternative with a benefit/cost ratio of less than 1.0.

2.2. Flood Damage Assessment Model

The FEMA "Riverine Flood, Full Data Module (Version 5.2.3, 1999)" Benefit:Cost model, hereafter referred to as FEMA BC, was used for estimating flood damages in this study. The FEMA BC is an EXCEL spreadsheet-based program that has built-in functions to compute probability based damages, given user-entered information, such as economic and physical building information, and flood information. As noted in the previous section, the estimated damages represent the benefit in the B:C analysis. To increase efficiency and accuracy in inputting data into the FEMA BC model, a custom import application was developed in Visual Basic for Applications (VBA). This import application took data that had been compiled into tables, and automatically created FEMA BC models. Appendix A presents the import tables used to create the FEMA BC models. As indicated previously, the damage estimates presented in this report are for planning and general ranking purposes only. A more detailed B:C analysis should be performed before further mitigation action is taken.

2.3. Building Data

The amount of damage incurred by a flooded building is a function of the economic and physical characteristics of the building. A brief description of the building parameters used by the FEMA BC program for the flood damage assessment is provided below.

Building Type: The building type provides physical style information (i.e. number of stories, presence of basements, etc.) for a building. FEMA BC categorizes building types into six general building types. Each building type has a unique, built-in, flood depth to damage relationship that the program uses to estimate the damages to a given building (e.g. a house with a basement incurs damage at a higher rate than an identical house without a basement).

Building Value: The building value refers to the economic value of the building. It is required by FEMA BC since flood damages are a function of the economic value of the building. Building values were estimated from Mecklenburg County tax parcel data and were assumed to equal 125% of the "improvement value". This assumption is consistent with the six previous watershed-wide studies completed in 2001.

Content Value: Content value is the estimated value of the contents in a building. Damages to building contents often represent a significant portion of total flood damage for a given structure. In large-scale studies such as this, the content value is often expressed as a percentage of the building value (e.g. contents in a residence are worth 25% of building value). For this study, flooded buildings were grouped into five categories based on their use (i.e. residential, commercial, etc.). Content to building value percentages were then developed for each category and used in the FEMA BC model. It should be noted that this methodology differs from that used in the previous six watershed studies completed in 2001, which used a content to building value of 25% for all structures.

Floor Elevation: Floor elevation refers to the elevation of the lowest finished floor. The model uses this to determine the elevation at which flood damage commences. Floor elevations were obtained from surveyed elevation certificates obtained from Mecklenburg County. Elevation certificates were surveyed/created for buildings not having existing ones.

Displacement Cost: The displacement cost represents the cost that is incurred when occupants of a building are displaced and thus must live/operate in a temporary location while damage is being repaired. Flat displacement costs of $5,250/month for single-family residential buildings and $12,000/month for multi-family residential buildings were used in this study. These estimates were based on per diem information provided by the NC Department of Emergency Management. Non-residential buildings were assumed to have a $0 displacement cost. Costs related to being displaced were assumed to be accounted for in lost revenue estimates discussed below. It should be noted that this methodology differs from that used in the previous six watershed studies completed in 2001, which used a single flat displacement cost ($5,250/month) for all structures.

Business Loss Cost: The business loss cost is an estimate of the amount of loss revenue incurred by a business when normal operations are disturbed (or halted) due to a flood. Business costs are highly building specific and difficult to estimate. However, for the purposes of the watershed-wide planning study losses of $10,000, $18,800, and $37,500 per month were used for general commercial, warehouse, and offices, respectively. Residential properties were given a business loss of $0. These estimates were developed from economic information obtained the Charlotte Chamber of Commerce and internet business sites. It should be noted that this methodology differs from that used in the previous six watershed studies completed in 2001, which did not account for business loss cost.

2.4. Hydraulic Data

Hydraulic data specifies the frequency and magnitude of flooding at a given building. It is used in conjunction with physical building data to assess flood depths, and subsequent flood damages, for a given building. FEMA BC requires water surface elevations (WSEs) from four storm events: 10%, 2%, 1%, and 0.2% annual chance flood events, which are typically defined as 10-, 50-, 100-, and 500-year storm events, respectively.

This study used future condition WSEs in the FEMA BC program for each of the storm events. The 100-yr WSEs were previously developed in HEC-RAS (Version 2.2) for the County by Watershed Concepts. Since the County's HEC-RAS models did not have future condition WSEs for the other storm events (i.e. 10-, 50-, and 500-yr), they were created separately. First, future condition flows were developed by applying the previously developed built-out land use conditions to the 10-, 50-, and 500-yr HEC-1 hydrology models. The future condition WSEs were then calculated by running the future condition flows through the HEC-RAS models. WSEs were calculated at each floodprone building by applying a station to each building and then interpolating the HEC-RAS output to obtain a WSE for the station of the building.

2.5. Modeling Process

The FEMA BC model utilizes the above information to produce an estimated annual cost of flood damage. This expected annual damage cost takes into account damages from all frequency storms inputted into the model, and is calculated in a multiple-step process. First, raw damages for building, contents, displacement, and business losses are computed. Building and content damages are estimated by comparing flood depths associated with each storm event with built-in (or user specified) depth-damage functions (DDFs). Building and content DDFs used in this study are given in Appendix C. Displacement and business costs are estimated by using built-in (or user specified) curves to assess the amount of time the structure is unusable for a given flood depth, and then multiplying this "downtime" by monthly displacement/business loss costs. Next, a probability-based curve is developed from user-entered discharges and WSEs that accounts for probability of each storm event. Lastly, the raw damage functions (DDFs) are compared with the probability curve of to calculate the average annual damage. A detailed description of flood damage assessment statistics is beyond the context of this report. The reader is referred to the FEMA BC Users Guide for more information.

The flood damage assessment portion of this study was conducted on buildings located in the 100-yr Future Condition Floodplain (FCF), with finished floor elevations below the predicted 100-yr future condition WSE. It should be noted that since the FEMA BC includes the 500-yr storm event (i.e. the 0.2% chance event), computed damages include damages from storms larger than the 100-yr. However, improvement alternatives were design based on the 100-yr storm event.

2.6. Economic Analysis

Once the floodprone buildings in a study area are identified and their flood related damages assessed, the next step in a benefit:cost analysis is to identify potential mitigation alternatives and then develop a cost to implement these alternatives. The cost to implement a given improvement alternative represents the "cost" portion of the B:C ratio. Before the a B:C ratio is calculated, all benefits and costs must be in the same time reference (e.g. present lump sum cost, annual cost, etc.). As noted above, the FEMA BC calculates damages (i.e. benefits) as an average annual cost. Conversely, cost estimates for improvement alternatives are typically developed as a present worth lump sum (or a combination lump sum and annual cost), as they were in this project. For clarity, all benefits and costs were standardized to present value lump sum terms. The annualized benefits calculated in the FEMA BC were transformed to present value lump sum using standard engineering economic equations with a 50-yr project life and a 7% interest rate.

The final step in the B:C analysis is to make a mitigation recommendation. B:C ratios are calculated for all the proposed improvement alternatives, from which alternatives that are cost-effective (i.e. B:C > 1.0) are identified. Any additional, non-quantitative factors are then considered in conjunction with the B:C ratios, to identify a recommended action for the building or group of buildings. If the B:C ratio is less than 1.0 for all improvement alternatives and there are no significant non-quantitative benefits (i.e. water quality, public recreation, etc.), then a "no-action" option is recommended.

2.7. Improvements

A number of flood damage mitigation improvement alternatives were considered for each flooded building or group of flooded buildings. General options for improvement alternatives included: property acquisition, structure elevation, flood proofing, construction of floodwalls/levees, channel improvements, infrastructure improvements, detention, and a no action option.

Costs and subsequent B:C ratios (as described above) were developed for each improvement alternative that was deemed as a feasible alternative. More detailed information on the improvements investigated in this study and the economic analysis results are presented in Sections 3.5.1 and 3.5.2, respectively.

3. FLOOD HAZARD MITIGATION

3.1. Storm Water Service Requests

Mecklenburg County and the City of Charlotte maintain a joint City/County storm water service request hotline where residents can call and request service for storm water related issues/problems. Requests can be made for any storm water related issues (e.g. pipe repair, inoperable structure, yard flooding, etc.), and are thus typically associated with localized issues (which are not addressed in this study), rather than stream overbank flooding. However, presenting this information can be useful for identifying chronic problems.

Information provided by MCSWS indicates that there have been three (3) recent storm water service requests. All the requests were for properties along McMullen Creek, however, none of the requests are for buildings that were identified as flooding in the 100-yr FCF (i.e. included in the B:C analysis). The addresses of the outstanding requests are provided below for general reference:

- 4328 Deepwood Drive (July 2001)
- 3624 Chevington Road (February 2002)
- 3608 Chevington Road (May 2002).

3.2. Repetitive Loss Structures

A repetitive loss structure is defined as any structure that has had two or more flood-related insurance claims during a 10-year period. Repetitive loss structures are of special interest in local mitigation planning since they are being targeted by FEMA for mitigation assistance, and thus are generally the most eligible for federal funding.

Information provided by MCSWS indicates that there are eight (8) repetitive loss properties within the McMullen Creek Watershed. A total of nineteen (19) claims amounting to approximately $121,000 have been paid to these properties between 1982 and 2003. Similarly to the storm water service requests, repetitive loss structure claims may be the result of localized issues as well as, stream overbank flooding.

Two of the eight repetitive loss structures were identified as flooding in the 100-yr FCF, and thus included in the B:C analysis (denoted with an asterisk (*)). The addresses of the repetitive loss structures are provided below:

- 4039 Abingdon Road
- 400 Allendale Place
- 3532 Chevington Road
- 227 Chillingworth Lane
- 2422 Cloister Drive
- 2500 Cloister Drive
- 4815 Stafford Circle*
- 1100 Willhaven Drive*.

3.3. Permanent Storm Water Easements

Based on GIS database information obtained from City SWS, there are thirty one (31) permanent storm water easements within the McMullen Creek Watershed, of which twenty five (25) are located on properties along one of the study streams in this report. The addresses of the 25 easements are listed below. Seven (7) of the addresses are included in the B:C analysis and are denoted with an asterisk (*).

- 111 Circlewood Drive
- 1101 Circlewood Drive
- 2432 Cloister Drive
- 2442 Cloister Drive
- 4645 Emory Lane
- 4703 Emory Lane

- 4751 Emory Lane
- 5120 Havilon Court
- 5126 Havilon Court
- 400 Roselawn Place
- 406 Roselawn Place
- 4815 Stafford Circle*
- 5101 Strawberry Hill Drive
- 5105 Strawberry Hill Drive
- 5111 Strawberry Hill Drive*
- 5125 Strawberry Hill Drive*
- 5131 Strawberry Hill Drive*
- 5135 Strawberry Hill Drive*
- 5141 Strawberry Hill Drive
- 5145 Strawberry Hill Drive
- 5151 Strawberry Hill Drive
- 5155 Strawberry Hill Drive
- 1130 Willhaven Drive*
- 1142 Willhaven Drive*
- 1153 Willhaven Drive

3.4. Roadway Overtopping Locations

Roadway overtopping refers to the situation where the calculated WSE in a stream is above the top of the roadway surface. Although this study focused on the mitigation of floodprone buildings, overtopping depths were identified at each road crossing, since overtopping can represent a significant hazard during large storm events. For example, motor vehicles can be swept away in as little as 24 inches of flood flow depths over a road.

Roadway culverts/bridges are typically designed to pass a certain frequency storm event without overtopping, based on their level of service. For example a residential road is often designed to be protected from a 10-yr and smaller storm events, where as an interstate may be designed to be protected from a 100-yr and smaller storm events. Storms larger than the design frequency are "allowed" to overtop the road, and thus not considered to be a problem. However, it is considered a problem if a storm event equal to or smaller than the design frequency overtops the roadway (ex. a 2-yr or 10-yr event overtops a residential roadway).

Roadway overtopping depths were identified within the McMullen Creek Watershed by comparing results of the HEC-RAS models to roadway geometry. Evaluating the level of service and an appropriate "designed" capacity for road crossings was beyond the scope of this study, therefore roadway overtopping "problems" were not specifically identified. However, since public roads are designed for a 10-yr event or greater, any roadway which is overtopped in the 10-yr event can be considered as problematic. Overtopping depths for the future condition 10-, 50-, and 100-yr storms at all study stream roadway crossings, are presented in Table 5 below.

