I, Amy T. Harvey, Deputy Town Clerk of the Town of Chapel Hill, North Carolina, hereby certify that the attached is a true and correct copy of (2021-05-05/R-11) adopted as amended by the Chapel Hill Town Council on May 5, 2021.

This the 31st day of August, 2021.

Amy T. Harvey

Amy T. Harvey
Deputy Town Clerk

A RESOLUTION TO ADOPT THE EASTWOOD LAKE SUBWATERSHED STUDY REPORT, APPENDICES, AND MERGED PRIORITY LISTS (2021-05-05/R-11)

WHEREAS, the Town Council adopted the Stormwater Master Plan that included a recommendation to continue the subwatershed studies; and

WHEREAS, the Town of Chapel Hill contracted with W. K. Dickson, Inc. to perform the Eastwood Lake Subwatershed Study; and

WHEREAS, W. K. Dickson, Inc. has completed the Eastwood Lake Subwatershed Study Report and Appendices and provided merged priority lists for primary and secondary systems.

NOW, THEREFORE, BE IT RESOLVED by the Council of the Town of Chapel Hill that the Council adopts the Eastwood Lake Subwatershed Study and Appendices, and approves the merged priority lists of projects.

BE IT FURTHER RESOLVED that the Town Manager provide additional detail before moving beyond next steps on specific projects in the priority lists to look at the environmental impacts.

BE IT FURTHER RESOLVED that the Town Manager provide information on a disconnect downspouts pilot program.

This the 5th day of May, 2021.

WK DICKSON
community infrastructure consultants

Town of Chapel Hill
Eastwood Lake Subwatershed Study

Volume I : Report

June 2020

TOWN OF CHAPEL HILL

Eastwood Lake Subwatershed Study Volume I: Report

WKD # 20170067.00.RA

June 2020

Prepared for

Town of Chapel Hill
405 Martin Luther King, Jr. Boulevard
Chapel Hill, NC 27514

Prepared by
W. K. Dickson & Co., Inc.
Raleigh, NC
919/782/0495
NC License No. F-0374

TABLE OF CONTENTS

List of Abbreviations L-1

Executive Summary ES-1

Introduction 1-1

1.1 Project Description 1-1

1.2 Design Standards and Criteria 1-4

Existing Watershed Conditions 2-1

2.1 Citizen Input 2-1

2.2 Watershed Characteristics 2-4

2.3 Existing Conditions Survey and Field Data Collection 2-6

Existing Watershed Analysis 3-1

3.1 Primary System Hydrologic and Hydraulic Analyses 3-1

3.1.1 Hydrology 3-1

3.1.2 Hydraulics 3-2

3.2 Secondary System Hydrologic and Hydraulic Analyses 3-6

3.2.1 Hydrology 3-6

3.2.2 Hydraulics 3-6

3.3 Stream Stability Field Assessments 3-23

3.3.1 Booker Creek 3-23

3.3.2 Methods 3-23

3.3.3 Unified Stream Assessment Protocol Description 3-25

3.3.4 EPA Rapid Bioassessment Protocol (RBP) Description 3-26

3.3.5 Results and Discussion 3-27

3.4 Outfall Analysis 3-34

3.4.1 Process 3-34

3.4.2 Results 3-40

3.5 Neighborhood Analysis 3-43

3.5.1 Process 3-43

3.5.2 Results 3-47

Flood Mitigation Alternatives 4-1
4.1 Overall Booker Creek Watershed 4-3
4.2 Eastwood Lake West 4-6
4.3 Eastwood Lake East 4-11
4.4 Hydrology 4-20
4.5 Hydraulics 4-21
Condition Assessment 5-1
5.1 Project Background 5-1
5.2 Criticality Analysis 5-1
5.3 Identification of Critical Infrastructure 5-5
5.4 Town-Maintained Asset Analysis 5-6
5.5 Future Use of Prioritization Tool 5-11
Water Quality Recommendations 6-1
6.1 Stream Stabilization Projects 6-1
6.2 SCM Project Identification 6-10
6.2.1 Outfall Opportunities 6-10
6.2.2 Neighborhood Opportunities 6-29
6.3 Water Quality Modeling 6-36
Anticipated Permitting 7-1
7.1 North Carolina Division of Water Resources 401 Water Quality Certification and US Army Corps 404 Permit 7-1
7.2 Individual Permits 7-3
7.3 Federal Emergency Management agency (FEMA) 7-3
7.4 Erosion and Sedimentation Control 7-3
Cost Estimates 8-1
Prioritization and Recommendations 9-1
References 10-1

