

# **CITY OF LEBANON**

## **CITY-WIDE DRAINAGE EVALUATION**

### **EXECUTIVE SUMMARY**

#### **Introduction**

Neel-Schaffer performed an engineering evaluation of drainage issues and flooding concerns within the City of Lebanon (City) jurisdictional limits. The evaluation included performing a field investigation, identification of drainage infrastructure maintenance requirements, developing hydrologic and hydraulic models to identify/confirm drainage problems, and identification of structural alternatives for points of interest identified by City staff.

The majority of drainage infrastructure deficiencies are located in older subdivisions or areas that have been annexed by the City. Older subdivisions were typically developed without proper design of drainage systems or dedication of drainage easements. The identification of maintenance issues consisted of locating and quantifying drainage-related maintenance items, within each pre-defined study area, such as ditch cleanout, removal of sediment in existing culverts, removal of excessive vegetation/debris from culverts/bridges, and other drainage-related maintenance items. The goal was to restore drainage to the design level originally intended at the time of construction to the maximum extent practicable, while staying within the existing right-of-way. Evaluation of maintenance items was based on the remedial maintenance approach, which corrects specific deficiencies in the existing system without necessarily upgrading the complete downstream drainage system. A maintenance list was developed for each watershed.

Hydrologic and hydraulic computer models were developed for each point of interest to evaluate existing conditions and proposed structural alternatives intended to alleviate drainage and flooding problems to the maximum extent practicable. The alternatives were developed with the goal of reducing the watershed peak discharge and resulting flood elevations in areas where the existing drainage issues were located. The 2-, 5-, 10-, 25-, 50-, and 100-year recurrence intervals were evaluated for existing conditions and for each structural alternative to determine the current drainage system's level of service and level of improvement that is anticipated after the structural alternative is implemented. Improvements were evaluated based on how much the level of service was increased for road and property flooding. The alternatives were also evaluated to ensure that they would not increase flooding of areas upstream or downstream of the point of interest.

Identification of drainage/flooding problems and potential solutions within each watershed area was based on severity/frequency of flooding, history/knowledge of the sites provided by City staff and private property owners, level of benefit obtained versus cost, required private property easements, and consideration of the following order of priority:

1. Structure flooding;
2. Flooding of crawl space/HVAC/garage
3. Road flooding; and
4. Nuisance (i.e. yard) flooding

Based on those variables, the watershed areas were prioritized as shown below. The Johnson Heights and Head Homes subdivisions were ranked last since both the problems and solutions were determined to be private property drainage issues. Therefore, these two watersheds are not summarized in the Executive Summary. Refer to Section 6 and Section 7 of the enclosed report for a summary of these two watersheds.

1. Cumberland University Area;
2. Bartons Creek – Tributary 3 at Nashville & Eastern Railroad;
3. Oak Hill Drive/Bartonwood Drive Area;
4. U.S. Highway 231 (North Cumberland Street);
5. Richmond Hills Subdivision;
6. Johnson Heights Subdivision; and
7. Head Homes Subdivision.

An engineering report was developed for each watershed. The engineering reports include description and findings of the field evaluation, technical approach and assumptions for watershed modeling, model results for structural alternatives evaluated, potential impacts of implementing the alternatives, and preliminary opinion of construction costs for each alternative. The engineering reports also include a detailed list of maintenance deficiencies, a photograph log and location map detailing each deficiency, and preliminary opinion of construction cost to correct maintenance issues. Each engineering report also includes maps/drawings of conceptual drainage improvement recommendations for proposed structural alternatives.

### **Cumberland University Area**

The Cumberland University area includes several streets, intersections, and private properties surrounding the campus of Cumberland University that routinely experience flooding during short, intense rainfall events. This causes unsafe conditions for motorists as well as nuisance flooding for multiple property owners in the area. No structural flooding is known to exist in this area; but due to the widespread street and private property nuisance flooding, and the fact that most culverts and ditches in this area are significantly undersized and do not meet current regulations, this area was given high priority.