Table 5. Roadway Overtopping Problem Locations

McMullen Creek	Crossing Structure Type/Size	FC 100-yr WSE (FT. NAVD)	FC 10-yr Overtopping Depth (FT)	FC 50-yr Overtopping Depth (FT)	FC 100-yr Overtopping Depth (FT)
I-485 West *	Bridge	536.2	-6.4	-2.9	-1.8
Pineville-Matthews Road	4-12'x12' Box	543.2	-6.0	-2.6	-1.5
Johnston Road	Bridge	545.9	-9.4	-6.2	-5.2
Quail Hollow Road	Bridge	568.7	-14.4	-12.0	-11.4
Mountainbrook Road	3-12'x12' Box	595.5	-2.4	0.9	1.9
Sharon View Road	3-12'X14' Box	608.2	-7.0	-4.2	-3.1
Colony Road	2-22'x11.5' CMPA	613.8	-5.0	-0.4	0.8
Fariview Road	1-13'x7 & 3-11'x13' Box	626.6	-3.3	-0.6	0.5
Arborway	3-10'x10' Box	635.9	-0.7	2.1	2.6
Providence Road	2-12'x14' Box	652.3	-7.3	-3.1	-1.5

Randolph Road	2-11'x11' Box	659.2	1.4	2.6	3.0
Lincrest Place	3-4' RCP	667.7	3.1	4.9	5.4
Addison Drive	2-4' RCP	667.8	1.8	3.2	3.8
McMullen Creek Tributary					
Addison Drive	2-6' RCP	670.9	1.8	2.5	2.9
Private Church Drive	2-4' RCP	680.0	2.6	3.1	3.5
N.Sharon Amity Road	1-11.5'x6.5' CMPA	687.2	1.0	1.6	1.8

* Flooding from McAlpine Creek backwater, WSEs from Sta 23351 in McAlpine HEC-RAS model.

For those roadways which do indicate significant overtopping the County may want to be consider the following general issues for future action:

- Signage of roadway overtopping warning for avoiding road crossing during flood event.
- Coordination with Police Dept. and Fire Dept. for special attention during flood event.
- Routine inspection for bridge/culvert scour and safety conditions, such as a lack of guardrail (or handrail). Guardrail post would give indication of the edge of the structure when inundated during flood flows.

3.5. Flood Mitigation Improvement Analysis

The flood damage assessment, discussed in Section 2, identified a total of 309 floodprone buildings (i.e. buildings whose footprint intersects the 100-yr FCF) within the McMullen Creek Watershed. This figure excludes miscellaneous accessory buildings such as garages, sheds, park shelters, and similar. Further analysis, survey, and comparison with existing County elevation certificates, revealed that 74 (24%) of these 309 buildings have a finished floor elevation below the predicted 100-yr future condition WSE, and thus are expected to incur flood damage. Figure 5 provides a conceptual illustration of the floodprone and flooding buildings.

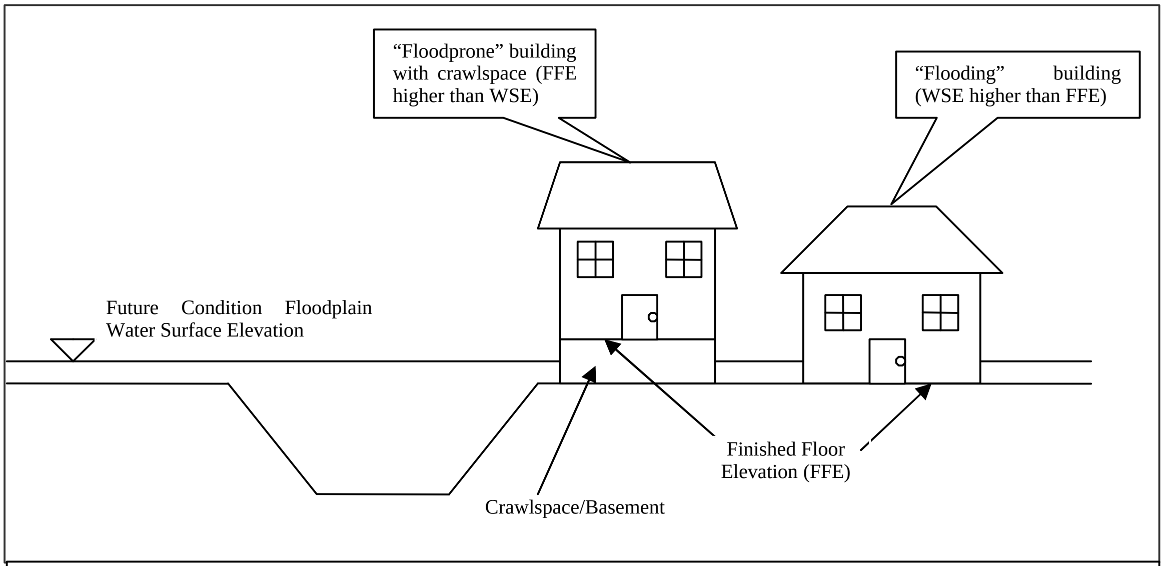


Figure 5. "Floodprone" versus "Flooding" Building Concept Illustration

Since local flood mitigation efforts are often undertaken with the goal of receiving financial assistance from FEMA, additional information was organized to facilitate receiving funding. FEMA considers a number of criteria in evaluating flood mitigation assistance (FMA) and Hazard Mitigation Grant Fund (HMGP) requests. One such criterion – repetitive loss structure information, was previously discussed in this section. Another criterion that is used, relates to whether or not floodprone structures were built before Flood Insurance Rate Maps (FIRMs) were available. Buildings constructed prior to available FIRM maps are termed as "pre-FIRM" structures – those built after firm maps are termed "post-FIRM" structures. FIRM maps for Mecklenburg County were first produced in 1978. In addition to FMA and HMGP, pre- and post-FIRM information is also used in the Community Rating System (CRS) evaluation, which can provide additional assistance to municipalities and property owners. Table 6 provides a summary of floodprone building and pre-/post-FIRM information for the study streams in the McMullen Creek Watershed.

Table 6. Flooding Structures Summary

Stream Name	Floodprone Buildings*			Flooding Buildings**		
	Pre-FIRM	Post-FIRM	Sub-Total	Pre-FIRM	Post-FIRM	Sub-Total
McMullen Creek	108	177	285	32	36	68
McMullen Creek Tributary	24	0	24	6	0	6
WATERSHED TOTALS	132	177	309	38	36	**74**

* Buildings that are within the 100-yr future condition floodplain
** Buildings with a finished floor elevation below the 100-yr future condition water surface elevation

Note: Pre-FIRM structures were constructed before 1978; Post-FIRM structures were constructed in 1978 or later.

Flood mitigation of buildings predicted to incur flood damage is the primary focus of this report. Thus, mitigation improvement alternatives were investigated for these 74 "flooding" buildings, and are discussed in the following sub-sections.

3.5.1. Overview of Mitigation Improvement Alternatives

Several potential improvement alternatives were evaluated to eliminate/reduce flooding damage along the study streams. These alternatives were generally evaluated for flood reduction capability, constructability, social/environmental impact, downstream impact, and economic feasibility. The evaluation was a planning level evaluation only - no design calculations, survey, or detailed analysis were used. The alternatives evaluated included: "no action", property acquisition, structure elevation, flood proofing, construction of levees/floodwalls, infrastructure modification, channel modification, and upstream detention. An overview and preliminary evaluation of each alternative is discussed below.

Alternative 1 – No Action

In any flood mitigation study, where public safety or other concern is not a critical issue, there is the "no action" alternative (i.e. leaving the flooding situation as it is). This is the default alternative that is used when there is no other feasible option, or when the damages associated with periodic flooding do not justify the costs associated with implementing any of the other alternatives (i.e. B:C < 1.0 for all other alternatives). The "no action" option was considered as a feasible alternative, and is further discussed in the evaluation of specific problem areas in the next sub-section.

Alternative 2 – Property Acquisition

Property acquisition is a process in which flood-prone properties are purchased and converted to wetland detention, park area, or some other open space which would allow flood waters to naturally expand. Acquisition is a simple and practical solution since it physically removes the structure from the floodplain, rather than trying to engineer a solution, which always has risk associated with it. In addition, this method provides environmental and aesthetic benefits, and downstream flooding relief.

Another advantage of property acquisition is that Mecklenburg County has significant experience with it for flood mitigation. The County has acquired over 130 floodprone properties for other projects, and thus gone through the many aspects associated with buyout (i.e. funding, real estate, technical, etc.). The County has used the acquired land for water quality enhancements, stream restoration, and other beneficial uses.

The primary constraints of property acquisition are economic feasibility and social impacts. The cost of acquisition is often high in urban areas, and thus economics may favor other improvement alternatives. In addition, sometimes flood-prone areas have historical, sentimental, or other significance that generates strong public opposition.

For the purposes of this planning study, property acquisition was assumed to consist of property buyout and building demolition. The cost associated with property buyout, for each parcel, was obtained from the County tax database (2002). A unit cost for demolition of $0.25 per cubic foot of building was added to the market value to estimate total property acquisition costs. Property acquisition was considered as a feasible alternative at appropriate locations, and is further discussed in the evaluation of specific problem areas in the next sub-section.

Alternative 3 – Structure Elevation

Structure elevation is a mitigation alternative in which a floodprone structure is physically elevated above the predicted flood elevations. Standard practice is to elevate a structure to one foot (1-ft) above the 100-yr WSE (i.e. 1-ft freeboard). This is typically accomplished on existing structures by extending foundation walls, or using piles, columns, or fill to elevate the structure.

One benefit of structure elevation is that there is minimal change in natural of flood flows. Although, it is possible to elevate almost any structure, it is most appropriate for smaller structures (e.g. residential buildings), especially those with crawlspaces or basements. A limitation of elevation is that although the living area of the structure is protected during a flood event, the surrounding area is inundated, and thus evacuation of the structure may be necessary.

Structure elevation costs were estimated from unit costs provided in FEMA Publication 259 (2001). The original unit costs were adjusted to reflect current economic conditions (i.e. ENR Construction Index) and geographic conditions (i.e. locality adjustment). Adjusted unit costs ranged from $14 to $39 per square foot, depending on building conditions (i.e. wood vs. brick, built on crawl space vs. slab, etc.). A 20% contingency was applied to all unit costs to derive final elevation costs. Structure elevation was considered as a feasible alternative at appropriate locations, and is further discussed in the evaluation of specific problem areas in the next sub-section.

Alternative 4 – Flood Proofing

Flood proofing can refer to several flood damage reduction techniques, however, in this context flood proofing refers to watertight reconstruction of buildings, or "dry" flood proofing. Watertight construction can include sealing building walls with waterproof substances and using flood shields or doors to protect building openings from floodwaters. Flood proofing is generally only applicable for flood depths less than 3 feet, as depths greater than 3 feet generally require structural reinforcement due to the increased hydrostatic and uplift forces caused by the floodwaters (USACE, 1993).

Similar to structure elevation, flood proofing can be implemented on most types of structures, however, it is most appropriate for masonry buildings built with slab-on-grade construction (e.g. warehouses, industrial/commercial buildings, etc.). Generally, these types of structures are sturdy and are more capable of withstanding greater forces associated with floodwaters. In addition, flood-proofing construction, such as watertight doors and flood shields are generally less aesthetically obtrusive on industrial buildings.

The costs associated with flood proofing are a function of the number/type of openings a building has, construction materials, and properties of the buildings utilities. Since this information is very building specific, a flat cost of $50,000 per structure was assumed for this project. This estimate is based on previous flood proofing experience in Mecklenburg County. A 20% contingency was applied to the flat rate to estimate final costs for flood proofing. Flood proofing was considered as a feasible alternative at appropriate locations, and is further discussed in the evaluation of specific problem areas in the next sub-section.

Alternative 5 – Construction of Levees/Floodwalls

Floodwalls and levees are constructed to create a physical barrier between floodwaters and low-lying structures. The primary difference between a levee and a floodwall is that a levee is an earthen embankment with sloped sides, whereas, a floodwall is a concrete or brick wall with vertical sides. Unlike the alternatives mentioned above, floodwalls and levees usually provide protection on a general area, rather than on individual structures.

Floodwalls are often preferred in urban settings because they are thinner, occupy less space, and generally require less maintenance than levees. The primary drawback of floodwalls and levees is that they can greatly constrict the natural flow of water. This constriction can subsequently increase stream velocities, remove natural storage, and increase upstream and downstream water surface elevations. High velocities can increase erosion potential, as well as have adverse environmental effects. The removal of natural storage and the increase in downstream water surface elevations can create increased flooding conditions downstream. In addition, levees also impede the path of natural drainage to a creek, thus requiring an additional drainage system to be constructed.

Costs for constructing levees and floodwalls are highly project dependent, since there are many site specific factors in design (i.e. soils, conflicts with utilities, local permitting, etc.). For purposes of this planning study, costs for levees/floodwalls were estimated from unit costs provided in FEMA Publication 259 (2001). The original unit costs were adjusted to reflect current economic conditions (i.e. ENR Construction Index) and geographic conditions (i.e. locality adjustment). Adjusted unit costs ranged from $31 to $370 per linear foot, depending on the height and type of structure (i.e. levee vs. floodwall). A 30% contingency was applied to all unit costs to estimate final construction costs. Construction of levees/floodwalls was considered as a feasible alternative at appropriate locations, and is further discussed in the evaluation of specific problem areas in the next sub-section.

Alternative 6 – Infrastructure Modification

Infrastructure modification refers to making adjustments to bridges, culvert, and/or roadways to protect floodprone structures and/or to eliminate roadway overtopping. Inadequately sized bridges/roadways are often are a cause of many urban drainage problems. When hydraulic capacity of a bridge/roadway is exceeded, flood waters can build up behind the abutments and cause upstream flooding. The potential effectiveness of increasing the capacity of bridges/roadways can be seen by examining the flood profile. The flood profile displays the difference in the water surface elevation between the downstream and upstream sides. If the profile shows a large difference in upstream and downstream water surface elevations, increasing the size of the pipe or culvert will reduce the backwater effect. However, if there is little difference in the water surface elevations, the significance of enlarging the pipe or culvert will have little effect. It is important to consider the potential downstream impact for any infrastructure modification in order to ensure that increasing flow capacity in one location will not create or worsen flood hazards downstream.

