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Dilcrest Watershed Analysis

Prepared for



October 2010

SECTION 1: INTRODUCTION

1.0 City of Florence Storm Water Management

The City of Florence (City) has been involved in the maintenance, cleaning, rehabilitation, and inspection of storm water facilities since 1990. In that year, the City completed a comprehensive Storm Water Drainage Master Plan. The Plan provided much needed information on the general locations of flooding issues.

The City's storm water system currently includes approximately 142 miles of storm lines and 196 detention/retention basin, 12 of which are maintained by the City. The City maintains approximately 136 miles of sanitary sewer. The City also complies with the requirements of the U.S. EPA "Clean Water Act" and both Phase I and Phase II of the NPDES Storm Water Program.

Since 1990, the City has been studying and resolving areas of flooding outlined in the Master Plan. Portions of the Dilcrest study area were included in the 1990 study titled, "South Fork Tributary". Improvements included "Culvert and Channel Work", however, these improvements were not funded at the time.

In 2005, the City updated the Storm Water Master Plan. The updated plan outlined the agencies that have jurisdiction within various types of drainage ways. The updated plan also outlined the specific regulations related to construction within a drainage way. The plan defined waters of the United States, waters of the Commonwealth of Kentucky, waters of the City of Florence and non-jurisdictional waters. The Dilcrest Watershed includes areas within all of these jurisdictions. Activities proposed within the waters of the United States will require a Corps of Engineers permit. Activities proposed within the waters of the Commonwealth of Kentucky will require permitting by the Kentucky Division of Water. Improvements within the waters under Corps of Engineers or Commonwealth of Kentucky jurisdiction may require mitigation of lost streams and wetlands. Mitigation is both costly and difficult to accomplish. Bank stabilization and other green solutions may be possible without mitigation requirements.

1.1 Dilcrest Watershed Study Defined

The Dilcrest Watershed consists of approximately 348 acres of drainage area. Surface water from the study area flows into an unnamed tributary of the South Fork of Gunpowder Creek (SFGC). SFGC is identified as an impaired stream by the U.S. EPA.



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The study area includes Dilcrest Manor Subdivision, Shamrock Hill Subdivision, Saddlebrook Farms Subdivision (formerly Kentucky Raceway), the Northern Kentucky Industrial Park, McEvoy farmland, KYTC – I-75/I-71, and miscellaneous commercial sites. The study area includes the following Zoning Districts: R-1F, SR-1, SR-2, O-1, O-2, C-1, C-3, R, and I-2.

The study area includes 190 acres within the City of Florence and 158 acres within unincorporated Boone County. The study falls within the jurisdiction of the following agencies/municipalities: City of Florence, Boone County, Boone County Water District, Northern Kentucky Water District, Kentucky Transportation Cabinet, Boone County Planning Commission, Northern Kentucky Industrial Park (NKIP) Planning Board, Kentucky Division of Water, Sanitation District No.1 and Corps of Engineers.

Appendix A, Figure 1 shows the watershed in its entirety.

Appendix A, Figure 2 shows distinction between City and County Portions of the Watershed

1.2 Dilcrest Watershed Study Area Land Uses

The Dilcrest Watershed study area includes the following residential neighborhoods/subdivisions:

<u>Residential Neighborhood</u>	<u>Date(s) of Construction</u>
• Dilcrest Manor Subdivision (<i>within City of Florence</i>)	1957
• Shamrock Hill Subdivision (<i>largely outside City of Florence</i>)	1954
• Saddlebrook Farms Subdivision (<i>within City of Florence</i>)	1989
• Carol Lane Apartments (Portion) (<i>within City of Florence</i>)	1972

The Dilcrest watershed study area includes portions of the Northern Kentucky Industrial Park started in 1960. NKIP is largely within unincorporated Boone County. The study area also includes commercial uses, mainly along U.S. 42 and Steilen Drive. These uses started developing in the late 1950s.



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In addition, the Dilcrest watershed study area includes I-75/I-71 pavement. This interstate highway first opened in 1962 and has had extensive improvements. The original highway had two (2) lanes, on both north and south bound, with a grass median. The highway has now been expanded to four (4) lanes in both directions with a paved median.

1.3 History of Dilcrest Watershed

The 1990 Storm Water Master Plan identified a portion of the Dilcrest Watershed as Project No. 10 “South Fork Tributary”. The Master Plan recommended improvements which included “culvert and channel work”. The original estimate was \$50,000.00 (1990 dollars). However, the City recommendation, at that time, was to make the project optional (no funding available). No further action was taken with this project. It should be noted that the numbering of the projects (i.e., Project No. 10) was not meant as any type of priority designation.

In 1995, a substantial rain event caused basement flooding at the low point of Adella Drive. The flooding caused debris to obstruct the existing (undersized) culvert and flood the home on Lot 146 Dilcrest Manor Subdivision (8206 Adella Drive). The City reacted immediately and developed a plan to replace the culvert under Adella Drive and continue the storm sewer to the main channel (tributary to South Fork of Gunpowder Creek – Project No. 10, described above).