List of Figures

Figure ES-1: Project Overview Map ES-7
Figure 1-1: Vicinity Map 1-2
Figure 1-2: Eastwood Lake Watershed Map 1-3
Figure 2-1: Flooding Public Questionnaires Results Map 2-2
Figure 2-2: Erosion Public Questionnaires Results Map 2-3
Figure 3-1: Eastwood Lake Existing Conditions Floodplain 3-5
Figure 3-2: Shady Lawn Road System Existing Conditions 3-8
Figure 3-3: Arlington Street #1 System Existing Conditions 3-9
Figure 3-4: Arlington Street #2 System Existing Conditions 3-11
Figure 3-5: Rock Creek Road Closed System Existing Conditions 3-12
Figure 3-6: South Lakeshore Drive/Ridgecrest Drive System Existing Conditions 3-14
Figure 3-7: South Lakeshore Drive/Woodhaven Road System Existing Conditions 3-15
Figure 3-8: South Lakeshore Drive/Rolling Road System Existing Conditions 3-17
Figure 3-9: South Lakeshore Drive System Existing Conditions 3-18
Figure 3-10: Allard Road System Existing Conditions 3-19
Figure 3-11: Curtis Road System Existing Conditions 3-21
Figure 3-12: Woodshire Lane/Huntington Drive System Existing Conditions 3-22
Figure 3-13: Stream Assessment Reach Location Map 3-24
Figure 3-14: Stream Assessment Reach Score Map 3-30
Figure 3-15: Stream Assessment Habitat Score Map 3-33
Figure 3-16: Eastwood Lake Outfall Analysis Results Map 3-42
Figure 4-1: Eastwood Lake Project Areas 4-2
Figure 4-2: Overall Booker Creek Watershed Storage Area Locations 4-5
Figure 4-3: Eastwood Lake – West Alternative 4-8
Figure 4-4: Woodshire Lane/Huntington Drive System 4-10
Figure 4-5: Shady Lawn Road System Alternative 4-12
Figure 4-6: Arlington Street #1 System Alternative 4-14
Figure 4-7: Arlington Street #2 System Alternative 4-15
Figure 4-8: South Lakeshore Drive /Ridgecrest Drive System Alternative 4-17
Figure 4-9: South Lakeshore Drive /Rolling Road System Alternative 4-18
Figure 5-1: Stormwater Pipes Scoring Results Map 5-3
Figure 5-2: Stormwater Structures Scoring Results Map 5-4
Figure 5-3: Town-Maintained Stormwater Pipes Scoring Results Map 5-8
Figure 5-4: Town-Maintained Stormwater Structures Scoring Results Map 5-9
Figure 6-1: Proposed Stream Projects West Focus Area 6-3
Figure 6-2: Proposed Stream Projects East Focus Area 6-4
Figure 6-3: Outfall Assessment – Outfall EL0431 6-13
Figure 6-4: Outfall Assessment – Outfall EL0389 6-14
Figure 6-5: Outfall Assessment – Outfall EL0541 6-15

Figure 6-6: Outfall Assessment – Outfall EL0109 6-18
Figure 6-7: Outfall Assessment – Outfall EL0343/EL0344 6-19
Figure 6-8: Outfall Assessment – Outfall EL0074 6-20
Figure 6-9: Outfall Assessment – Outfall EL0545 6-23
Figure 6-10: Outfall Assessment – Outfall EL0200 6-24
Figure 6-11: Outfall Assessment – Outfall EL0523 6-25
Figure 6-12: Outfall Assessment – Outfall EL0157/EL0162 6-27
Figure 6-13: Outfall Assessment – Outfall EL0520 6-28
Figure 6-14: Lake Forest Neighborhood 6-31
Figure 6-15: Eastwood Road – Johnson Farm Neighborhood 6-32
Figure 6-16: Forest Creek Neighborhood 6-33
Figure 6-17: Coker Woods West 2 Neighborhood 6-34
Figure 6-18: Coker Hills Neighborhood 6-35