Costs for infrastructure modification are highly project dependent, since they depend on the type and magnitude of improvements being made (e.g. upsizing culverts, raising roadways, adding bridges, etc.). Due to the wide variety of modifications, costs were developed using general estimating procedures and state bid tables. Infrastructure modification was considered as a feasible alternative at appropriate locations, and is further discussed in the evaluation of specific problem areas in the next sub-section.

Alternative 7 **–** Channel Modification

Modifications to an existing channel can provide a means of reducing flooding, and can include: widening channel banks, clearing of channel sections, lowering channel inverts and cutting back side slopes. The basic mechanism for these improvements is increasing channel conveyance, thus allowing more water flow through the channel boundaries. Channel improvements are generally more applicable to controlling higher frequency, smaller magnitude storms, rather than providing protection against larger magnitude storms, as is the case in this study. This is because flow in the higher magnitude storms is generally spread out in the floodplain area, rather than contained within the channel. In addition, improvements to the channel in highly urban areas are more complex, due to the numerous roadway decks, small work area, and the presence of a stream junction.

Channel modification for flood control has become less popular in recent years due to adverse environmental and aesthetic effects that modification can cause. Examples of adverse effects include an increase in flow velocities, erosion potential, sedimentation, habitat degradation, and downstream flooding. Channel modification for flood control is indeed contradictory to many of the recent efforts of Mecklenburg County to restore previously modified streams to a more natural, healthy state (e.g. Freedom Park Stream Restoration Project). Due to these factors, channel modification will not be further evaluated in this report.

Alternative 8 **–** Upstream Detention

Upstream detention is another option for mitigating floodprone areas. Unlike the previous alternatives which involve modifications directly in the floodprone area, detention is generally implemented upstream of the problem location, where there may or may not be any flooding problems. The basic of idea of a detention facility is to reduce peak flood flows (and thus reduce peak WSEs) by temporarily storing the flood flows, and releasing them at a designed rate. The impact of detention is typically an attenuation or "flattening" of the flood hydrograph. Similar to channel improvements, detention is often used for smaller magnitude storms, and in new land development. Detention can be used for large magnitude floods, but the amount of land required for holding the larger volume of floodwater is often a limiting factor, especially in highly urban areas such as the study watershed. Large detention ponds can have adverse environmental effects as well as bring opposition from the public. Due to these factors, detention will not be further evaluated in this report.

3.5.2. Problem Area Evaluation

As previously noted in this section (Table 6), there were a total of 74 buildings identified within the McMullen Creek Watershed for which potential mitigation alternatives were investigated. For clarity in analysis and presentation, the identified buildings were categorized into flood problem areas based on study stream, geographic proximity, and cause/magnitude of flooding. A total of 68 buildings along McMullen Creek were grouped into 18 individual flood problem areas (MM01 – MM18). Six flooding buildings along McMullen Creek Tributary were grouped into one flood problem area (MMT1). Results of the mitigation improvement alternative analysis for the individual flood problem areas are summarized below. Figure E-1 is an overall map that shows locations of the problem areas. Figures E-2 through E-8 illustrate the specific location of recommended improvements for each problem area. All E-figures are located in the Executive Summary. In addition, a summary of the individual B:C analysis, which includes addresses and parcel identification numbers for each individual structure, is presented in Appendix B.

MM01 – McAlpine Wastewater Treatment Plant (Figure E-2)

Problem area MM01 includes two buildings in the McAlpine Creek WWTP complex – located at the confluence of McMullen Creek and McAlpine Creek. The buildings were identified as a pump station and a switch gear station. These structures are located in the flood fringe outside of the community encroachment (0.1 foot) floodway. Flooding depths range are 0.6 and 0.8 respectively in the future condition 100-yr storm. Dewberry staff met with Charlotte-Mecklenburg Utilities (CMU) officials in November 2002 and followed up via phone in October 2003 to discuss flood hazard and flood control for the McAlpine WWTP. CMU indicated that there are projects presently underway that will protect the pump station and switch gear station against the future condition 100-yr storm event. Completion of final design and construction is expected by the end of 2004. More details are provided in the November 2002 meeting minutes included in Appendix D. Since CMU is providing flood protection to the flooding buildings, the recommendation for MM01 is no action.

Table 7. Problem Area MM01 Mitigation Summary

	Total # of Buildings Flooding	Average Flood Depth	Max Flood Depth	Total Flood Damage	Recommended Mitigation	Buildings Protected by Mitigation	Benefit From Mitigation	Total Mitigation Cost	Overall B:C Ratio for Mitigation
Floodway	0	-	-	-	-	-	-	-	-
Non-Floodway	2	0.7	0.8	$258,957	No Action*	2	$258,957	-	-
Totals	2	0.7	0.8	$258,957	No Action*	2	$258,957	-	-

*CMU to provide flood protection through existing projects

MM02 – Candlelight Court/Lone Star Circle (Figure E-2)

Problem area MM02 includes six residential houses along McMullen Creek – four on Candlelight Court and two on Lone Star Circle. None of these houses are within the community encroachment (0.1 foot) floodway. Flooding depths in the future condition 100-yr storm range from 0.2 ft to 1.0 ft, with an average of 0.5 ft. Four alternatives were evaluated for MM02 – no action, property acquisition, structure elevation, and the construction of an 810 ft levee. Individual B:C ratios for the buildings ranged from 0.1 to 0.7. All of the investigated alternatives resulted in a B:C ratio of less than 1.0, therefore, the recommendation for the MM02 problem area is no action.

Table 8. Problem Area MM02 Mitigation Summary									
	Total # of Buildings Flooding	Average Flood Depth	Max Flood Depth	Total Flood Damage	Recommended Mitigation	Buildings Protected by Mitigation	Benefit From Mitigation	Total Mitigation Cost	Overall B:C Ratio for Mitigation
Floodway	0	-	-	-	-	-	-	-	-
Non-Floodway	6	0.5	1.0	$77,119	No Action	0	-	-	-
Totals	6	0.5	1.0	$77,119	No Action	0	-	-	-

MM03 – Park Vista Circle/Camelback Circle (Figure E-2)

Problem area MM03 includes four residential houses along McMullen Creek – two on Park Vista Circle and two on Camelback Circle. None of these houses are within the community encroachment (0.1 foot) floodway. Flooding depths in the future condition 100-yr storm range from 0.1 ft to 1.4 ft, with an average of 0.8 ft. Three alternatives were evaluated for MM03 – no action, property acquisition, and structure elevation. Individual B:C ratios for the buildings ranged from 0.1 to 0.5. All of the investigated alternatives resulted in a B:C ratio of less than 1.0, therefore, the recommendation for the MM03 problem area is no action.

Table 9. Problem Area MM03 Mitigation Summary									
	Total # of Buildings Flooding	Average Flood Depth	Max Flood Depth	Total Flood Damage	Recommended Mitigation	Buildings Protected by Mitigation	Benefit From Mitigation	Total Mitigation Cost	Overall B:C Ratio for Mitigation
Floodway	0	-	-	-	-	-	-	-	-
Non-Floodway	4	0.8	1.4	$62,352	No Action	0	-	-	-
Totals	4	0.8	1.4	$62,352	No Action	0	-	-	-

MM04 – Charter Oak Lane (Figure E-3)

Problem area MM04 includes three townhouse complex buildings located on Charter Oak Lane (between Johnston Road and Pineville-Mathews Road) along McMullen Creek. None of the buildings are within the community encroachment (0.1 foot) floodway. Flooding depths in the future condition 100-yr storm range from 1.3 ft to 2.7 ft, with an average of 2.1 ft. Three alternatives were evaluated for MM04 – no action, property acquisition, and structure elevation. Individual B:C ratios for the buildings ranged from 0.3 to 0.8. All of the investigated alternatives resulted in a B:C ratio of less than 1.0, therefore, the recommendation for the MM04 problem area is no action.

Table 10. Problem Area MM04 Mitigation Summary									
	Total # of Buildings Flooding	Average Flood Depth	Max Flood Depth	Total Flood Damage	Recommended Mitigation	Buildings Protected by Mitigation	Benefit From Mitigation	Total Mitigation Cost	Overall B:C Ratio for Mitigation
Floodway	0	-	-	-	-	-	-	-	-
Non-Floodway	3	2.1	2.7	$206,832	No Action	0	-	-	-
Totals	3	2.1	2.7	$206,832	No Action	0	-	-	-

MM05 – Cedar Creek Lane (Figure E-3)

Problem area MM05 includes one apartment building (Summit Creek Apartment Complex) on Cedar Creek Lane along McMullen Creek. The structure is inundated by 0.4 feet of water in the future condition 100-yr storm, but is outside of the community encroachment (0.1 foot) floodway. Three alternatives were evaluated for MM05 – no action, property acquisition, and structure elevation. B:C ratios for acquisition and elevation were both 0.1, therefore, the recommendation for the MM05 problem area is no action.

Table 11. Problem Area MM05 Mitigation Summary									
	Total # of Buildings Flooding	Average Flood Depth	Max Flood Depth	Total Flood Damage	Recommended Mitigation	Buildings Protected by Mitigation	Benefit From Mitigation	Total Mitigation Cost	Overall B:C Ratio for Mitigation
Floodway	0	-	-	-	-	-	-	-	-
Non-Floodway	1	0.4	0.4	$53,961	No Action	0	-	-	-
Totals	1	0.4	0.4	$53,961	No Action	0	-	-	-

MM06 – Standing Stone Court (Figure E-3)

Problem area MM06 includes two residential houses located on Standing Stone Court along McMullen Creek. Both of theses houses are outside the community encroachment (0.1 foot) floodway. Flooding depths in the future condition 100-yr storm range from 1.9 ft to 4.3 ft, with an average of 3.1 ft. Three alternatives were evaluated for MM06 – no action, property acquisition, and structure elevation. Individual B:C ratios for the buildings ranged from 0.2 to 2.2. The house with the predicted 4.3 flood depth (Parcel ID 20949123) had a B:C ratio of just less than 1.0 for acquisition and a value of 2.2 for elevation. The other residence had B:C ratios less than 1.0. The recommended alternative for MM06 is elevation of one residential house and no action for the other.

Table 12. Problem Area MM06 Mitigation Summary									
	Total # of Buildings Flooding	Average Flood Depth	Max Flood Depth	Total Flood Damage	Recommended Mitigation	Buildings Protected by Mitigation	Benefit From Mitigation	Total Mitigation Cost	Overall B:C Ratio for Mitigation
Floodway	0	-	-	-	-	-	-	-	-
Non-Floodway	2	3.1	4.3	$411,718	Elevation/No Action	1	$336,766	150,000	2.2
Totals	2	3.1	4.3	$411,718	Elevation/No Action	1	$336,766	150,000	2.2

MM07 – Summer House Court/ Wolf Trap Court (Figure E-3)

Problem area MM07 includes ten residential houses on Summer House Court and Wolf Trap Court, along McMullen Creek. All of these houses are located outside the community encroachment (0.1 foot) floodway. Flooding depths in the future condition 100-yr storm range from 0.3 ft to 1.8 ft, with an average of 0.7 ft. Four alternatives were evaluated for MM07 – no action, property acquisition, structure elevation, and a combination levee/wetland. The combination levee/wetland would consist of an approximate 6+ ft high, 1400 ft long, levee section along the back side of the houses. The levee by itself (i.e. without the wetland) had a B:C ratio of approximately 0.6, however, it is not hydraulically feasible by itself (i.e. would raise WSE). Thus, the wetland and/or stream restoration would be required on the opposite bank to account for lost conveyance/storage from the levee. B:C ratios for the buildings ranged from 0.1 for acquisition to 0.4 for elevation. The combination levee/wetland had a B:C of 0.3. Although the combination levee/wetland had an inadequate B:C, the east bank of McMullen Creek at this location appears to be a suitable site for wetland creation/restoration. There are several incoming tributaries, the area is flat, and the site is on poorly drained soils (Monacan class). The recommendation for the MM07 problem area is no action for flood mitigation purposes, but further investigation of wetland creation/restoration along the East bank.

Table 13. Problem Area MM07 Mitigation Summary									
	Total # of Buildings Flooding	Average Flood Depth	Max Flood Depth	Total Flood Damage	Recommended Mitigation	Buildings Protected by Mitigation	Benefit From Mitigation	Total Mitigation Cost	Overall B:C Ratio for Mitigation
Floodway	0	-	-	-	-	-	-	-	-
Non-Floodway	10	0.7	1.8	$196,992	No Action/Wetland*	0	-	-	-
Totals	10	0.7	1.8	$196,992	No Action/Wetland*	0	-	-	-

* Wetland is for potential environmental restoration, contingent upon further investigation. It does not provide flood mitigation benefit.

MM08 – Carmel Acres Drive (Figure E-4)

Problem area MM08 includes two residential houses located on Carmel Acres Drive, along McMullen Creek. Both of theses houses lie within the community encroachment (0.1 foot) floodway. Flooding depths in the future condition 100-yr storm range from 0.5 ft to 5.9 ft, with an average of 3.4 ft. Three alternatives were evaluated for MM08 – no action, property acquisition, and structure elevation. Computed flood damages are very high for the house with the 5.9 flood depth (Parcel ID 20926221), since it is expected to experience significant flooding even at the 10-yr storm event. Individual B:C ratios for the buildings ranged from 0.1 to 19.4. The house with the 5.9 predicted flood depth had a B:C ratio greater than 1.0 for both acquisition and elevation (10.3 and 19.4 respectively). The recommendation for the MM08 problem area is property acquisition of the house flooding by 5.9 feet and no action for the other.