The City was unable to obtain the necessary easement to extend the culvert all the way south to the main channel. The City did construct a portion of the replacement storm sewer to lessen the flood potential. Debris build-up is still an issue. The home on Lot 146 has a garage below grade and could still flood.

In addition to the City improvements discussed above, Boone County has made some storm water improvements within Shamrock Hill Subdivision. Those improvements are in the upper reaches of the stream between Adella Drive and Harms Hill Drive, near Sycamore Drive. The improvements were made after the County received complaints of yard and basement flooding.

Residents of Dilcrest Manor Subdivision have complained of yard erosion along Harms Hill Drive. Residents along portions of North Dilcrest have experienced yard flooding from surface runoff flowing from Shamrock Hill Subdivision.



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In the spring of 2010, rain events caused yard flooding and erosion within Dilcrest Manor Subdivision. Evidence of bacterial flows was reported by a homeowner on North Dilcrest. Both Dilcrest Manor and Shamrock Hill have abandoned septic systems. These septic tanks were not safe loaded as part of the decommissioning. Some waste flows may still occur during large rain events. The Shamrock Hill Subdivision Plat identifies that individual systems were to be approved by Boone County Health Board. Sanitary sewers were constructed at some point in time after original development. Residents of North Dilcrest also complained of “orange” coloring in the main stream channel running from NKIP (SD1 and Boone County Jurisdiction).

Historical Sources:

- *U.S. Geological Survey Union Quad*
- *City of Florence Surface and Storm Water Drainage Master Plan Volumes I & II, 1988*
- *Preliminary Engineering Study for Storm Water Improvements, 1990*
- *Revised City Storm Water Master Plan, 2005*
- www.florence-ky.gov
- www.epa.gov
- *Boone County Clerks records*

1.4 Dilcrest Watershed Study Scope of Services

In 2009, the City of Florence asked Viox & Viox to conduct a study of the flooding and drainage issues in the Dilcrest Watershed. The study was conducted over an eight month period. The study’s scope included four main phases: data collection, data analysis, preparation of findings, and recommendations. In addition to the preparation of the final report, the firm will summarize the findings and recommendations to City officials and the community via public presentation(s) with visuals.

The data collection phase included the compilation of eyewitness accounts of the flooding problems through resident questionnaires, interviews, photographs, and videos. In addition, courthouse research of the dates of development within the Dilcrest basin was conducted.



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Data collection also included flow monitoring and rain gauge data. Viox & Viox, through its sub-consultant STANTEC, placed and monitored four flow meters. Precipitation data was taken from the City's permanent Rain Gauge on Rosetta Drive. The flow monitors were located at the downstream end of the Adella Drive culvert (8207 Adella Drive), the downstream end of the East Dilcrest Drive culvert (8193 E. Dilcrest Drive), and the downstream end of the West Dilcrest Drive culvert (194 West Dilcrest Drive).

The fourth flow monitor was originally located under the bridge leading to 8164 East Dilcrest, however, the monitor was damaged and the resident objected to its replacement. The New monitor was moved slightly downstream to a point in the creek behind 193 West Dilcrest.

The monitoring equipment recorded the rainfall in 5 minute increments, as well as the flow rate, depth, and velocity of the storm water at the aforementioned locations.

After the thorough collection of data, Viox & Viox performed a careful analysis of the information. The data was primarily analyzed using the EPA Storm Water Management Model (SWMM) V5.0.008. The collected data allowed Viox & Viox to test and calibrate the computer modeling programs to ensure precision and accuracy.

Viox & Viox prepared the study findings and developed recommendations based on the computer simulations, onsite observations, public comments, and other historical data. These recommendations were carefully considered based on sound engineering principles, cost, and, most importantly, public safety.



SECTION 2: DATA COLLECTION

2.0 Field Data Collection and Observation

In order to provide reliable conclusions and recommendations, this analysis is based on actual field collected data and observation, rather than relying on standard hydrologic assumption. The data collected for the purpose of this analysis can be divided into three categories; Physical Structures, Field Observations, and Hydrologic Data.

2.1 Physical Structures

Viox & Viox, Inc. precisely located all major storm sewer structures in the watershed area using standard surveying methods as well as survey quality Global Positioning System (GPS) methods. The structures located include, but are not limited to, all structures containing flow monitors as well as the main culvert crossing at Interstate 71/75.

2.2 Field Observation

On multiple occasions during the analysis, Viox & Viox engineering staff performed field inspections after large storm events. Evidence, such as the location and level of debris, was noted for comparison to the hydrologic model. This data was used to aid in the calibration and refinement of the computerized model.

2.3 Hydrologic Data

Viox & Viox, through its sub-consultant STANTEC, located four flow monitoring stations throughout the analysis area. The flow monitors were in place and recorded data from March 3, 2010 to July 27, 2010, during that time period there were several storms of varying size and durations. The flow monitors were located near areas of known erosion and flooding problems.

The first flow monitor, (DIL1), was located near the downstream end of the study area at the outlet headwall of the W. Dilcrest Dr. road crossing. This crossing consists of a 96" diameter corrugated metal pipe and is located just downstream of the confluence of the three major reaches of the watershed.