List of Tables

Table ES-1: Flood Control Project Prioritization – Primary Systems ES-9
Table ES-2: Flood Control Project Prioritization – Secondary Systems ES-9
Table 1-1: Project Area Design Standards and Criteria 1-4
Table 2-1: Overall Booker Creek Watershed Existing Land Use 2-5
Table 2-2: Overall Booker Creek Watershed Future Land Use 2-5
Table 2-3: Eastwood Lake Subwatershed Existing Land Use 2-5
Table 2-4: Eastwood Lake Subwatershed Future Land Use 2-5
Table 2-5: Inventory Summary – Closed System Structures 2-6
Table 2-6: Inventory Summary – Pipes* 2-6
Table 3-1: Existing Conditions Flows from HEC-HMS for Eastwood Lake Subwatershed 3-2
Table 3-2: Existing Condition of Primary System Crossings 3-3
Table 3-3: Hydraulic Performance for Existing Conditions Roadway Flooding 3-4
Table 3-4: Statistical Summary of USA Stream Stability Scores 3-28
Table 3-5: Statistical Summary of EPA Habitat Assessment Scores 3-31
Table 3-6: Factor Description and Evaluation 3-35
Table 3-7: Factors and Scoring 3-39
Table 3-8: Summary Ranking of Outfalls for Eastwood Lake 3-41
Table 3-9: Neighborhood Analysis Results 3-49
Table 4-1: Potential Flood Storage Areas 4-4
Table 4-2: Hydraulic Performance for Eastwood Lake – West and East 4-19
Table 4-3: WSEL Reductions for Future Conditions 4-19
Table 4-4: Future Conditions Flows from HEC-HMS for Eastwood Lake Subwatershed 4-20
Table 4-5: Flow Reductions for Future vs. Future with All Projects for Eastwood Lake Subwatershed .. 4-21
Table 5-1: Stormwater Pipes Scoring Summary and Distribution 5-5
Table 5-2: Stormwater Structures Scoring Summary and Distribution 5-6

Table 5-3: Town Stormwater Pipes Scoring Summary and Distribution 5-10
Table 5-4: Town Stormwater Structures Scoring Summary and Distribution 5-11
Table 6-1: Summary of Stream Stabilization Projects* 6-2
Table 6-2: Eastwood Lake Outfall Opportunities 6-10
Table 6-3: Existing Surface Water Loadings Based on Current Land Uses in the Watershed 6-36
Table 6-4: Identified Outfalls Modeled in WTM and Their Associated SCM Types 6-37
Table 6-5: Surface Water Loadings Based on Modeled Identified Outfalls Loading Reductions 6-38
Table 6-6: Acreages Used in the Neighborhoods WTM Analysis 6-39
Table 6-7: Surface Water Loadings Based on Modeled Neighborhood Retrofit Reductions 6-39
Table 6-8: Estimated Stream Restoration Loading Reductions 6-40
Table 6-9: Surface Water Loadings Based on Estimated Stream Restoration Reductions 6-41
Table 6-10: Summary of Load Reduction Estimates 6-41
Table 7-1: Permitting Matrix for Proposed Projects 7-4
Table 8-1: Preliminary Project Cost Estimates 8-1
Table 8-2: Summary of Stream Project Cost Estimates 8-3
Table 8-3: Summary of Outfall Retrofit Project Cost Estimates 8-4
Table 9-1: Flood Reduction Prioritization – Flood Storage/Primary System Projects 9-2
Table 9-2: Flood Reduction Project Prioritization – Secondary System Projects 9-2