Table 14. Problem Area MM08 Mitigation Summary

	Total # of Buildings Flooding	Average Flood Depth	Max Flood Depth	Total Flood Damage	Recommended Mitigation	Buildings Protected by Mitigation	Benefit From Mitigation	Total Mitigation Cost	Overall B:C Ratio for Mitigation
Floodway	2	3.4	5.9	$2,744,292	Property Acquisition/No Action	1	2,715,725	263,222	10.3
Non-Floodway	0	-	-	-	-	-	-	-	-
Totals	2	3.4	5.9	$2,744,292	Property Acquisition/No Action	1	2,715,725	263,222	10.3

MM09 – Huckleberry Road (Figure E-5)

Problem area MM09 includes the clubhouse for the Beverly Woods residential community off Huckleberry Road, along the West side of McMullen Creek. The structure is inundated by 4.7 feet of water in the future condition 100-yr storm, and lies within the community encroachment (0.1 foot) floodway. Three alternatives were evaluated for MM09 – no action, property acquisition, and structure elevation. B:C ratios for acquisition and elevation are 3.3 and 16.1. Normally, the general rule of always recommending acquisition over all other mitigation alternatives (rather than recommending the alternative with the highest B:C) could be waived for a situation like this, where the structure in question is a recreational structure, rather than a residence or commercial structure. However, since the clubhouse is in both the 0.1 and 0.5 foot floodways, the recommendation for MM09 is acquisition.

Table 15. Problem Area MM09 Mitigation Summary

	Total # of Buildings Flooding	Average Flood Depth	Max Flood Depth	Total Flood Damage	Recommended Mitigation	Buildings Protected by Mitigation	Benefit From Mitigation	Total Mitigation Cost	Overall B:C Ratio for Mitigation
Floodway	1	4.7	4.7	$1,026,403	Acquisition	1	$1,026,403	$310,246	3.3
Non-Floodway	0	-	-	-	-	-	-	-	-
Totals	1	4.7	4.7	$1,026,403	Acquisition	1	$1,026,403	$310,246	3.3

MM10 – Johnny Cake Lane/Mountainbrook Road (Figure E-6)

Problem area MM10 includes six residential houses located on a 1690 foot reach of McMullen Creek, downstream of Mountainbrook Road. One house is on Mountainbrook Road and the other five are on Johnny Cake Lane. The house on Mountainbrook Road and one other on Johnny Cake Lane are located in the community encroachment (0.1 foot) floodway, while the others are located in the floodplain fringe. Flooding depths in the future condition 100-yr storm range from 0.4 ft to 3.2 ft with an average of 2.2 ft. Three alternatives were evaluated for MM10 – no action, property acquisition, and structure elevation. Individual B:C ratios for the buildings ranged from 0.1 to 5.7. The recommendation for the MM10 problem area is property acquisition of the house on Mountainbrook Road and one house on Johnny Cake Lane (Parcel ID 20911206), elevation of two houses, and no action for the remaining two houses. The B:C ratio of acquisition for the house on Mountainbrook Road is actually slightly less than 1.0 (i.e. 0.95), however, acquisition is recommended over elevation since it is in the floodway.

Table 16. Problem Area MM10 Mitigation Summary

	Total # of Buildings Flooding	Average Flood Depth	Max Flood Depth	Total Flood Damage	Recommended Mitigation	Buildings Protected by Mitigation	Benefit From Mitigation	Total Mitigation Cost	Overall B:C Ratio for Mitigation
Floodway	2	2.6	2.7	$349,200	Acquisition/No Action	1	$243,169	$255,552	1.0
Non-Floodway	4	2.0	3.2	$445,060	Acquisition/ Elevation/ No Action	3	$430,900	$274,464	1.6
Totals	6	2.2	3.2	$794,260	Acquisition/ Elevation/ No Action	4	$674,069	$530,016	1.3

MM11 –Downstream Sharon View Road (Figure E-6)

Problem area MM11 includes two residential houses located on an 860 foot reach of McMullen Creek, downstream of Sharon View Road. There is one house on Shaker Drive and another on Cambria Road. Both houses are located in the floodplain fringe. Flooding depths in the future condition 100-yr storm for the two houses are 1.5 and 1.6. Both houses are already elevated on full story foundations. Three alternatives were evaluated for MM11 – no action, property acquisition, and structure elevation. Floodwalls were initially considered, however, these were disregarded since both houses are elevated, thus the floodwall would need to be greater than 8 feet high to mitigate minor flooding. Individual B:C ratios for the two buildings were both less than 1.0, therefore “no action” is the recommended mitigation.

Table 17. Problem Area MM11 Mitigation Summary

	Total # of Buildings Flooding	Average Flood Depth	Max Flood Depth	Total Flood Damage	Recommended Mitigation	Buildings Protected by Mitigation	Benefit From Mitigation	Total Mitigation Cost	Overall B:C Ratio for Mitigation
Floodway	0	-	-	-	-	-	-	-	-
Non-Floodway	2	1.6	1.6	$236,062	No Action	0	-	-	-
Totals	2	1.6	1.6	$236,062	No Action	0	-	-	-

MM12 –Sharon View Road/Colony Road (Figure E-6)

Problem area MM12 includes six condominium complexes in an area near Sharon View Road and Colony Road, along a 1720 foot reach of McMullen Creek. All of the structures are within the floodplain fringe. Flooding depths in the future condition 100-yr storm range from 1.1 ft to 5.6 ft with an average of 3.2 ft. Due to the complexity of this problem area from multiple roadway crossings, varying building types (split-level, 2-story), flooded buildings on both sides of Creek, and other factors, several individual and combination alternatives were evaluated at this problem area. In addition to the standard no action, property acquisition, and structure elevation, infrastructure improvements and several different floodwall alternatives were evaluated at MM12. The infrastructure improvements (upsizing culverts) were initially considered at both road crossings since there is noticeable head loss (i.e. > 2') at each of the crossings. However, further investigation revealed that in addition to being very costly, several of the buildings flood at depths over 4 feet, and thus would still incur flood damage after the improvements. Thus, the infrastructure improvements alternative was disregarded. Numerous floodwall options were investigated, but several were dismissed due to hydraulic infeasibility (i.e. increasing WSE, and thus flooding structures on opposite side of creek). Overall, four alternatives were considered for MM12 – no action, property acquisition, structure elevation, and a combination floodwall/stream restoration alternative.

The combination floodwall/stream restoration would consist of an approximate 480 foot long, 8 foot high floodwall section along the back side of two of the condo buildings and approximately 800 feet of stream restoration. A bankfull bench cut on the opposite undeveloped bank would be used to account for lost storage/conveyance from the floodwall, and could be potentially used for a wetland creation site. Individual B:C ratios for the buildings ranged from 0.2 to 3.9. The recommendation for the MM12 problem area is no action for three buildings, acquisition of one building, and a combination floodwall/stream restoration project to protect the two remaining buildings.

Table 18. Problem Area MM12 Mitigation Summary

	Total # of Buildings Flooding	Average Flood Depth	Max Flood Depth	Total Flood Damage	Recommended Mitigation	Buildings Protected by Mitigation	Benefit From Mitigation	Total Mitigation Cost	Overall B:C Ratio for Mitigation
Floodway	0	-	-	-	-	-	-	-	-
Non-Floodway	6	3.2	5.6	$1,876,943	Floodwall-Stream Restoration/ Acquisition/ No Action	3	$1,428,474	$570,532	2.5
Totals	6	3.2	5.6	$1,876,943	Floodwall-Stream Restoration/ Acquisition/ No Action	3	$1,428,474	$570,532	2.5

MM13 – Fairview Road (Figure E-6)

Problem area MM13 includes the clubhouse for the Foxcroft residential community just upstream of the Fairview Road crossing on McMullen Creek. The structure is inundated by 1.1 feet of water in the future condition 100-yr storm, and lies within the community encroachment (0.1 foot) floodway. Three alternatives were evaluated for MM13 – no action, property acquisition, and structure elevation. B:C ratios for the two improvements alternatives were both 0.2. Since none of the alternatives were cost-effective, the recommendation for MM13 is no action.

Table 19. Problem Area MM13 Mitigation Summary									
	Total # of Buildings Flooding	**Average Flood Depth**	**Max Flood Depth**	**Total Flood Damage**	**Recommended Mitigation**	**Buildings Protected by Mitigation**	**Benefit From Mitigation**	**Total Mitigation Cost**	**Overall B:C Ratio for Mitigation**
Floodway	1	1.1	1.1	$11,137	No Action	0	-	-	-
Non-Floodway	0	-	-	-	-	-	-	-	-
Totals	1	1.1	1.1	$11,137	No Action	0	-	-	-

MM14 – Abingdon Road (Figure E-7)

Problem area MM14 includes one residential house on Abingdon Road along McMullen Creek. The structure is inundated by 1.4 feet of water in the future condition 100-yr storm, and lies within the community encroachment (0.1 foot) floodway. Four alternatives were evaluated for MM14 – no action, property acquisition, and structure elevation, and a 440 foot long floodwall. B:C ratios for the building ranged from 0.1 for acquisition to 0.8. Since none of the alternatives were cost-effective, the recommendation for problem area MM14 is no action.

Table 20. Problem Area MM14 Mitigation Summary									
	Total # of Buildings Flooding	**Average Flood Depth**	**Max Flood Depth**	**Total Flood Damage**	**Recommended Mitigation**	**Buildings Protected by Mitigation**	**Benefit From Mitigation**	**Total Mitigation Cost**	**Overall B:C Ratio for Mitigation**
Floodway	1	1.4	1.4	$44,977	No Action	0	-	-	-
Non-Floodway	0	-	-	-	-	-	-	-	-
Totals	1	1.4	1.4	$44,977	No Action	0	-	-	-

MM15 – Pinehurst Apartments Drive (Figure E-7)

Problem area MM15 includes one split-level apartment building in a complex off of Pinehurst Apartments Drive. The building (at least the lower portion of the building) is inundated by 1.5 feet of water in the future condition 100-yr storm, and is located outside of the community encroachment (0.1 foot) floodway. Four alternatives were evaluated for MM15 – no action, property acquisition, and structure elevation, and a 620 foot long, combination earthen berm/floodwall. The combination berm/floodwall would consist of a 340 foot earthen berm section along the back side of the apartments, which would transition to an approximate 280 foot floodwall along the southwest side of the property. B:C ratios for the building ranged from 0.2 for acquisition to 1.6 for the berm/floodwall. The location of the levee is primarily in a back water area between more constrictive channel cross-sections in the County HEC-RAS models, so the impact on the WSE due to the small berm/floodwall is assumed to be negligible. The recommendation for area MM15 problem areas is constructing an average six foot high, 620 feet long, combination earthen berm/ floodwall.

Table 21. Problem Area MM15 Mitigation Summary									
	Total # of Buildings Flooding	**Average Flood Depth**	**Max Flood Depth**	**Total Flood Damage**	**Recommended Mitigation**	**Buildings Protected by Mitigation**	**Benefit From Mitigation**	**Total Mitigation Cost**	**Overall B:C Ratio for Mitigation**
Floodway	0	-	-	-	-	-	-	-	-
Non-Floodway	1	1.5	1.5	$165,554	Levee/ Floodwall	1	$165,554	$102,518	1.6
Totals	1	1.5	1.5	$165,554	Levee/ Floodwall	1	$165,554	$102,518	1.6

MM16 – Willhaven Drive/Strawberry Hill Drive (Figure E-8)

Problem area MM16 includes five residential houses on Willhaven Drive, and four apartment buildings off of Strawberry Hill Drive, along a 1370 foot reach of McMullen Creek. The five residential houses are located in the community encroachment (0.1 foot) floodway, whereas the apartment buildings are in the floodplain fringe. Flooding depths in the future condition 100-yr storm range from 0.2 ft to 5.0 ft, with an average of 1.7 ft. The residential houses are all on lower ground and are predicted to experience more significant flooding. Three alternatives were evaluated for MM16 – no action, property acquisition, and structure elevation. A floodwall option was initially considered, however, was it was dismissed since it would block access to the residential houses. Individual B:C ratios for the buildings ranged from 0.1 to 13.0. Three of the residential buildings had cost-effective B:C ratios - Parcel ID 18511115 had a B:C ratio of greater than 1.0 for acquisition, while the other two (Parcel IDs 18511114 and 18511130) had cost-effect B:Cs for elevation. Since the B:C of acquisition for Parcel ID 18511115 was close to 1.0 (0.9) and it is in the floodway, it was recommended for acquisition. The property at 1100 Willhaven Drive (PID 18511117) is a FEMA repetitive loss structure, but it has a higher floor elevation than the other residences and thus is not predicted to incur as much flood damage. The recommendation for the MM16 problem area is acquisition for two buildings, structure elevation for one building, and “no action” for the other six.