The second flow monitor, (DIL2), was located at the downstream end of the culvert at Adella Drive. This culvert consists of a 42" diameter aluminized steel pipe (spiral ribbed). It is located just downstream of the previously noted 1995 flooding incident.



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The third flow monitor, (DIL3), was located at the downstream end of the road crossing at E. Dilcrest. The culvert consists of a 42" corrugated metal culvert. This point is just upstream of an area noted to be experiencing significant erosion in the backyard of a home along Harms Hill Drive.

The fourth flow monitor, (DIL4), was originally located at the downstream end of the bridge at 8164 E. Dilcrest Drive, however, it was moved to an open channel section of creek just downstream of the bridge. This area has been noted to experience high flows during medium to large rain events.

All three flow monitors were model Sigma 910 AV. These monitors have the ability to measure flow depth, flow velocity, and flow rate. These measurements were taken at 5 minute intervals, 24-hours a day.

The rain gauge data was provided by the permanent City rain gauge at Rosetta Drive, and recorded reading at 5 minute intervals, 24-hours a day.

Appendix A, Figure 3 shows the locations of these monitors.

2.4 Property Owner Surveys, Interviews, and Documentation

On June 30, 2010, the City of Florence and Viox and Viox conducted resident interviews at the Florence Government Center to discuss the existing flooding problems with the residents living within the study area. The residents' comments are summarized below.

Mr. Gene Smith – 8215 N. Dilcrest

Mr. Smith has lived at this property for 26 years. Mr. Smith said that his backyard floods and he will have standing water and marshy ground for up to a week after heavy rains. He also says that he has seen erosion of the creek channel which runs through his property. Mr. Smith brought pictures of his back yard dated June 15th and June 16th, 2010. He also brought a copy of a mortgage survey which he marked to indicate where the stream runs through his property and where the water stands in his yard.

Mr. Smith said that the rain has washed away portions of his garden in some years. He has found several holes in his yard where crayfish have dug around in his garden. He stated that some of the water running through his yard has an oily sheen, so he thinks there may be some water quality issues. Mr. Smith said that a few years ago, he was working in the garden after a heavy rain and his feet were covered in the mud. Afterward, he developed an infection on his feet which had to be treated with antibiotics.



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Mr. Smith said that he has three drainage ditches in his backyard. He said there is a 15" culvert on his property which frequently backs up. He also says that he believes the flooding has worsened since they fixed the road and new houses were built nearby. He stated that his neighbor's property at 8219 N. Dilcrest (D'Addario) is always flooded after heavy rain.

Michael and Sarah Hayden – 8178 N. Dilcrest

Mr. and Mrs. Hayden said that they have lived at this address for 9 years. They stated that they have experienced flooding in their yard, standing water in their yard, and water in their garage and basement. The Haydens brought pictures dated June 9, 2010, showing the effects of a recent rain storm. Mrs. Hayden brought pictures of her property after the rainstorm and also pictures taken from the cul-de-sac of N. Dilcrest, which shows the flooded creek bed. The Haydens said that they have talked to City officials several times over the years regarding the flooding issues.

Mr. and Mrs. Hayden said that after a heavy rain, the water runs between their house and their neighbor's property at 8176 N. Dilcrest (Knochelmann) and also runs through their backyard. The water can get fairly high and runs very fast. They said that the standing water attracts mosquitoes. She said the flooding happens most often in the springtime.

Mr. Henry Brinkman – 137 W. Dilcrest

Mr. Brinkman stated that he has lived at this property since 1988. The creek runs through his backyard. He stated that when he moved in 22 years ago, the creek was only a few feet wide, but the creek is now about 12 feet wide and much deeper. He brought photographs showing the creek bed erosion and one photo which shows a crack in his driveway. He believes the entire hillside is moving and his driveway seems to have shifted approximately 3 inches over time.

Mr. Brinkman says that his garden used to flood, but has not flooded since a pipe was installed on a nearby property several years ago (address?). He says that the water can flow very fast in the creek and the creek bed continues to erode. He has considered placing rock/gravel and barrels in the creek bed to attempt stabilization. Mr. Brinkman said that after heavy rain, water will flow down his neighbor's driveway (address?) and cut across his backyard.



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Mr. Jerome Knochelmann, II – 8176 N. Dilcrest

Mr. Knochelmann's parents came to discuss the flooding issues at their son's home, as he is in the military and is currently being deployed to Afghanistan. Mr. and Mrs. Knochelmann stated that their son purchased the property in January 2010. They said that after a heavy rain, water flows from behind 39 Sycamore Drive, (unincorporated county), and flows between the Knochelmann house and his neighbor's house at 8178 N. Dilcrest (Hayden). The Knochelmans brought two photographs from the June 9, 2010 storm. Mr. and Mrs. Knochelmann stated that their son has a sump pump with a battery backup which has kept the water out of his unfinished basement.

Mrs. Lisa Hickey – 8108 Harms Hill Drive

Mrs. Hickey stated that she lives in the cul-de-sac and is representing the other residents on the cul-de-sac of Harms Hill Drive. She said that after heavy rain, water will flood her backyard and the backyards at 8106 and 8107 Harms Hill Drive. The water will rush down the street and overflow the catch basin into the yards. She said the water is coming from two different directions.