A description of the proposed structural improvements and preliminary estimated project costs for Cumberland University are shown below. The costs include engineering/design fees and 20 percent contingency, but do not include property acquisition or easements:

<b>Cumberland University Area Structural Improvements</b>	<b>Preliminary Estimated Project Cost</b>
Storm sewer/curb & gutter along West Spring Street between South Greenwood Street and Sinking Creek	\$ 457,500.00
Storm sewer/curb & gutter along Cumberland Drive, rerouted storm drain beneath South Greenwood near dormitory, two detention ponds (0.3 acre and 0.4 acre) with inlet/outlet ditches	\$ 267,000.00
Storm sewer/curb & gutter along Martin Avenue between South Tarver Avenue and creek (Tarver Branch)	\$ 139,400.00
Storm sewer/curb & gutter along West Spring Street between South Tarver Avenue and creek (Tarver Branch)	\$ 131,800.00
Storm sewer/curb & gutter along West Spring Street between Pennsylvania Avenue and creek (Tarver Branch)	\$ 158,200.00
Storm sewer and drainage improvements between Martin Avenue/Cleveland Avenue and creek (Tarver Branch)	\$ 29,100.00
<b>Total Cost of Recommended Structural Improvements</b>	<b>\$ 1,183,000.00</b>

In addition to the structural recommendations, numerous remedial maintenance issues were found throughout the watershed study area during the field reconnaissance. A preliminary cost estimate for the remedial maintenance items are shown below:

<b>Cumberland University Area Remedial Maintenance Items</b>	<b>Preliminary Estimated Project Cost</b>
1. Debris/sediment removal from culvert ends at 36 locations	\$ 14,400.00
2. Culvert end repair at fourteen locations	\$ 9,800.00
3. Debris/sediment removal from channel at three locations – 3,875 L.F.	\$ 15,500.00
4. Debris/sediment removal from roadside ditch at five locations – 4,010 L.F.	\$ 16,000.00
5. Remove sediment/debris from catch basins at five locations	\$ 2,500.00
6. Repair catch basins at two locations	\$ 2,000.00
<b>Total Maintenance Cost</b>	<b>\$ 60,200.00</b>

**Bartons Creek – Tributary 3 at Nashville & Eastern Railroad**

This area includes the Maple Hill Sports Complex on Carver Lane and several other businesses located between the Nashville & Eastern Railroad and Highway 70 (Lebanon Road) that suffered flood damages during the May and August 2010 flood events. Although localized structural flooding has occurred during significant storm events, much of this area lies within the FEMA-defined floodplain of Tributary 3 to Bartons Creek, and therefore improvements will be subject to FEMA rules and restrictions. Furthermore, due to the high cost of the recommended structural improvements compared to level of flood reduction and difficulty of implementation, it was ranked below the Cumberland University area.

A description of the proposed structural alternatives and preliminary estimated project costs for the Bartons Creek – Tributary 3 watershed are shown below. The following costs include engineering/design fees, permitting fees, FEMA review fees (where applicable), and 20 percent contingency but do not include property acquisition or easements:

<b>Bartons Creek - Tributary 3 Structural Alternatives</b>	<b>Preliminary Estimated Project Cost</b>
Alternative 1: Replace existing (4) railroad culverts with 100-foot, multi-span railroad bridge and lower the streambed elevation.	\$ 308,400.00
Alternative 2: Multi-span railroad bridge plus construct a 4.2 acre detention pond adjacent to Carver Lane, and construct a 3.4 acre detention basin south of Highway 70.	\$ 677,500.00

In addition to the proposed structural improvements described above, numerous remedial maintenance issues were found throughout the watershed study area during the field reconnaissance. A preliminary cost estimate for the proposed maintenance items are shown below:

<b>Bartons Creek - Tributary 3 Remedial Maintenance Items</b>	<b>Preliminary Estimated Project Cost</b>
1. Channel cleanout at seven locations - 1,550 L.F.	\$ 7,750.00
2. Debris/sediment removal from culvert ends at six locations	\$ 3,000.00
3. Culvert end repair at one location	\$ 1,000.00
<b>Total Maintenance Cost</b>	<b>\$ 11,750.00</b>

**Oak Hill Drive/Bartonwood Drive Area**

Several properties located on Bartonwood Drive north of Winston Avenue suffered flood damages during the May and August 2010 flood events, but structures were not flooded. In addition, it was determined that the culvert beneath Bartonwood Drive is significantly undersized and does not meet current regulations. The drainage ditch shows significant active erosion at the upstream side of the existing culvert under Bartonwood Drive, and significant deposition on the downstream side of the culvert. This indicates that the existing pipe configuration is not properly sized and aligned for the volume of water draining to it. Due to the level of benefit obtained versus relatively low cost, this area was ranked in third position.