Table 22. Problem Area MM16 Mitigation Summary									
	Total # of Buildings Flooding	**Average Flood Depth**	**Max Flood Depth**	**Total Flood Damage**	**Recommended Mitigation**	**Buildings Protected by Mitigation**	**Benefit From Mitigation**	**Total Mitigation Cost**	**Overall B:C Ratio for Mitigation**
Floodway	5	2.8	5.0	$1,273,712	Acquisition/ Elevation/ No Action	3	$1,185,691	$433,195	2.7
Non-Floodway	4	0.4	0.7	$107,204	No Action	0	-	-	-
Totals	9	1.7	5.0	$1,380,916	Acquisition/ Elevation/ No Action	3	$1,185,691	$433,195	2.7

MM17 – Wonderwood Drive/Shasta Lane (Figure E-8)

Problem area MM17 includes two residential houses on Wonderwood Drive and Shasta Lane, along McMullen Creek. Flooding depths in the future condition 100-yr storm range from 0.9 ft to 1.3 ft, with an average of 1.1 ft. Both of these houses are located outside of the community encroachment (0.1 foot) floodway. Three alternatives were evaluated for MM17 – no action, property acquisition, and structure elevation. Individual B:C ratios for the buildings ranged from 0.1 to 0.6. All of the investigated alternatives resulted in a B:C ratio of less than 1.0, therefore, the recommendation for the MM17 problem area is no action.

Table 23. Problem Area MM17 Mitigation Summary

	Total # of Buildings Flooding	Average Flood Depth	Max Flood Depth	Total Flood Damage	Recommended Mitigation	Buildings Protected by Mitigation	Benefit From Mitigation	Total Mitigation Cost	Overall B:C Ratio for Mitigation
Floodway	0	-	-	-	-	-	-	-	-
Non-Floodway	2	1.1	1.3	$47,806	No Action	0	-	-	-
Totals	2	1.1	1.3	$47,806	No Action	0	-	-	-

MM18 – McMullen Creek/McMullen Creek Tributary Confluence (Figure E-8)

Problem area MM18 includes nine residential houses on Addison Drive, Lincrest Place, and Emory Lane near the McMullen Creek/McMullen Creek Tributary confluence. All but one of these houses are located within the community encroachment (0.1 foot) floodway. Flooding depths in the future condition 100-yr storm range from 0.4 ft to 2.3 ft, with an average of 1.3 ft. Three alternatives were evaluated for MM18 – no action, property acquisition, and structure elevation. Individual B:C ratios for the buildings ranged from 0.1 to 1.4, with structure elevation giving higher values. Two of the nine houses – Parcel Ids 18507103 and 18510336, had B:C ratios greater than 1.0 for structure elevation. Since their respective B:C ratios for acquisition were well under 1.0 (i.e. 0.4 and 0.6), they are recommended for elevation Thus, the recommendation for MM18 is structure elevation for the two buildings, and no action for the other seven.

Table 24. Problem Area MM18 Mitigation Summary

	Total # of Buildings Flooding	Average Flood Depth	Max Flood Depth	Total Flood Damage	Recommended Mitigation	Buildings Protected by Mitigation	Benefit From Mitigation	Total Mitigation Cost	Overall B:C Ratio for Mitigation
Floodway	8	1.2	2.3	$265,940	Elevtation/ No Action	2	$134,764	$116,496	1.2
Non-Floodway	1	1.3	1.3	$28,608	No Action	0	-	-	-
Totals	9	1.3	2.3	$294,549	Elevtation/ No Action	2	$134,764	$116,496	1.2

MMT1 – Stratford Circle/Emory Lane (Figure E-8)

Problem area MMT1 includes six residential houses on Stratford Circle and Emory Lane along an approximate 700 ft reach along McMullen Creek Tributary. Four of the six houses are within the community encroachment (0.1 foot) floodway. In addition, the house at 4815 Stafford Circle is a FEMA repetitive loss structure. Flooding depths in the future condition 100-yr storm range from 0.3 ft to 1.4 ft, with an average of 0.9 ft. Three alternatives were evaluated for MMT1 – no action, property acquisition, and structure elevation. Individual B:C ratios for the buildings ranged from 0.1 to 0.9. All of the investigated alternatives resulted in a B:C ratio of less than 1.0, therefore, the recommendation for the MMT1 problem area is no action.

Table 25. Problem Area MMT1 Mitigation Summary

	Total # of Buildings Flooding	Average Flood Depth	Max Flood Depth	Total Flood Damage	Recommended Mitigation	Buildings Protected by Mitigation	Benefit From Mitigation	Total Mitigation Cost	Overall B:C Ratio for Mitigation
Floodway	4	1.14	1.35	$195,860.19	No Action	0	-	-	-
Non-Floodway	2	0.51	0.68	$42,920.32	No Action	0	-	-	-
Totals	6	0.9	1.4	$238,781	No Action	0	-	-	-

4. CONCLUSIONS AND RECOMMENDATIONS

McMullen Creek Watershed encompasses a 15.3 square mile urban area in the south-central portion of Mecklenburg County, North Carolina. The Watershed contains two County-regulated streams that have mapped future condition floodplains (FCFs) - McMullen Creek and McMullen Creek Tributary. The primary focus of this preliminary report was to conduct a review of pertinent stream/watershed information, assess flood damages, and investigate flood hazard mitigation alternatives along the regulated streams in the Watershed. A secondary focus was to characterize environmental quality in the Watershed and to provide general recommendations for environmental restoration. The findings of this report are summarized below.

Flood Hazard Mitigation

There are 309 structures within the FCF boundaries in the McMullen Creek Watershed. Comparison of flood information with building elevation certificates revealed that 74 of the 309 structures have their lowest finished floor below the predicted water surface elevation (WSE) of the FCF, and thus are considered "flooding" structures. Flood damages for these 74 buildings were estimated using the FEMA Full Riverine Benefit:Cost model (FEMA BC) totaled to over $10 million (2003 dollars).

Several alternatives were developed to mitigate flood damages and enhance environmental quality for problem areas identified along the study streams. A benefit:cost (BC) economic analysis was performed to evaluate cost-effectiveness of the alternatives at each problem area. The alternatives were then compared for their economic, technical, and social feasibility, from which a recommended mitigation strategy was developed for each problem area. If no improvement alternatives were identified as being cost effective or technically feasible, no action was recommended (i.e. leave building as-is).

The alternative evaluation indicated that it is cost-effective to provide flood protection for 16 of the 74 flooding buildings. The estimated benefits (i.e. damages reduced) and improvement costs are approximately $7.7 million and $2.5 million respectively. This indicates that a relatively few amount of the buildings are receiving the majority of the flood damages, and that focusing mitigation efforts on these buildings will provide the most return for mitigation dollars spent.

Environmental Characterization

The McMullen Creek Watershed is located in an established, highly urbanized area within the City of Charlotte. Land use is predominately residential (> 80%), but also includes limited commercial, industrial, vacant, and other uses. The streams in the Watershed have been modified (e.g. straightened, widened, armored, etc.) to accommodate urbanization, and thus do not exhibit natural, healthy stream characteristics. Reference to local water/biological monitoring data indicates overall "fair" conditions, however, benthic sample readings were classified as "poor" at several sites. The majority of environmental analysis included in this PER are broad in nature, however, several locations were identified for potential environmental restoration within the Watershed (Figure E-1). In addition, investigation of the GIS tax parcel database reveals that the County owns significant portions of vacant land adjacent to McMullen Creek. This land will likely be used for proposed greenways along the Creek, which in turn will likely incorporate water quality and/or environmental restoration features. It is recommended that more detailed analysis be conducted at a smaller scale level to investigate other environmental restoration opportunities.