She stated that the water has reached as high as the top of her trampoline in her yard. She also knows that the residents at 183 W. Dilcrest have had water in their garage. She mentioned that there is some water coming from a new pipe on a property on Adella. She believes that the problem has worsened after Saddlebrook Apartments were built behind her property. She also believes there may be pollutants in the runoff coming from the nearby Industrial Park.

The following property owners submitted written survey responses:

Mr. Robert D. Barth – 8195 N. Dilcrest

Mr. Barth has lived at this address for 10 ½ years. The creek channel runs through his property. He stated that after a heavy volume of rain, the creek channel will overflow its banks and cause the soil and plant material to erode away. He continued to say that when the creek overflows, the water will flood the low area of his yard. He also said that after heavy rains, drainage from areas uphill from his property impacts his front yard. He has experienced these problems within the past 6 months. Mr. Barth believes that the water runoff and erosion is causing the yard to shift. He says there is evidence of this in the driveway, porch, deck, and the front, back, and left sides of his yard.



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Ms. Nancy Borne – 173 W. Dilcrest

Ms. Borne has lived at this property for 20 years. She stated that the creek channel runs along the bottom of the hill in the utility easement area behind her property. She stated that she lives on the high side of the street and has not experienced any flooding issues.

Ms. Mary Cahill – 8166 N. Dilcrest

This survey was returned as undeliverable.

Ms. Carol Clements – 161 W. Dilcrest

Ms. Clements has lived in this house for 11 months. She stated that a small part of the creek channel runs through her property. She has not experienced any flooding problems.

Chris & Joelle D’Addario – 8219 N. Dilcrest

Mr. and Mrs. D’Addario stated that they have lived at this property for four years. The creek channel runs through their property. After heavy rain, water will stand in their backyard, but will recede within two to three days. In addition, they have noticed ongoing creek bank erosion. The D’Addario’s included two pictures of the creek bed. They stated that a tree on their property near the creek is now surrounded by hollow earth because of the constant bank erosion. They fear that if something is not done to slow the water in the creek, their backyard will completely erode.

Mr. Patrick Day – 193 W. Dilcrest

Mr. Day has lived at this property for 12 years. The creek channel runs through his property. Mr. Day stated that he has noticed that the creek bed is approximately 5 feet deeper than it was 12 years ago. He stated that he has lost part of his backyard due to the continual erosion. He has also experienced both flooding and standing water in his yard after heavy rain. Mr. Day also stated that he has noticed a washout of the area upstream of the road/culvert. He stated that the flooding and standing water recedes several hours after the rain stops, but it can occur any time throughout the year after a heavy rain. Mr. Day added that he has had to reinforce the creek bank at his own expense, but he is still losing land.



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Mr. Michael Eilerman – 8193 N. Dilcrest

Mr. Eilerman has been at this property for one year. He stated that the creek channel runs through his property. He indicated that his yard floods every time there is heavy rain. He has also experienced erosion of the creek bed on his property. He stated that the sides of the creek bank continue to slip into the creek and the soil is eroding around the concrete culvert next to the driveway. He is concerned that this soil erosion may eventually cause his concrete driveway to crack. He stated that the problem occurs with every heavy rain event, but the water will usually recede within one to two hours. He has experienced the problems within the past six months. He added that the culvert for the storm drain is on his property. The water from the culvert frequently exceeds one foot and causes excessive erosion.

Mr. Bruce Hartmann – 8184 N. Dilcrest

Mr. Hartmann has lived at this property for seven years. Mr. Hartmann stated that his house is located at the bottom of a hill and that, after a heavy rain, water will pool in his yard between his house and his neighbor's property at 8182 N. Dilcrest. He said that the rain will run off of a neighbor's property at the top of the hill into his backyard and then exit on both sides of his house into the front yard. He also stated that his basement used to flood until he dug a French drain and, since then, he has not had the problem. Mr. Hartmann stated that the standing water in his yard will recede after a couple of hours in the summer months, however, in the spring his backyard may stay wet for weeks. Mr. Hartmann claims that he has experienced this problem year round and that it has happened in the past 6 months. Mr. Hartmann drew a rough sketch of how the water flows on his property. He indicated that the water comes down from the property at 39 Sycamore Drive, (unincorporated county), then runs through his backyard, and then branches out and flows heavily on both sides of his house to the street, (between 8186 N. Dilcrest and his house and between his house and 8182 N. Dilcrest). Mr. Hartmann also explained that the sump pump at 8182 N. Dilcrest continually pours out water. In the winter, the water will run down the street in front of his house and create "a skating rink". He has had a guest fall and hurt herself on the ice.

Michael and Sarah Hayden – 8178 N. Dilcrest

Mr. and Mrs. Hayden have lived at this property for 8 years, 11 months. Mr. and Mrs. Hayden spoke to Viox & Viox regarding their flooding issues on June 30, 2010 (see resident interview above).