A description of the proposed structural alternatives and preliminary estimated project costs are shown below. The following costs include engineering/design fees and 20 percent contingency:

<b>Oak Hill Drive/Bartonwood Drive Area Structural Alternatives</b>	<b>Preliminary Estimated Project Cost</b>
Replace existing Bartonwood Drive cross drain with 90 L.F. 60-inch by 38-inch elliptical RCP. Install riprap apron at outlet of cross drain. Install erosion control measures upstream of the cross drain. Repair failing retaining wall and channel banks upstream of Bartonwood Drive. Improve channel downstream of Bartonwood Drive (205 LF) and install erosion control measures.	<b>\$ 79,700.00</b>

In addition to removing debris and obstructions described above, numerous remedial maintenance issues were found throughout the watershed study area during the field reconnaissance. A preliminary cost estimate for the proposed maintenance items are shown below:

<b>Oak Hill Drive/Bartonwood Drive Area Remedial Maintenance Items</b>	<b>Preliminary Estimated Project Cost</b>
1. Debris/sediment removal from culvert ends at five locations	\$ 2,500.00
2. Debris/sediment removal from channel at three locations – 3,300 L.F.	\$ 16,500.00
3. Culvert end repair at three locations	\$3,000.00
4. Remove trash/debris from natural detention/low area	\$ 4,500.00
<b>Total Maintenance Cost</b>	<b>\$ 23,000.00</b>

**U.S. Highway 231 (North Cumberland Street)**

Several homes between Oakdale Drive and Elmwood Drive suffered flood damages during the May and August 2010 flood events. Storm water rose to a level of three to four feet deep in this area, but it is not believed that water inundated first floor living spaces. Damages were primarily incurred in garages, crawl spaces, and to HVAC units. Due to the high cost of structural improvements and relatively low benefit area, this project was ranked in fourth position.

A description of the proposed alternatives and preliminary estimated project costs are shown below. The following costs include engineering/design fees and 20 percent contingency:

<b>U.S. Highway 231 Structural Alternatives</b>	<b>Preliminary Estimated Project Cost</b>
Alternative 1: Replace Existing Hwy. 231 Cross Drain with 2-48" RCPs and Replace Existing 20" Storm Sewer with 2-30" RCPs	\$ 353,500.00
Alternative 2: Replace Existing 20" Storm Sewer with 2-30" RCPs (No Cross Drain Replacement)	\$ 316,800.00
Alternative 3: Replace Existing Hwy. 231 Cross Drain with 2-48" RCPs and Replace Existing 20" Storm Sewer with 1-6'x3' Concrete Box Culvert	\$ 509,000.00
Alternative 4: Replace Existing 20" Storm Sewer with 1-6'x3' Concrete Box Culvert (No Cross Drain Replacement)	\$ 472,400.00

In addition to the recommended structural improvements, numerous remedial maintenance issues were found throughout the watershed study area during the field reconnaissance. A preliminary cost estimate for the proposed maintenance items are shown below:

<b>U.S. Highway 231 Remedial Maintenance Items</b>	<b>Preliminary Estimated Project Cost</b>
1. Culvert end repair at eight locations	\$ 8,000.00
2. Debris/sediment removal from culvert ends – at least seven locations	\$ 3,500.00
3. Debris/sediment removal from channel at one – 150 L.F.	\$ 750.00
4. Install erosion control measures at three locations	\$ 4,000.00
<b>Total Maintenance Cost</b>	<b>\$ 16,250.00</b>

**Richmond Hills Subdivision**

Several homes on Barnes Drive suffered flood damages during the May and August 2010 flood events. Storm water rose to a level that caused nuisance flooding in the area, but it is not believed that water inundated first floor living spaces. Damages were primarily incurred in garages, crawl spaces, and to HVAC units. Because the recommended solution that will obtain the most flood reduction includes purchasing a portion of a private tract of land that is outside of the City limits, this area was ranked in fifth position.