5. REFERENCES

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APPENDIX A

MCMULLEN CREEK WATERSHED FEMA BC IMPORT SPREADSHEET
UPDATED 10/21/03

UNQBLD_ID	STRM_NAME	STRM_STA	BANK	PID	SITUS1	SITUS2	OWNER_NAME	CNTVAL_PCT	BLDG_USE	STYLE_TYPE	BLDG_TYPE	FFE_88	YEAR_BUILT	HIST_FLAG	HEATD_AREA	BLDG_VAL	ESCRIP	Q010yr	Q050yr	Q100yr	Q500yr	WSE010yr	WSE050yr	WSE100yr	WSE500yr	DPLCMNTCST	STREVNCS	MANUAL	IFLDWAY	IFLDWAY	COMMNTS
2164	McMullen Creek Trib	2258.253	R	16308308	4735 EMORY LN	CHARLOTTE, NC	WHILDEN CARLETON N JR	0.25	AMILY RES	SPLIT LEVEL	3	674.05	1964	N	2896	137500	/white s	1175	1794	2047	2626	673.41	674.4	674.73	675.41	$5,250.00	$0.00	N	N	N	
2179	McMullen Creek Trib	2154.289	R	16308309	4743 EMORY LN	CHARLOTTE, NC	CLAY B WAYNE	0.25	AMILY RES	1.0 STORY	1	673.85	1961	N	1620	94700	k shutter	1175	1794	2047	2626	672.81	673.84	674.18	674.89	$5,250.00	$0.00	N	N	N	
2211	McMullen Creek Trib	1903.382	R	16308311	4815 STAFFORD CR	CHARLOTTE, NC	ELLIOTT AARON A	0.25	AMILY RES	1.0 STORY	1	671.85	1962	N	1938	97020	siding,	1175	1794	2047	2626	671.35	672.48	672.85	673.63	$5,250.00	$0.00	N	N	Y	
2225	McMullen Creek Trib	1809.122	R	16308312	4833 STAFFORD CR	CHARLOTTE, NC	TREACY MARGARET M	0.25	AMILY RES	1.0 STORY	1	671.15	1960	N	1702	87700	w/blue sh	1175	1794	2047	2626	671.05	672.15	672.5	673.26	$5,250.00	$0.00	N	N	Y	
2231	McMullen Creek Trib	1708.566	R	16308313	4841 STAFFORD CR	CHARLOTTE, NC	DUNN RICHARD G	0.25	AMILY RES	1.0 STORY	1	670.85	1955	N	1923	103000	k w/blac	1175	1794	2047	2626	670.76	671.82	672.14	672.86	$5,250.00	$0.00	N	N	Y	
2244	McMullen Creek Trib	1579.797	R	16308314	4849 STAFFORD CR	CHARLOTTE, NC	DAVIS HAROLD J	0.25	AMILY RES	1.0 STORY	1	670.85	1956	N	1946	111910	siding,	1240	1983	2288	3009	670.47	671.46	671.75	672.41	$5,250.00	$0.00	N	N	Y	
2281	McMullen Creek	52873.095	R	18507107	4942 ADDISON DR	CHARLOTTE, NC	CLODFELTER ROGER F	0.25	AMILY RES	1.0 STORY	1	666.75	1961	N	1664	89630	ng w/red	1603	2437	2758	3542	665.3	667.1	667.7	669.1	$5,250	$0	N	Y	Y	
2288	McMullen Creek	52858.094	R	18507106	5000 ADDISON DR	CHARLOTTE, NC	HOUSTON JOHN BARR III	0.25	AMILY RES	1.0 STORY	1	666.75	1966	N	2328	104790	/brown b	1603	2437	2758	3542	665.3	667.1	667.7	669.1	$5,250	$0	N	N	Y	
2295	McMullen Creek	52843.791	R	18507105	5012 ADDISON DR	CHARLOTTE, NC	SPIVEY CREIGHTON C	0.25	AMILY RES	1.0 STORY	1	666.65	1965	N	2091	99310	siding, b	1603	2437	2758	3542	665.3	667.1	667.7	669.1	$5,250	$0	N	N	Y	
2304	McMullen Creek	52888.197	R	18507104	5020 ADDISON DR	CHARLOTTE, NC	ROBINSON A P JR	0.25	AMILY RES	1.0 STORY	1	666.35	1965	N	1822	88740	siding, b	1603	2437	2758	3542	665.3	667.1	667.7	669.1	$5,250	$0	N	N	N	
2309	McMullen Creek	52908.397	R	18507103	5028 ADDISON DR	CHARLOTTE, NC	CARRARA KRIS S	0.25	AMILY RES	1.0 STORY	1	665.65	1966	N	1688	90530	/yellow s	1603	2437	2758	3542	665.3	667.1	667.7	669.1	$5,250	$0	N	N	Y	
2321	McMullen Creek	52785.964	R	18507102	5114 LINCREST PL	CHARLOTTE, NC	DICKENS HENRY VAN	0.25	AMILY RES	1.0 STORY	1	666.45	1980	N	1924	115570	w/stone	1603	2437	2758	3542	665.2	667.1	667.6	669.1	$5,250	$0	N	Y	Y	
2333	McMullen Creek	53243.688	L	18510336	5126 ADDISON DR	CHARLOTTE, NC	PALUMBO RENEE C	0.25	AMILY RES	1.0 STORY	1	665.55	1965	N	1584	79210	/dark-gre	1603	2437	2758	3542	665.6	667.3	667.8	669.2	$5,250	$0	N	Y	Y	
2335	McMullen Creek	53233.502	L	18510335	5138 ADDISON DR	CHARLOTTE, NC	MASON EMORY H JR	0.25	AMILY RES	1.0 STORY	1	666.65	1964	N	1619	82120	w/white	1603	2437	2758	3542	665.6	667.3	667.8	669.2	$5,250	$0	N	Y	Y	
2341	McMullen Creek	53222.445	L	18510334	5200 ADDISON DR	CHARLOTTE, NC	STAFFORD DARIN KEITH	0.25	AMILY RES	1.0 STORY	1	667.45	1962	N	1942	105280	black & w	1603	2437	2758	3542	665.6	667.3	667.8	669.2	$5,250	$0	N	N	Y	
2398	McMullen Creek	51337.936	R	18506113	313 WONDERWOOD DR	CHARLOTTE, NC	QUERY GORDON STOWE JR	0.25	AMILY RES	1.0 STORY	1	661.9	1962	N	1296	75650	k w/ gray	2814	4357	4894	6465	661.2	662.7	663.2	664.4	$5,250	$0	N	N	N	
2421	McMullen Creek	51683.379	L	18509129	249 SHASTA LN	CHARLOTTE, NC	SCOTT PAUL S	0.25	AMILY RES	1.0 STORY	1	663.95	1955	N	1644	85200	tback gr	2814	4357	4894	6465	662.6	664.3	664.8	666.1	$5,250	$0	N	N	N	
2455	McMullen Creek	49863.012	L	18511117	1100 WILLHAVEN DR	CHARLOTTE, NC	SMITH GREGORY W	0.25	AMILY RES	1.5 STORIES	2	656.45	1969	N	1846	102700	y w/red &	2814	4357	4894	6465	655.4	657.3	657.9	659.5	$5,250	$0	N	Y	Y	
2465	McMullen Creek	49713.126	L	18511129	1110 WILLHAVEN DR	CHARLOTTE, NC	HALL JOHN M	0.25	AMILY RES	1.0 STORY	1	655.65	1968	N	1970	106010	k trim, wl	2814	4357	4894	6465	655.1	657.0	657.6	659.3	$5,250	$0	N	Y	Y	
2469	McMullen Creek	49598.399	L	18511130	1120 WILLHAVEN DR	CHARLOTTE, NC	THOMPSON HARRY MORTON IV	0.25	AMILY RES	1.0 STORY	1	655.05	1969	N	1872	93330	black & w	2814	4357	4894	6465	654.9	656.8	657.4	659.1	$5,250	$0	N	Y	Y	
2472	McMullen Creek	49480.111	L	18511115	1130 WILLHAVEN DR	CHARLOTTE, NC	BRAYBOY JOHN	0.25	AMILY RES	1.0 STORY	1	652.25	1969	N	1934	95550	k w/blue	2814	4357	4894	6465	654.7	656.6	657.2	659.0	$5,250	$0	N	Y	Y	
2476	McMullen Creek	49254.15	L	18511114	1142 WILLHAVEN DR	CHARLOTTE, NC	BUMGARDNER FRANCES M	0.25	AMILY RES	SPLIT LEVEL	3	653.75	1968	N	2324	114220	w/brown	2814	4357	4894	6465	654.3	656.3	657.0	658.7	$5,250	$0	N	Y	Y	
2478	McMullen Creek	48914.333	L	18511131	35 STRAWBERRY HILL DRI	CHARLOTTE, NC	OWNER VARIES	0.25	PARTMENT	tory, w/o Basem	2	656.25	1981	N	6843	217950		2814	4357	4894	6465	653.7	655.7	656.5	658.3	$12,000	$0	Y	N	N	
2481	McMullen Creek	48791.859	L	18511131	31 STRAWBERRY HILL DRI	CHARLOTTE, NC	OWNER VARIES	0.25	PARTMENT	tory, w/o Basem	2	655.65	1981	N	6843	217950		2814	4357	4894	6465	653.5	655.5	656.3	658.1	$12,000	$0	Y	N	N	
2484	McMullen Creek	48672.108	L	18511131	25 STRAWBERRY HILL DRI	CHARLOTTE, NC	OWNER VARIES	0.25	PARTMENT	tory, w/o Basem	2	655.75	1981	N	6843	217950		2814	4357	4894	6465	653.3	655.3	656.1	658.0	$12,000	$0	Y	N	N	
2486	McMullen Creek	48494.656	L	18511131	11 STRAWBERRY HILL DRI	CHARLOTTE, NC	OWNER VARIES	0.25	PARTMENT	tory, w/o Basem	2	655.45	1981	N	6218	217950		2814	4357	4894	6465	652.6	654.7	655.6	657.5	$12,000	$0	Y	N	N	
2516	McMullen Creek	45714.216	L	18312111	3920 PROVIDENCE ROAD	CHARLOTTE, NC	AGON GROUP LIMITED PARTN	0.25	PARTMENT	tory, w/o Basem	2	639.16	1967	N	17980	497176		2814	4357	4894	6465	638.5	640.2	640.6	642.0	$12,000	$0	Y	N	N	
2518	McMullen Creek	43927.642	R	18307412	4035 ABINGDON RD	CHARLOTTE, NC	CAMPBELL PAUL E	0.25	AMILY RES	2.0 STORIES	2	636.44	1966	N	3154	184590	n brick, t	2871	4474	5040	6721	634.8	637.3	637.9	639.4	$5,250	$0	N	N	Y	
2534	McMullen Creek	40453.74	L	18318447	7701 FAIRVIEW RD	CHARLOTTE, NC	OXCROFT EAST HOMES ASSO	0.75	ALUE-IMPI	1.0 STORY	1	625.74	1977	N	1032	51530	wim Club	2954	4555	5120	6878	623.3	626.1	626.8	627.9	$0	$10,000	N	N	Y	
2545	McMullen Creek	38080.59	R	18315C99	821 COLONY CROSSING DF	CHARLOTTE, NC	BROWN MARK SHEPPARD	0.25	CONDO	2.0 STORIES	2	613.74	1980	N	2504	182000	ownhous	2954	4555	5120	6878	610.1	613.8	614.8	616.6	$12,000	$0	Y	N	N	
2547	McMullen Creek	37105.351	R	18315C98	COLONY CROSSING DRIVE	CHARLOTTE, NC	OWNER VARIES	0.25	CONDO	tory, w/o Basem	2	608.2	1982	N	7380	549293		2954	4555	5120	6878	606.8	609.5	610.5	613.5	$12,000	$0	Y	N	N	
2548	McMullen Creek	37431.293	L	18315C97	3744 WINDING CREEK LN	CHARLOTTE, NC	DEESE DEBRA LYNN	0.25	CONDO	2.0 STORIES	2	609.8	1973	N	8568	367600	stone tri	2954	4555	5120	6878	608.1	612.7	613.9	615.6	$12,000	$0	Y	N	N	
2549	McMullen Creek	36968.5	L	18315C96	3638 MAPLE GLENN LN	CHARLOTTE, NC	JOYCE NANCY WILSON	0.25	CONDO	2.0 STORIES	2	604.7	1973	N	4284	183800	stone trin	2954	4555	5120	6878	606.6	609.3	610.3	613.4	$12,000	$0	Y	N	N	
2550	McMullen Creek	36770.946	L	18315C96	E GLEN LANE (WESTERN B	CHARLOTTE, NC	OWNER VARIES	0.25	CONDOS	Level, w/o Base	3	606.1	1973	N	15408	685502		2954	4555	5120	6878	606.0	608.8	609.8	613.1	$12,000	$0	Y	N	N	
2551	McMullen Creek	36361.23	L	18315C96	E GLEN LANE (SOUTHERN	CHARLOTTE, NC	OWNER VARIES	0.25	CONDOS	tory, w/o Basem	2	606.5	1973	N	5904	300691		2954	4555	5120	6878	604.9	607.9	609.0	612.4	$12,000	$0	Y	N	N	
2554	McMullen Creek	35596.078	R	20905621	3015 SHAKER DR	CHARLOTTE, NC	TOPPING JULIE G	0.25	AMILY RES	CH W/BASEM	4	603.1	1970	N	3822	169760	gray shu	2954	4555	5120	6878	602.1	604.1	604.7	606.2	$5,250	$0	N	N	N	