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Mr. James Hensley – 8211 N. Dilcrest

Mr. Hensley has lived at this property for 9 ½ years. He stated that the creek channel runs through his property. He has not had any flooding problems.

David and Cheryl Hopper – 181 W. Dilcrest

Mr. and Mrs. Hopper have lived at this property for 19 ½ years. The creek channel runs behind their property. The Hoppers stated that the bottom of the hill in their yard stays damp and muddy for days after a rain. Their yard also tends to flood after a rain or after the snow thaws. Over the years the creek has widened and has become closer to their fence line. They tried to put a play area with mulch at the bottom of their hill, but it stayed too muddy and is mosquito infested. The Hopper's stated that the yard will have puddles and will be muddy after a rain, and never completely dries out. They experience this problem year round. Mr. and Mrs. Hopper have called the City of Florence many times about the flooding problems. Their yard also tends to accumulate branches and trash which flow from the creek upstream. This has been a problem for years.

Jerry Knochelmann – 8176 N. Dilcrest

(Mr. Knochelmann's parents spoke with Viox & Viox on June 30, 2010 regarding the flooding issues). Mr. Knochelmann has lived at the property for less than one year. He does not think that the actual creek channel runs through his property, however, after a heavy rain, water flows from two different directions through his yard. After the flooding, water will stand in the yard for several days. He stated that there is a low spot in the yard which tends to hold water. The flooding has been a problem in recent months and has been going on for over ten years, according to his neighbors. Mr. Knochelmann's parents gave Viox & Viox pictures of his property after a recent rain storm.

Ms. Charlynn Mallory – 177 W. Dilcrest

Ms. Mallory has owned this property for 4 years, but has never lived there. She states that the creek channel runs behind her property. She is unaware of any flooding problems.



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Ms. Mary Price – 28 N. Dilcrest

Ms. Price has lived at this property for 3 years. She has not experienced any flooding problems.

Mr. Ed Prindle – 145 W. Dilcrest

Mr. Prindle has lived at this property for 22 years. The creek channel runs along the back of his property. He stated that his backyard near the creek floods a couple of times a year. There has been standing water in that area which may not recede for several days. He also stated that the creek bed continues to erode. The flooding issues occur mostly in the spring, but sometimes in the summer, after long, hard, rain events. He has experienced these problems during the past 6 months.

Carrol Rawlings – 8206 Adella Drive

Mr. Rawlings has lived at this property for 20 years. The creek channel runs through his property. He experiences standing water in his yard only after extremely heavy rain. He also experienced flooding in his basement prior to the installation of a new storm drain. Mr. Rawlings added that there are two storm drains running under his property. The older drain runs along his driveway and it appears that water is running beside the drain and causing the edge of the driveway to collapse. He is very concerned about this problem and has called the City of Florence several times.

Mr. Dale D. Riggle – 189 W. Dilcrest

Mr. Riggle has lived at this address for one year. The creek channel runs through his property. He has experienced standing water in his yard and creek bank erosion. He has experienced the problem within the past six months and it tends to occur after both heavy cloudbursts and long rain events. Mr. Riggle added that his retaining wall is in need of repair after the constant soil erosion. The creek bank is washing away, especially on the side of the property leading up to the existing culvert.



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Mr. Scott Saylor – 202 W. Dilcrest

Mr. Saylor has lived at this property for 3 years. The creek channel does not run through his property, but does run through the property next door. He has not experienced any flooding issues, but stated that the creek does flood and tends to have an odor when this occurs.

Mr. Gary Shuler, Jr. – 243 W. Dilcrest

Mr. Shuler has lived at this address for 6 years. He has not experienced any flooding issues.

Gene and Nancy Smith – 8215 N. Dilcrest

The Smiths have lived at this property for 26 years. Mr. Smith spoke to Viox & Viox regarding their flooding issues on June 30, 2010 (see resident interviews above). The Smiths added that after losing about 25% of their garden one year, Mr. Smith used a shovel to widen the stream. Since then, the grassy soil has shifted to partially close the stream. The water will stand in their yard for about one week and the yard will stay very muddy for another week. The Smiths stated that they have been experiencing the flooding issues continually for over ten years. Mr. Smith explained that the mud has turned a dark gray color over the years. He was recently enlarging a drainage ditch to the stream and the muck soaked through his shoes. His feet turned bright red. The doctor believed he had either a bacterial or parasitic infection which was treated with medication. He also added that approximately 20 years ago, a service station which was located on U.S. 42 upstream from his property, had to close due to leaking gas tanks.

Mr. Dan Steffen – 8107 Harms Hill Drive

Mr. Steffen has lived at this address for 11 years. The creek channel runs through his property. He experiences standing water in his yard when the creek backs up after heavy downpours. He indicated that his yard can look like a lake at times. He continued by stating that when his family moved into the home in April 1999, the creek bank was narrow (his dogs were able to easily jump across the creek). The creek bank is now six to eight feet wide in most areas. Mr. Steffen added that several of his trees have died along the creek and in his yard due to the flooding issues. Mr. Steffen said that the flooding usually occurs after heavy rain. The creek is wide enough now to handle long steady rain, but short cloudbursts will flood over the creek bank. Mr. Steffen enclosed a photo of the flooded creek dated June 14, 2008.