LIST OF APPENDICES

Appendix A Hydrologic Analysis
Appendix B Hydraulic Analysis
Appendix C Watershed Map, Land Use Map, and Soils Map
Appendix D Citizen Input
Appendix E SCS Hydrologic Input Data
Appendix F Time of Concentration Calculations
Appendix G Preliminary Opinion of Probable Construction Costs
Appendix H Hydraulic and Hydrologic Input and Output
Appendix I Condition Assessment Methodology
Appendix J Digital Copy of Hydraulic and Hydrologic Models
Appendix K Stream Assessment
Appendix L Prioritization Matrix

LIST OF ABBREVIATIONS

CCTV	Closed-Circuit Television
CLOMR	Conditional Letter of Map Revision
CMP	Corrugated Metal Pipe
DCIA	Directly Connected Impervious Area
DEMLR	Division of Energy, Mineral, and Land Resources
DEQ	Department of Environmental Quality
DIP	Ductile Iron Pipe
D/S	Downstream
DWR	Division of Water Resources
EA	Environmental Assessment
EMC	Event Mean Concentrations
EPA	Environmental Protection Agency
GIS	Geographic Information System
GPS	Global Positioning Systems
FEMA	Federal Emergency Management Agency
HEC-HMS	Hydrologic Engineering Centers Hydrologic Modeling System
HEC-RAS	Hydrologic Engineering Centers River Analysis System
HOA	Homeowners' Association
IP	Individual Permit
LBC	Lower Booker Creek
LF	Linear Feet/Foot
LOMR	Letter of Map Revision
MDR	Medium Density Residential
NAD	North American Datum

NAVD	North American Vertical Datum
NCDEQ	North Carolina Department of Environmental Quality
NCDOT	North Carolina Department of Transportation
NCWRC	North Caroline Wildlife Resources Commission
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NSDQ	National Stormwater Quality Database
NWP	Nationwide Permit
O&M	Operations and Maintenance
OWASA	Orange Water and Sewer Authority
PCN	Pre-Construction Notification
RBP	Rapid Bioassessment Protocol
RCBC	Reinforced Concrete Box Culvert
RCD	Resource Conservation District
RCN	Runoff Curve Number
RCP	Reinforced Concrete Pipe
ROW	Right-of-Way
RSC	Regenerative Stormwater Conveyances
SCM	Stormwater Control Measure
SEPA	State Environmental Policy Act
SHPO	State Historic Preservation Office
SWMM	Storm Water Management Model
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
UNC	University of North Carolina at Chapel Hill

U/S	Upstream
USA	Unified Stream Assessment
USACE	The United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
WSEL	Water Surface Elevation
WTM	Watershed Treatment Model

EXECUTIVE SUMMARY

The Town of Chapel Hill retained WK Dickson to complete a Subwatershed Study and Plan for the Eastwood Lake subwatershed. As noted in the Town's Stormwater Master Plan adopted in September 2014, the development of subwatershed plans is a strategic initiative as part of the following goals of the Town's Stormwater Management Program:

- Address stormwater quantity (flooding) as an integral component within the program;
- Address stormwater quality as an integral function within the program;
- Protect and restore natural stream corridors.

The Eastwood Lake subwatershed is approximately 700 acres (~1.1 square miles) and is located in the north central portion of Chapel Hill. The subwatershed is the middle part of the overall Booker Creek watershed (~6.3 square miles), which includes the Booker Headwaters, Crow Branch, Lower Booker Creek, and Cedar Fork subwatersheds in addition to Eastwood Lake. While the overall watershed is generally residential in land use, the majority of Crow Branch includes a portion of the future Carolina North campus, and the central portion of Lower Booker Creek is highly commercialized including the Blue Hill District (formerly Ephesus Fordham).

The Eastwood Lake Subwatershed Study includes a process to assess how stormwater is currently managed within the subwatershed, to evaluate the impact of future development on the conveyance infrastructure, and to develop recommendations for improving the management of stormwater including the identification of capital projects. The process begins with assessing the existing conveyance infrastructure which included locating and attributing over 500 drainage structures and five (5) miles of pipes within the Eastwood Lake subwatershed. Additionally, the WK Dickson team evaluated 34,000 linear feet of open stream and channels in part to identify areas of erosion and buffer impacts.