2557	McMullen Creek	34979.403	R	20905603	3416 CAMBRIA RD	CHARLOTTE, NC	GRAY ROBERT F	0.25	AMILY RES	CH W/BASEM	4	600.9	1970	N	4244	185400	hite colu	2954	4555	5120	6878	599.7	601.8	602.4	603.8	$5,250	$0	N	N	N	
2560	McMullen Creek	33562.299	L	20911220	3532 MOUNTAINBROOK RD	CHARLOTTE, NC	BROWN VASCUE O	0.25	AMILY RES	CH W/BASEM	4	590.81	1965	N	4304	194190		2954	4555	5120	6878	590.6	592.9	593.5	595.5	$5,250	$0	N	Y	Y	
2563	McMullen Creek	32151.584	L	20911208	3505 JOHNNY CAKE LN	CHARLOTTE, NC	HAGLER DONALD CARY JR	0.25	AMILY RES	2.0 STORIES	2	586.14	1972	N	2288	118850	ng w/wh	2971	4585	5092	6880	585.9	587.8	588.3	590.0	$5,250	$0	N	N	N	
2565	McMullen Creek	32066.391	L	20911207	3501 JOHNNY CAKE LN	CHARLOTTE, NC	HOLLIS CHARLES D III	0.25	AMILY RES	1.5 STORIES	2	586.04	1972	N	2478	138600	ng, red &	2971	4585	5092	6880	585.7	587.6	588.1	589.8	$5,250	$0	N	N	N	
2567	McMullen Creek	31967.557	L	20911206	3425 JOHNNY CAKE LN	CHARLOTTE, NC	JACKSON EDWIN L	0.25	AMILY RES	2.0 STORIES	2	584.74	1973	N	2572	136940	ht wood,	2971	4585	5092	6880	585.5	587.4	587.9	589.6	$5,250	$0	N	N	N	
2568	McMullen Creek	31909.333	L	20911110	3424 JOHNNY CAKE LN	CHARLOTTE, NC	TUCKER GREGORY L	0.25	AMILY RES	SPLIT FOYER	3	587.44	1972	N	2451	118520	brick fro	2971	4585	5092	6880	585.4	587.3	587.8	589.5	$5,250	$0	N	N	N	
2569	McMullen Creek	31876.086	L	20911205	3421 JOHNNY CAKE LN	CHARLOTTE, NC	MEADOR KARLA Y	0.25	AMILY RES	2.0 STORIES	2	585.34	1973	N	2500	135160	siding w/	2971	4585	5092	6880	585.3	587.2	587.8	589.4	$5,250	$0	N	Y	Y	
2576	McMullen Creek	29919.982	R	20912445	3815 HUCKLEBERRY RD	CHARLOTTE, NC	BEVERLY WOODS EAST	0.75	LUB-LODG	1.0 STORY	1	577.14	1965	N	1272	134080	& racke	2971	4585	5092	6880	579.6	581.4	581.9	583.5	$0	$10,000	N	Y	Y	
2603	McMullen Creek	20119.512	L	20926221	3929 CARMEL ACRES DR	CHARLOTTE, NC	MATTHEWS CHRISTOPHER	0.25	AMILY RES	1.5 STORIES	2	553.17	1988	N	2754	191960		2971	4585	5092	6880	556.9	558.6	559.0	560.4	$5,250	$0	N	Y	Y	
2608	McMullen Creek	20250.966	L	20926106	3920 CARMEL ACRES DR	CHARLOTTE, NC	SMITH DORIS B	0.25	AMILY RES	1.0 STORY	1	558.24	1956	N	2232	142070	stone & w	2971	4585	5092	6880	556.9	558.7	559.1	560.5	$5,250	$0	N	N	Y	
2636	McMullen Creek	14106.503	R	20948174	3103 WOLF TRAP CT	CHARLOTTE, NC	HARWOOD DONALD R	0.25	AMILY RES	2.0 STORIES	2	548.23	1989	N	2536	143160	"fan" wi	3776	5220	5601	7015	544.9	547.6	548.5	550.1	$5,250	$0	N	N	N	
2637	McMullen Creek	14034.53	R	20948175	3107 WOLF TRAP CT	CHARLOTTE, NC	HAINES KAREN	0.25	AMILY RES	2.0 STORIES	2	548.2	1998	N	1782	117280	rim, blac	3776	5220	5601	7015	544.9	547.6	548.5	550.1	$5,250	$0	N	N	N	
2639	McMullen Creek	13963.639	R	20948176	10109 SUMMER HOUSE CT	CHARLOTTE, NC	ROGERS DAVID ELDON	0.25	AMILY RES	1.0 STORY	1	547.5	1990	N	1751	117840		3776	5220	5601	7015	544.8	547.6	548.5	550.1	$5,250	$0	N	N	N	
2642	McMullen Creek	13867.095	R	20948177	10115 SUMMER HOUSE CT	CHARLOTTE, NC	MENHART MICHAEL T	0.25	AMILY RES	1.5 STORIES	2	546.6	1989	N	2585	148070		3776	5220	5601	7015	544.8	547.5	548.4	550.0	$5,250	$0	N	N	N	
2644	McMullen Creek	13785.998	R	20948178	10121 SUMMER HOUSE CT	CHARLOTTE, NC	FAGAN JEFFREY J	0.25	AMILY RES	1.5 STORIES	2	547.8	1990	N	2536	154760		3939	5875	6493	8235	544.7	547.5	548.4	550.0	$5,250	$0	N	N	N	
2645	McMullen Creek	13488.138	R	20948187	10210 SUMMER HOUSE CT	CHARLOTTE, NC	SAMMARCO BEVERLY A	0.25	AMILY RES	1.0 STORY	1	547.73	1989	N	2150	134710	w/dk gre	3939	5875	6493	8235	544.6	547.4	548.3	549.9	$5,250	$0	N	N	N	
2647	McMullen Creek	13680.78	R	20948179	10201 SUMMER HOUSE CT	CHARLOTTE, NC	DALEY JAMES F	0.25	AMILY RES	1.5 STORIES	2	547.93	1990	N	2581	150250	wood doo	3939	5875	6493	8235	544.7	547.5	548.4	550.0	$5,250	$0	N	N	N	
2649	McMullen Creek	13610.248	R	20948180	10207 SUMMER HOUSE CT	CHARLOTTE, NC	MADHAVAIYA PRAKASH	0.25	AMILY RES	2.0 STORIES	2	547.83	1989	N	2536	138210	ng, 2-sto	3939	5875	6493	8235	544.6	547.5	548.3	550.0	$5,250	$0	N	N	N	
2654	McMullen Creek	13398.503	R	20948182	10219 SUMMER HOUSE CT	CHARLOTTE, NC	MANKOWSKI JOHN J	0.25	AMILY RES	1.5 STORIES	2	547.83	1988	N	2588	153060	w/wood	3939	5875	6493	8235	544.5	547.4	548.3	549.9	$5,250	$0	N	N	N	
2655	McMullen Creek	13291.936	R	20948183	10223 SUMMER HOUSE CT	CHARLOTTE, NC	GUEBERT FREDERICK T	0.25	AMILY RES	2.0 STORIES	2	546.96	1989	N	2536	139180		3939	5875	6493	8235	544.5	547.4	548.2	549.9	$5,250	$0	N	N	N	
2658	McMullen Creek	13007.046	R	20949121	10000 STANDING STONE CT	CHARLOTTE, NC	CLEMENTS JAMES M	0.25	AMILY RES	2.0 STORIES	2	546.3	1993	N	4007	312060		3939	5875	6493	8235	544.4	547.3	548.2	549.8	$5,250	$0	N	N	N	
2663	McMullen Creek	12910.297	R	20949123	10003 STANDING STONE CT	CHARLOTTE, NC	TRAN BINH VAN	0.25	AMILY RES	2.0 STORIES	2	543.8	1992	N	4044	290520		3939	5875	6493	8235	544.3	547.2	548.1	549.8	$5,250	$0	N	N	N	
2686	McMullen Creek	11318.564	R	20949375	7701 CEDAR CREEK LN	CHARLOTTE, NC	STATION HILL LLC	0.25	EN APART	2.0 STORIES	2	546.6	1982	N	14820	643587	nit Creek	3939	5875	6493	8235	542.8	546.0	547.0	548.6	$12,000	$0	Y	N	N	
2689	McMullen Creek	10035.49	L	22125178	7924 CHARTER OAK LN	CHARLOTTE, NC	OWNER VARIES	0.25	OWNHOUS	2.0 STORIES	2	542.04	1985	N	7297	343420	ouse, ha	3939	5875	6493	8235	540.3	543.6	544.7	547.0	$12,000	$0	Y	N	N	
2692	McMullen Creek	9816.145	L	22125130	8013 CHARTER OAK LN	CHARLOTTE, NC	CANON JACK L	0.25	OWNHOUS	2.0 STORIES	2	543.14	1984	N	1113	52280	ouse, ha	3939	5875	6493	8235	539.9	543.3	544.4	546.7	$12,000	$0	Y	N	N	
2694	McMullen Creek	9721.957	L	22125154	8005 CHARTER OAK LN	CHARLOTTE, NC	DEJURNETT MARY C	0.25	OWNHOUS	2.0 STORIES	2	542	1982	N	1072	47840	partments	3939	5875	6493	8235	539.7	543.2	544.3	546.6	$12,000	$0	N	N	N	
2707	McAlpine Creek	23351	R	22140205	8310 PARK VISTA CR	CHARLOTTE, NC	PEYTON HARRY L	0.25	AMILY RES	1.5 STORIES	2	535.6	1979	N	1488	75510	w/ blue s	8148	12744	14278	18969	531.5	535.0	536.2	539.3	$5,250	$0	N	N	N	
2718	McAlpine Creek	23351	R	22140215	8114 PARK VISTA CR	CHARLOTTE, NC	HOEY DONALD G	0.25	AMILY RES	2.0 STORIES	2	536.04	1980	N	1592	77990	ame, gre	8148	12744	14278	18969	531.5	535.0	536.2	539.3	$5,250	$0	N	N	N	
2738	McAlpine Creek	23351	R	22140243	10301 CAMELBACK CR	CHARLOTTE, NC	MORALES JESUS	0.25	AMILY RES	SPLIT FOYER	3	535.14	1980	N	1988	83490	ding w/dk	8148	12744	14278	18969	531.5	535.0	536.2	539.3	$5,250	$0	N	N	N	
2741	McAlpine Creek	23351	R	22140245	10315 CAMELBACK CR	CHARLOTTE, NC	FELTS DOUGLAS R	0.25	AMILY RES	SPLIT FOYER	3	534.74	1980	N	1988	77180	rick foun	8148	12744	14278	18969	531.5	535.0	536.2	539.3	$5,250	$0	N	N	N	
2757	McAlpine Creek	23351	R	22141211	11531 CANDLELIGHT CT	CHARLOTTE, NC	HINSON WILLIAM R	0.25	AMILY RES	1.0 STORY	1	535.64	1982	N	1307	64610	, brown	8148	12744	14278	18969	531.5	535.0	536.2	539.3	$5,250	$0	N	N	N	
2758	McAlpine Creek	23351	R	22141214	11528 CANDLELIGHT CT	CHARLOTTE, NC	NEILL BONNIE E	0.25	AMILY RES	1.0 STORY	1	535.94	1983	N	1053	60220	siding a	8148	12744	14278	18969	531.5	535.0	536.2	539.3	$5,250	$0	N	N	N	
2759	McAlpine Creek	23351	R	22141212	11535 CANDLELIGHT CT	CHARLOTTE, NC	JAGIELNICKI ANDREW J	0.25	AMILY RES	1.0 STORY	1	535.74	1983	N	1688	80950	ding w/br	8148	12744	14278	18969	531.5	535.0	536.2	539.3	$5,250	$0	N	N	N	
2760	McAlpine Creek	23351	R	22141213	11532 CANDLELIGHT CT	CHARLOTTE, NC	DOERING BURKHARD J	0.25	AMILY RES	1.5 STORIES	2	535.14	1981	N	1575	78740	own sidi	8148	12744	14278	18969	531.5	535.0	536.2	539.3	$5,250	$0	N	N	N	
2762	McAlpine Creek	23351	R	22141232	11525 LONE STAR CR	CHARLOTTE, NC	KLUCHER MATTHEW S	0.25	AMILY RES	1.0 STORY	1	535.2	1983	N	1307	65240	some br	8148	12744	14278	18969	531.5	535.0	536.2	539.3	$5,250	$0	N	N	N	
2763	McAlpine Creek	23351	R	22141233	11529 LONE STAR CR	CHARLOTTE, NC	STRICKLAND ROBERT	0.25	AMILY RES	1.0 STORY	1	536	1982	N	1664	84130	trim and	8148	12744	14278	18969	531.5	535.0	536.2	539.3	$5,250	$0	N	N	N	
2770	McMullen Creek	974.393	R	22112101	12701 LANCASTER HWY	CHARLOTTE, NC	CITY OF CHARLOTTE	3	NDUSTRIA	tory, w/o Basem	1	535.39	9999	N	2500	200000	WTP BLI	8148	12744	14278	18969	531.5	535.0	536.2	539.3	$0	$18,800	Y	N	N	
2771	McMullen Creek	554.291	R	22112101	12701 LANCASTER HWY	CHARLOTTE, NC	CITY OF CHARLOTTE	3	NDUSTRIA	tory, w/o Basem	1	535.58	9999	N	8200	600000	WTP BLI	8148	12744	14278	18969	531.5	535.0	536.2	539.3	$0	$18,800	Y	N	N	