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Mr. David Stewart – 8192 N. Dilcrest

Mr. Stewart has lived at this address for 17 years. He stated that after a long, heavy rain event, he will experience standing water in his yard. In addition, he has a finished basement which has flooded and ruined the carpet. Specifically, he experienced flooding problems after a rain event in October 2009. He has had problems within the past 6 months, as well.

Mr. James Sullivan – 8205 N. Dilcrest

Mr. Sullivan has lived at this property for 25 years. He has not experienced any flooding problems.

Daniel & Jacqueline Tombragel – 8180 N. Dilcrest

Mr. and Mrs. Tombragel have lived at this property for 26 years. The creek channel runs through their neighbor's property. Their survey indicated that they have had flooding in their yard after heavy rain. The water floods along the edge of their property, but flows mainly into neighboring property. The flooding has occurred within the past six months.

Mr. David Williams – 8186 N. Dilcrest

Mr. Williams has lived at this property for 26 years. The creek channel does not run through his property. Mr. Williams stated that in June 1997, it rained approximately 2 inches in 45 minutes and the water flooded into his garage. He indicated that the water receded immediately after the rain stopped. He said that a catch basin was installed on the street in 1997. He has not experienced a problem in over ten years.

Ms. Marlene Wilson – 129 W. Dilcrest

Ms. Wilson has lived at this property for 40 years. She has never experienced any type of flooding issues.

Appendix A, Figure 4 shows the locations of the above mention residents.



SECTION 3: DATA ANALYSIS

3.0 Summary of Field Observations and Hydrologic Data

During the planning portion of this project it was determined that the storms of highest interest would likely be short duration, high intensity events. This was determined due to the fact that the watershed is reasonably small and most accounts of flooding were of the flash flood variety. Several rain events matching this description occurred during the monitoring period. These storms are summarized in the following table.

Table 1

Date	Total Rainfall (in)	Duration (min)	Intensity (in/hr)
5/1/2010	0.24	30	0.48
6/9/2010	2.06	60	2.06
6/19/2010	0.61	90	0.40
7/20/2010	0.50	30	1.00

Detention and Flood Control design uses a storm's frequency of occurrence as a basis for design. For example, local regulations require detention facilities to be designed to detain the 2, 10, 25, and 50-year storm events and provide flood control in the 100-year storm event. Therefore, it is useful to estimate the frequency rating of the monitored storms in order to gain a better understanding of the function of the detention facilities. It is also relevant to note that the short duration, high intensity storms, noted above, roughly follow a Type II 24-hr rainfall distribution. The Type II 24-hr distribution is the distribution most common in local detention facility design. The following table summarizes the rainfall quantities and their associated frequency of occurrence.

Table 2

	SCS 24-hr Rainfall (in)	IDF Intensity (in/hr) (Tc=20min)
6-month	2.07	Not available
1-year	2.56	Not available
2-year	3.05	2.6
10-year	4.36	3.9
25-year	5.15	4.6
50-year	5.78	5.0
100-year	6.44	5.5

The most significant storm during the monitoring period occurred on June 9, 2010. The distribution of this storm was even more peak intensive than a standard Type II distribution, so comparison to Table 2 is somewhat difficult.



SECTION 3: DATA ANALYSIS

However, based on the totality of the information, it was estimated that the peak of the June 9th storm was roughly equivalent to that of the 2-year storm.

3.1 Site Specific Data and Analysis

From the physical data collected, an accurate computer model of the watershed was created and calibrated. The main program used in the analysis was the United States Environmental Protection Agency Storm Water Management Model (EPA SWMM), Version 5.0. This program is designed for small urban watersheds and is therefore well suited for this application.

The results of previously conducted small watershed studies within the City have demonstrated that standard hydrologic assumption used in detention and storm water design regulations do not always accurately represent actual measured flows. This discrepancy is most likely due to local variations in soil infiltration and localized weather patterns. The results actually show that the standard assumptions over estimate the flow generation of this area. These results lead us to conclude that to accurately model a small watershed, it is necessary to collect flow and rain gauge data and develop a watershed specific model for analysis. The model was calibrated by adjusting infiltration rates and watershed characteristics until the modeled data matched the measured data.

The first area analyzed was in the rear yards of the homes along the Dilcrest Drive, upstream of the northern most culvert crossing of E. Dilcrest Drive. This area was noted to experience erosion.

Table 3 (SWMM designation=36CMP)

Storm	Peak Flow (mgd)	Peak Velocity (fps)	Peak Depth (ft)
6-month	1.45	3.00	1.21
1-year	1.89	3.25	1.29
2-year	2.23	3.41	1.35
10-year	3.32	3.83	1.57
25-year	3.88	4.00	1.66
50-year	4.56	4.19	1.76
100-year	5.03	4.31	1.83



SECTION 3: DATA ANALYSIS

Table 4 shows the model results for the 42” culvert under Adella Drive. The area has previously been noted to experience significant ponding water and debris backup. This culvert was previously upgraded in 1995 after reported flooding. It should also be noted that the modeled data at this location is very similar to the measured data from the 2-year storm recorded on June 9, 2010.