A description of the proposed structural alternatives and preliminary estimated project costs are shown below. The following costs include engineering/design/permitting fees and 20 percent contingency:

<b>Richmond Hills Structural Alternatives</b>	<b>Preliminary Estimated Project Cost</b>
Alternative 1: Grade 1,150 L.F. of main drainage channel. Clear debris, sediment, trees and brush from approximately 1,900 L.F. of main drainage channel.	\$ 40,700.00
Alternative 2: Alternative 1 plus construct 4.2-acre detention pond.	\$ 240,400.00

In addition to removing debris and obstructions described above, numerous remedial maintenance issues were found throughout the watershed study area during the field reconnaissance. A preliminary cost estimate for the proposed maintenance items are shown below:

<b>Richmond Hills Remedial Maintenance Items</b>	<b>Preliminary Estimated Project Cost</b>
1. Ditch grading at four locations – 750 L.F.	\$ 3,750.00
2. Debris/sediment removal from culvert ends at five locations	\$ 2,500.00
<b>Total Maintenance Cost</b>	<b>\$ 6,250.00</b>

**Conclusions**

The Middle Tennessee Advisory Service’s general position, based on case law, is that public funds should only be used for public purposes. A public purpose is generally anything that promotes the public health, welfare, morals, security, prosperity, or contentment of the residents of the City. Remedial maintenance within the City right-

of-way to restore the drainage system and prevent frequent flooding of streets/intersections and structural alternatives to prevent upstream and downstream flooding meets the public purpose definition.

Generally, local governments have a duty to operate and maintain drainage systems into which they intentionally divert storm water, whether from publically owned streets and roads, development of public lands, or from private developments from which the local government, by dedication, has accepted the responsibility (and liability) for operation and maintenance of the drainage system. Unfortunately, due to lack of funding for drainage related issues, most local governments typically do not address drainage maintenance issues or flooding problems until someone complains or major flooding occurs.

The City has drainage related issues such as road/intersection flooding during frequent rainfall events, flooding of crawl spaces and HVAC units, nuisance flooding, and a significant backlog of remedial drainage maintenance items. Controlling flooding is vital to the safety of the citizens of Lebanon. Therefore, drainage control is an important service that the City provides. The City has received approximately 435 drainage complaints between 1998 and 2010. There is not a history of flooding of structure first floors or repetitive losses.

The City should make it a priority to resolve the remedial maintenance issues prior to implementing flood reduction capital improvement projects. While performing remedial maintenance will not solve flooding problems; it is critical to correct them immediately so that the drainage system can function as designed and conditions do not worsen, leading to possible flooding problems in the future. In addition, it is important to note that areas identified as requiring remediation should be regularly scheduled for maintenance by City crews to prevent future buildup of debris and sediment. As shown in the table below, it is estimated that \$139,665.00 is needed to address current remedial drainage issues alone.

<b>Watershed Study Area</b>	<b>Total Remedial Maintenance Costs</b>
Cumberland University Area	\$60,200.00
Bartons Creek – Tributary 3 (railroad)	\$11,750.00
Oak Hill Drive/Bartonwood Drive Area	\$23,000.00
U.S. Highway 231 (North Cumberland Street)	\$16,250.00
Richmond Hills Subdivision	\$6,250.00
Head Homes Subdivision	\$14,715.00
Johnson Heights Subdivision	\$7,500.00
<b>Total</b>	<b>\$139,665.00</b>

The City should consider developing a drainage policy or other appropriate mechanism to safeguard public welfare by addressing existing and future remedial drainage issues,

flooding of roads and intersections, private driveway culverts within City right-of-way, and drainage related issues on private property with and without drainage easements. Although Article II C.6.q. requires that a note on the final plat state: "Drainage easements outside dedicated R.O.W.s are not the responsibility of Wilson County or the City of Lebanon;" the City should consider a policy that requires an easement if drainage improvements are required and constructed outside the City right-of-way to ensure future maintenance of the drainage improvement.