APPENDIX B

MCMULLEN CREEK WATERSHED INDIVIDUAL BENEFIT:COST ANALYSIS SPREADSHEET
Mecklenburg County Flood Hazard Mitigation Project
Lower Little Sugar, Briar, Irwin, and McMullen Creek Watersheds

BUILDING INFORMATION				BENEFIT	COSTS					B/C RATIOS							
UNQBLD_ID	PID	SITE ADDRESS	FLD_GRP	FLOOD DAMAGE	ACQUISITION	ELEVATION	FLOOD PROOFING	LEVEE/FLOOD WALL	DRAINAGE IMPRVMNTS	ACQUISITION	ELEVATION	FLOOD PROOFING	LEVEE/FLOOD WALL	DRAINAGE IMPRVMNTS	IN 0.1' FLOODWAY?	NOTES	RECOMMENDED ALTERNATIVE
2770	22112101	12701 LANCASTER HWY	MM01	$71,253	$239,784	$117,780	$60,000	na	na	0.3	0.6	1.2	na	na	N	CMUD in design for improvements which will mitigate flood hazard	No Action
2771	22112101	12701 LANCASTER HWY	MM01	$187,704	$721,452	$285,852	$60,000	na	na	0.3	0.7	3.1	na	na	N	CMUD in design for improvements which will mitigate flood hazard	No Action
2757	22141211	11531 CANDLELIGHT CT	MM02	$11,717	$88,961	$61,575	na	$109,143	na	0.1	0.2	na	0.1	na	N		No Action
2758	22141214	11528 CANDLELIGHT CT	MM02	$9,536	$83,379	$49,609	na	$109,143	na	0.1	0.2	na	0.1	na	N		No Action
2759	22141212	11535 CANDLELIGHT CT	MM02	$12,628	$107,394	$79,525	na	$109,143	na	0.1	0.2	na	0.1	na	N		No Action
2760	22141213	11532 CANDLELIGHT CT	MM02	$17,141	$103,895	$74,201	na	$109,143	na	0.2	0.2	na	0.2	na	N		No Action
2762	22141232	11525 LONE STAR CR	MM02	$14,905	$89,161	$22,161	na	$109,143	na	0.2	0.7	na	0.1	na	N		No Action
2763	22141233	11529 LONE STAR CR	MM02	$11,192	$111,622	$78,394	na	$109,143	na	0.1	0.1	na	0.1	na	N		No Action
2707	22140205	8310 PARK VISTA CR	MM03	$13,097	$100,974	$25,231	na	na	na	0.1	0.5	na	na	na	N		No Action
2718	22140215	8114 PARK VISTA CR	MM03	$10,447	$103,266	$75,002	na	na	na	0.1	0.1	na	na	na	N		No Action
2738	22140243	10301 CAMELBACK CR	MM03	$17,748	$109,454	$93,659	na	na	na	0.2	0.2	na	na	na	N		No Action
2741	22140245	10315 CAMELBACK CR	MM03	$21,060	$103,144	$93,659	na	na	na	0.2	0.2	na	na	na	N		No Action
2689	22125178	7924 CHARTER OAK LN	MM04	$139,802	$462,420	$354,634	na	na	na	0.3	0.4	na	na	na	N		No Action
2692	22125130	8013 CHARTER OAK LN	MM04	$24,966	$69,619	$52,436	na	na	na	0.4	0.5	na	na	na	N		No Action
2694	22125154	8005 CHARTER OAK LN	MM04	$42,065	$65,056	$51,302	na	na	na	0.6	0.8	na	na	na	N		No Action
2686	20949375	7701 CEDAR CREEK LN	MM05	$53,961	$760,538	$698,200	na	na	na	0.1	0.1	na	na	na	N		No Action
2658	20949121	10000 STANDING STONE CT	MM06	$74,952	$374,081	$191,759	na	na	na	0.2	0.4	na	na	na	N		No Action
2663	20949123	10003 STANDING STONE CT	MM06	$336,766	$352,652	$150,000	na	na	na	1.0	2.2	na	na	na	N		Elevation
2636	20948174	3103 WOLF TRAP CT	MM07	$13,276	$190,768	$43,000	na	$55,770	na	0.1	0.3	na	0.2	na	N	Potential environmental/wetland restoration area	No Action
2637	20948175	3107 WOLF TRAP CT	MM07	$11,468	$162,626	$83,954	na	$55,770	na	0.1	0.1	na	0.2	na	N	Potential environmental/wetland restoration area	No Action
2639	20948176	10109 SUMMER HOUSE CT	MM07	$19,638	$163,093	$82,493	na	$55,770	na	0.1	0.2	na	0.4	na	N	Potential environmental/wetland restoration area	No Action
2642	20948177	10115 SUMMER HOUSE CT	MM07	$42,175	$195,825	$123,708	na	$55,770	na	0.2	0.3	na	0.8	na	N	Potential environmental/wetland restoration area	No Action
2644	20948178	10121 SUMMER HOUSE CT	MM07	$18,300	$202,368	$119,476	na	$55,770	na	0.1	0.2	na	0.3	na	N	Potential environmental/wetland restoration area	No Action
2645	20948187	10210 SUMMER HOUSE CT	MM07	$16,230	$181,160	$101,291	na	$55,770	na	0.1	0.2	na	0.3	na	N	Potential environmental/wetland restoration area	No Action
2647	20948179	10201 SUMMER HOUSE CT	MM07	$15,885	$197,993	$121,596	na	$55,770	na	0.1	0.1	na	0.3	na	N	Potential environmental/wetland restoration area	No Action
2649	20948180	10207 SUMMER HOUSE CT	MM07	$15,829	$185,818	$119,476	na	$55,770	na	0.1	0.1	na	0.3	na	N	Potential environmental/wetland restoration area	No Action
2654	20948182	10219 SUMMER HOUSE CT	MM07	$16,271	$200,824	$43,882	na	$55,770	na	0.1	0.4	na	0.3	na	N	Potential environmental/wetland restoration area	No Action
2655	20948183	10223 SUMMER HOUSE CT	MM07	$27,919	$186,788	$119,476	na	$55,770	na	0.1	0.2	na	0.5	na	N	Potential environmental/wetland restoration area	No Action
2603	20926221	3929 CARMEL ACRES DR	MM08	$2,715,725	$263,222	$139,991	na	na	na	10.3	19.4	na	na	na	Y		Acquisition
2608	20926106	3920 CARMEL ACRES DR	MM08	$28,568	$218,066	$77,808	na	na	na	0.1	0.4	na	na	na	Y		No Action
2576	20912445	3815 HUCKLEBERRY RD	MM09	$1,026,403	$310,246	$63,712	na	na	na	3.3	16.1	na	na	na	Y		Acquisition
2560	20911220	3532 MOUNTAINBROOK RD	MM10	$243,169	$255,552	$156,442	na	na	na	1.0	1.6	na	na	na	Y		Acquisition
2563	20911208	3505 JOHNNY CAKE LN	MM10	$79,092	$172,514	$40,498	na	na	na	0.5	2.0	na	na	na	N		Elevation
2565	20911207	3501 JOHNNY CAKE LN	MM10	$82,321	$191,484	$43,861	na	na	na	0.4	1.9	na	na	na	N		Elevation
2567	20911206	3425 JOHNNY CAKE LN	MM10	$269,487	$190,106	$47,438	na	na	na	1.4	5.7	na	na	na	N		Acquisition
2568	20911110	3424 JOHNNY CAKE LN	MM10	$14,160	$175,873	$115,472	na	na	na	0.1	0.1	na	na	na	N		No Action
2569	20911205	3421 JOHNNY CAKE LN	MM10	$106,031	$188,560	$119,640	na	na	na	0.6	0.9	na	na	na	Y		No Action
2554	20905621	3015 SHAKER DR	MM11	$127,574	$227,126	$136,078	na	$18,864	na	0.6	0.9	na	6.8	na	N	house has basement, levee infeasible (> 8')	No Action
2557	20905603	3416 CAMBRIA RD	MM11	$108,488	$244,032	$147,946	na	$31,665	na	0.4	0.7	na	3.4	na	N	house has basement, levee infeasible (> 8')	No Action
2545	18315C99	3821 COLONY CROSSING DR	MM12	$35,716	$189,512	$117,968	na	na	$600,000	0.2	0.3	na	na	0.1	N		No Action
2547	18315C98	COLONY CROSSING DRIVE	MM12	$192,079	$571,433	$353,177	na	na	na	0.3	0.5	na	na	na	N		No Action
2548	18315C97	3744 WINDING CREEK LN	MM12	$220,674	$393,304	$422,779	na	$32,380	na	0.6	0.5	na	6.8	na	N	levee not hydraulically feasible	No Action
2549	18315C96	3638 MAPLE GLENN LN	MM12	$775,768	$196,652	$217,764	na	na	na	3.9	3.6	na	na	na	N	split-level with significant flooding, elevation not feasible	Acquisition
2550	18315C96	MAPLE GLEN LANE (WESTERN BLDG)	MM12	$529,548	$731,726	$760,292	na	$186,940	na	0.7	0.7	na	2.8	na	N	Levee with stream restoration on opposite bank	Flood Barrier
2551	18315C96	MAPLE GLEN LANE (SOUTHERN BLDG)	MM12	$123,158	$318,403	$282,542	na	$186,940	na	0.4	0.4	na	0.7	na	N	Levee with stream restoration on opposite bank	Flood Barrier
2534	18318447	7701 FAIRVIEW RD	MM13	$11,137	$54,626	$48,620	na	na	na	0.2	0.2	na	na	na	Y		No Action
2518	18307412	4035 ABINGDON RD	MM14	$44,977	$371,552	$53,479	na	$211,640	na	0.1	0.8	na	0.2	na	Y		No Action
2516	18312111	3920 PROVIDENCE ROAD	MM15	$165,554	$674,108	$847,074	na	$102,518	na	0.2	0.2	na	1.6	na	N	Earthen berm/Floodwall combination	Flood Barrier
2455	18511117	1100 WILLHAVEN DR	MM16	$33,563	$167,738	$64,352	na	na	na	0.2	0.5	na	na	na	Y		No Action
2465	18511129	1110 WILLHAVEN DR	MM16	$54,458	$167,920	$70,140	na	na	na	0.3	0.8	na	na	na	Y		No Action
2469	18511130	1120 WILLHAVEN DR	MM16	$70,246	$168,946	$66,651	na	na	na	0.4	1.1	na	na	na	Y		Elevation
2472	18511115	1130 WILLHAVEN DR	MM16	$950,030	$173,352	$73,175	na	na	na	5.5	13.0	na	na	na	Y		Acquisition
2476	18511114	1142 WILLHAVEN DR	MM16	$165,416	$193,192	$84,473	na	na	na	0.9	2.0	na	na	na	Y	B:C close to 1 and in floodway	Acquisition
2478	18511131	5135 STRAWBERRY HILL DRIVE	MM16	$24,041	$261,956	$322,387	na	na	na	0.1	0.1	na	na	na	N		No Action
2481	18511131	5131 STRAWBERRY HILL DRIVE	MM16	$33,991	$261,956	$322,387	na	na	na	0.1	0.1	na	na	na	N		No Action
2484	18511131	5125 STRAWBERRY HILL DRIVE	MM16	$27,132	$261,956	$322,387	na	na	na	0.1	0.1	na	na	na	N		No Action
2486	18511131	5111 STRAWBERRY HILL DRIVE	MM16	$22,040	$260,081	$292,942	na	na	na	0.1	0.1	na	na	na	N		No Action

BUILDING INFORMATION				BENEFIT	COSTS					B/C RATIOS							
UNQBLD_ID	PID	SITE ADDRESS	FLD_GRP	FLOOD DAMAGE	ACQUISITION	ELEVATION	FLOOD PROOFING	LEVEE/FLOOD WALL	DRAINAGE IMPRVMNTS	ACQUISITION	ELEVATION	FLOOD PROOFING	LEVEE/FLOOD WALL	DRAINAGE IMPRVMNTS	IN 0.1' FLOODWAY?	NOTES	RECOMMENDED ALTERNATIVE
2398	18506113	313 WONDERWOOD DR	MM17	$29,244	$133,538	$45,179	na	na	na	0.2	0.6	na	na	na	N		No Action
2421	18509129	249 SHASTA LN	MM17	$18,562	$166,632	$57,310	na	na	na	0.1	0.3	na	na	na	N		No Action
2281	18507107	4942 ADDISON DR	MM18	$19,569	$122,122	$58,007	na	na	na	0.2	0.3	na	na	na	Y		No Action
2288	18507106	5000 ADDISON DR	MM18	$21,502	$166,774	$81,154	na	na	na	0.1	0.3	na	na	na	Y		No Action
2295	18507105	5012 ADDISON DR	MM18	$23,116	$152,333	$72,892	na	na	na	0.2	0.3	na	na	na	Y		No Action
2304	18507104	5020 ADDISON DR	MM18	$28,609	$149,206	$63,515	na	na	na	0.2	0.5	na	na	na	N		No Action
2309	18507103	5028 ADDISON DR	MM18	$58,046	$150,594	$60,100	na	na	na	0.4	1.0	na	na	na	Y		Elevation
2321	18507102	5114 LINCREST PL	MM18	$29,975	$176,342	$32,623	na	na	na	0.2	0.9	na	na	na	Y		No Action
2333	18510336	5126 ADDISON DR	MM18	$76,718	$138,962	$56,397	na	na	na	0.6	1.4	na	na	na	Y		Elevation
2335	18510335	5138 ADDISON DR	MM18	$24,717	$141,977	$56,438	na	na	na	0.2	0.4	na	na	na	Y		No Action
2341	18510334	5200 ADDISON DR	MM18	$12,296	$166,106	$67,698	na	na	na	0.1	0.2	na	na	na	Y		No Action
2164	16308308	4735 EMORY LN	MMT1	$31,493	$191,188	$136,436	na	na	na	0.2	0.2	na	na	na	N		No Action
2179	16308309	4743 EMORY LN	MMT1	$11,427	$144,560	$56,473	na	na	na	0.1	0.2	na	na	na	N		No Action
2211	16308311	4815 STAFFORD CR	MMT1	$34,723	$147,834	$67,559	na	na	na	0.2	0.5	na	na	na	Y		No Action
2225	16308312	4833 STAFFORD CR	MMT1	$56,321	$137,806	$59,332	na	na	na	0.4	0.9	na	na	na	Y		No Action
2231	16308313	4841 STAFFORD CR	MMT1	$63,304	$153,769	$67,036	na	na	na	0.4	0.9	na	na	na	Y		No Action
2244	16308314	4849 STAFFORD CR	MMT1	$41,513	$162,748	$67,838	na	na	na	0.3	0.6	na	na	na	Y		No Action
TOTALS		74		$10,129,610													

APPENDIX C

BUILDING DEPTH-DAMAGE FUNCTION (DDF) Mecklenburg County Flood Hazard Mitigation Project Lower Little Sugar, Briar, Irwin, and McMullen Creek Watersheds													
		Flood Depth (feet)											
Building Type	***Curve Type***	***-2***	***-1***	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***>8***
1 Story, w/o Basement	Local	0	0	9	22	35	40	45	50	55	55	55	55
2 Story, w/o Basement	Default	0	0	5	9	13	18	20	22	24	26	29	33
Split Level, w/o Basement	Default	0	0	3	9	13	25	27	28	33	34	41	43
1 or 2 Story, with Basement	Default	4	8	11	15	20	23	28	33	38	44	49	51
Split Level, with Basement	Default	3	5	6	16	19	22	27	32	35	36	44	48
Mobile Home	Default	0	0	8	44	63	73	78	80	81	82	82	82

NOTES: Local curve developed by Watershed Concepts (1998

Default curves from FEMA Full Riverine Benefit:Cost Model (V5.2.3)

CONTENTS DEPTH-DAMAGE FUNCTION (DDF) Mecklenburg County Flood Hazard Mitigation Project Lower Little Sugar, Briar, Irwin, and McMullen Creek Watersheds													
		Flood Depth (feet)											
Building Type	***Curve Type***	***-2***	***-1***	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***>8***
1 Story, w/o Basement	Local	0	0	8	18	30	50	55	60	65	70	75	75
2 Story, w/o Basement	Default	0	0	7.5	13.5	19.5	27	30	33	36	39	43.5	49.5
Split Level, w/o Basement	Default	0	0	4.5	13.5	19.5	37.5	40.5	42	49.5	51	61.5	64.5
1 or 2 Story, with Basement	Default	6	12	16.5	22.5	30	34.5	42	49.5	57	66	73.5	76.5
Split Level, with Basement	Default	4.5	7.5	9	24	28.5	33	40.5	48	52.5	54	66	72
Mobile Home	Default	0	0	12	66	90	90	90	90	90	90	90	90

NOTES: Local curve developed by Watershed Concepts (1998

Default curves from FEMA Full Riverine Benefit:Cost Model (V5.2.3)

Prepared By:
Neal Banerjee, PE
Dewberry
March 2003

APPENDIX D

MEETING MINUTES

PROJECT NAME: McAlpine WWTP

D&D PROJECT NO.: Meckco

MEETING LOCATION: WWTP

DATE: 11/13/02

ATTENDEES: Nikole Dalton, Dewberry & Dewberry, Inc.
Kim Neely, Plant Supervisor, CMUD
Eric Davidson, HDR

McAlpine WWTP is by far the largest treatment plant in the county. Presently, the design for a Consolidated Influent Pumping Station is being designed by HDR. Mr. Davidsion brought the current design development plan for the Pumping Station which is to replace two of the existing lift stations within the area threatened by the updated 100 yr flood data. The new facility is being elevated to 537 raising it above the current flood data.

One of the other critical structures in the current 100 year flood zone is the switch gear station. Currently, the plant is in the process of preliminary design to rebuild the switch station. The design will take flooding into consideration and thus will eliminate the switch station from flooding endangerment. Unfortunately, there is no guarantee that either of the above mentioned projects will definitely be built but the outlook is good considering the plant will require numerous upgrades to handle the area it serves as development increases.

Structures that are within the 100 year future land use flood plan but seem to be elevated adequately include Secondary Clarifiers 9 and 10 – (Elev. 537 and 538 are top of the wall elevations) and the Aeration basins (Elev. 545 top of walls).

Structures that are in danger of flooding include the Raw Activated Sludge (RAS) Pump Station, the screen and grit chambers (Elev. 535), the odor scrubber (Elev. 535) and the Equalization Pump Station (Elev. 536), and the drain valve vault.

All of the structures in danger of flooding are critical to maintaining plant operations.

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