Table 4 (42ASP)

Storm	Peak Flow (mgd)	Peak Velocity (fps)	Peak Depth (ft)
6-month	3.59	5.65	1.83
1-year	4.69	6.13	1.99
2-year	5.53	6.42	2.10
10-year	8.25	7.17	2.42
25-year	9.65	7.50	2.57
50-year	11.40	7.86	2.74
100-year	12.63	8.10	2.85

Table 5 shows model results for the 42” culvert under E. Dilcrest Drive at approximate address 8193. This culvert largely carries flows from the unincorporated portions of the Shamrock Hill Subdivision. As with the previous location, it should also be noted that the modeled data at this location is very similar to the measured data from the 2-year storm recorded on June 9, 2010.

Table 5 (42CMP3)

Storm	Peak Flow (mgd)	Peak Velocity (fps)	Peak Depth (ft)	
6-month	9.90	5.68	2.59	
1-year	13.36	6.17	2.91	
2-year	16.02	6.47	3.15	
10-year	22.38	7.75	3.66	culvert surcharged
25-year	24.34	7.64	3.80	culvert surcharged
50-year	26.76	7.42	3.98	culvert surcharged
100-year	28.59	7.71	4.10	culvert surcharged



SECTION 3: DATA ANALYSIS

The flows and velocities noted in Tables 3, 4, & 5, all show velocity and flow rates that are low to moderately erosive. Also, given standard design methodology, these three culverts appear to be adequately sized. The note “culvert surcharge” indicates that the water level exceeds the height of the culvert and the pipe is under pressurized flow.

Table 6 shows the results of the analysis in the main 48” culvert under the interstate.

Table 6 (I7548CMP)

Storm	Peak Flow (mgd)	Peak Velocity (fps)	Peak Depth (ft)	
6-month	11.03	5.14	2.61	
1-year	15.26	5.63	2.97	
2-year	18.61	5.94	3.23	
10-year	30.01	6.72	3.98	
25-year	36.06	7.01	4.36	culvert surcharged
50-year	43.79	7.29	4.81	culvert surcharged
100-year	49.30	7.42	5.10	culvert surcharged

The results for the driveway bridge to 8164 E. Dilcrest are shown below in Table 7.

Table 7 (BRIDGE)

Storm	Peak Flow (mgd)	Peak Velocity (fps)	Peak Depth (ft)
6-month	33.63	6.51	2.50
1-year	46.65	7.29	2.93
2-year	56.88	7.78	3.23
10-year	90.51	9.03	4.12
25-year	107.05	9.51	4.52
50-year	128.06	10.03	5.01
100-year	137.03	10.23	5.21

The results shown in Tables 6 & 7 are similar to the previously analyzed areas. The velocities are within the range of low to moderately erosive and the flow rates indicate the culverts are adequately sized. It should also be



SECTION 3: DATA ANALYSIS

noted that the modeled data at this location is very similar to the measured data from the 2-year storm recorded on June 9, 2010.

Table 8 shows the results for the 96" CMP culvert located at the downstream point of the study area. As with the previous location, it should also be noted that the modeled data at this location is very similar to the measured data from the 2-year storm recorded on June 9, 2010.

Table 8 (96CMP)

Storm	Peak Flow (mgd)	Peak Velocity (fps)	Peak Depth (ft)
6-month	50.42	9.51	4.06
1-year	69.98	10.46	4.70
2-year	85.42	11.05	5.16
10-year	134.51	12.57	6.42
25-year	158.93	13.15	6.98
50-year	189.26	13.78	7.05
100-year	206.80	14.10	8.02

culvert surcharged

This culvert also appears to be adequately sized, however, flow velocities are higher than those of the previously analyzed areas. This location shows moderately erosive velocities (8-14 fps).



SECTION 4: RECOMMENDATIONS & CONCLUSIONS

4.0 Recommendations

Viox & Viox has prepared the study findings and developed recommendations based on the computer simulations, onsite observations, public comments, and other historical data. These recommendations were carefully considered based on sound engineering principles, cost, and most importantly, public safety.

The following recommendations are based on the study findings. All recommendations will require further detailed design at a later date prior to implementation.

Recommendation #1

While the vast majority of this report focused on the main channel flow characteristics of the watershed, during the interview process, some off-channel flooding issues were identified. Specifically, residents reported very high storm water flows in backyards and between homes on E. Dilcrest between addresses 8174 and 8190. These flows are the result of storm water flows from the unincorporated portions of the Shamrock Hill Subdivision and the McEvoy property. The problem is exacerbated by the presence of several pools in the backyards that disrupt the natural storm water flow. If E. Dilcrest were to be developed today, it likely would have included surface drainage easements to avoid this type of flow blockage. Given the current situation, the most reasonable solution is to extend storm sewers between the houses and into the backyard to collect the water and move the flows into a storm sewer system. These areas are all on private property and not within the “waters of Florence”. Therefore any improvements would likely be the responsibility of the homeowners.

While there is little the City can do to correct these existing problems on private property it is recommended that the city meet with the Boone County Planning officials to discuss strengthening permit requirements for pools, decks, sheds and other out-structures. This will help prevent the blockage of surface runoff and avoid future issues similar to this situation.

Recommendation #2

The vast majority of the watershed was developed before the advent of storm water detention regulations. The isolated areas that do have storm water controls are very small facilities and are not highly effective. Regional detention would be a far more effective solution. Most resident complaints are



SECTION 4: RECOMMENDATIONS & CONCLUSIONS

located in the watershed reaches going north to Adella Drive and northeast toward Shamrock Hill Subdivision. Unfortunately, both of these reaches are nearly completely developed and contain no areas suitable for regional detention, however, the larger southern reach, toward I-75, has multiple opportunities. Upon development, the McEvoy property will be required to detain based on current storm water regulations. The City should try to partner with the eventual developer to provide additional regional detention to compensate for the areas of the watershed that were developed before detention regulations. Also, there is a current opportunity for regional detention at the I-75 crossing. The upstream side of the interstate culvert is located in a deep ravine with little to no development potential and is ideal for detention. Use of this area will require the cooperation of KYTC as well as multiple private industrial land owners.

Recommendation #3

As mentioned previously, the north reach of the watershed has seen consistent resident complaints regarding high flows and erosion, however, both the flow monitoring and model analysis reveal that the velocities in this area are not highly erosive. As with previous studies, most of the resident complaints revolve around the loss of usable yard to creek erosion. Erosion along a creek is a natural process. This process is accelerated by residents clearing natural vegetation from the creek banks in an effort to create more usable yard. Furthermore, these areas lie on private property and are outside the definition of the “waters of Florence”, therefore, it is likely that any improvements would need to be privately funded by the residents.

However, the observations, issues, and findings identified by this study indicate a need for an educational component. Public awareness of the protection of drainage channels, protection of vegetation and ground cover, and the consequences of redirecting surface runoff, are essential. Most of the areas in question are good candidates for green stream bank stabilization solutions. The City should provide information to residents and assist where possible in implementing bank stabilization in these areas.

Recommendation #3

The area south of Adella Drive and north of Harms Hill Drive has experienced conditions similar to those discussed in recommendation 3, however this area carries over 25 acres of water and therefore falls under the definition of the waters of Florence and may be eligible for City assistance. As in the previous area, the study indicates a need for an educational component. Public awareness of the protection of drainage channels, protection of



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vegetation and ground cover, and the consequences of redirecting surface runoff, are essential. Most of the areas in question are good candidates for green stream bank stabilization solutions. The City should provide information to residents and assist where possible in implementing bank stabilization in these areas. However, this portion of the channel also contains isolated areas where “Hard” or “Non-Green” solutions may be necessary but should be used as a last resort, and may require additional permits.

Recommendation #5

As part of our field observations, we also noted several deficiencies in the existing storm water infrastructure. Especially, along E Dilcrest, (approximate addresses 129 to 157), and along W. Dilcrest, (approximate addresses 8212 to 8196), a lack of adequate street drainage structures was noted. There have been no recorded resident complaints about excessive water in the street during rain events, however, in both cases there is nearly 800’ of street draining to a single set of catch basins. Current design standards require significantly more catch basins and this should be investigated further.

4.1 Conclusions

As opposed to previous studies conducted by the City, the order of implementation of these recommendations is not a factor. These recommendations, and any future design based on this study, should also consider that the simulated flow data does not include a factor of safety that is always present in standard engineering assumptions. A factor of safety is essentially a ratio by which the project is designed in excess of minimum requirements. This allows the designer to compensate for some of the uncertainty introduced by the extrapolation of data and limited sample sizes.

The implementation of these recommendations will improve the functionality of the watershed, particularly during the most common smaller storm events. It is, however, unrealistic to expect to eliminate all problems in a watershed that is densely populated and was largely developed before the advent of storm water control regulations. The north and northwest reaches of this water shed are nearly completely developed with both residential and commercial development. While commercial development does produce more run-off per acre than residential, completely undetained residential neighborhoods are a significant contributor to the increased storm water flows in the basin. Unfortunately, residential development also make it more difficult to introduce detention facilities at a later date since any such facility would inevitably be located in close proximity to a residence.

Additionally, while this study does not specifically address sanitary sewer or water quality issues, several observations and issues should be noted. Several residents have noted odor and/or colored storm water flows in



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relation to the industrial uses in the unincorporated county portion of the watershed. Within the city portion of the watershed, there are possible improperly abandoned septic tanks and one reported infection possibly due to contaminated storm water flows. Also, this report did not include the location of sanitary sewer facilities but it is likely that some of the storm water flows modeled in this report exceed the rim level of adjacent sanitary sewers and contribute significantly to inflow/infiltration rate.

All solutions proposed in this report will require detailed engineering design prior to construction. Before any stream improvements are proposed, individual property owners must grant easements and permits must be acquired. Any costs associated with easement acquisition will become part of the overall expense of the improvement. Additionally, many of these storm sewer improvements will necessitate sanitary sewer improvements, which will also add to project cost.