Utilizing the drainage infrastructure inventory geodatabase as well as available Geographic Information System (GIS) data, WK Dickson completed several spatial analyses to identify infrastructure that may need maintenance or replacement based on the likelihood and consequence of the failure of any particular asset. Contributing factors for prioritizing maintenance needs included age of infrastructure, material, size, visual assessments, and location. The Town should consider additional investigation such as closed-circuit television (CCTV) inspection for high priority areas. The proactive maintenance of infrastructure even in areas that are not floodprone will reduce disruptions to roadways and other Town infrastructure, ensure the designed level of service is routinely met, and most efficiently manage the Town's limited resources. Infrastructure maintenance is one of the strategic initiatives of Goal 2 of the Town's Stormwater Master Plan.

While proactive maintenance will extend the life of the existing infrastructure, in some instances the existing infrastructure does not provide the desired level of service. Within the Eastwood Lake subwatershed, there are several areas that have repetitive flooding during large storm

events. As part of this study, the conveyance system within floodprone areas was evaluated to determine the existing level of service, the future level of service based on built-out land use in the watershed, and the potential capital improvements that would be required to reduce the risk of flooding. The existing 25-year and 100-year floodplains were mapped as part of this study (See Figure 3-1) based on the current land use and hydrologic parameters within the watershed. In addition to modeling and mapping floodplains within the open portion of the conveyance system, WK Dickson evaluated the capacity needs for several closed or secondary systems identified as floodprone.

In part to help identify areas of concern within the watershed, the WK Dickson team conducted an expansive public outreach process. The public outreach allowed residents and business owners the opportunity to engage with team members, provide feedback on specific drainage issues, and learn about managing stormwater within the Booker Creek watershed. The community was able to give feedback through survey questionnaires, public forums, a project website, community events, and direct emails to the project team. Information collected during the outreach process, as well as information from Town staff, assisted the WK Dickson team in validating the hydraulic models against recent storm events and helped identify areas with repetitive flooding for further analysis. Engaging the community in stormwater management is critical for a successful program as many of the goals of the program are dependent on stewardship from the community.

Engagement from the community is even more critical when assessing Goals 3 and 4 of the Stormwater Master Plan with respect to water quality and protecting stream corridors. Many of the causes of water quality impairment from a runoff and riparian standpoint involve property outside of the Town's rights-of-way (ROW). Partnering with private residents and businesses will be an important component of the Town's Stormwater Program moving forward as it needs to comply with the Jordan Lake Rules and address impaired waters. Educating residents about proper pet waste disposal, fertilizer applications, and riparian buffer management will be critical for the success of any water quality program. The Eastwood Lake Subwatershed Study includes riparian assessments as well as a variety of GIS analyses that look for potential opportunities for retrofits to treat stormwater runoff and stabilize or restore eroding streams. Capital project recommendations that include Stormwater Control Measures (SCMs) and stream stabilization will likely require easements from landowners. Additionally, several neighborhoods have been identified for potential neighborhood green infrastructure retrofits. These can include modifications to the public ROW to promote the infiltration of stormwater runoff, as well as rain gardens and other practices on private property to treat rooftop drainage, prior to entering the conveyance system. These types of practices will require significant community buy-in prior to implementation. Individually these projects provide a small benefit; however, as more property owners implement practices to reduce the volume of runoff and pollutant loads, the cumulative downstream impacts on water quality and quantity can be significant.

After completing all of the assessments and modeling noted above, WK Dickson developed conceptual solutions for a wide variety of capital projects to address the goals noted above with respect to water quantity, quality, and protecting natural stream corridors.

The proposed capital projects are as follows with the locations of each project shown on Figure ES-1.

Project Recommendations

Significant flooding problems have been well documented in the Eastwood Lake subwatershed. Developing retrofit solutions to these types of flooding problems in developed areas is difficult because of the limited land available, topographic constraints, and existing infrastructure including roads, utilities, and buildings. Due to these constraints, a combination of projects will be required to achieve significant reductions in the frequency, duration, and severity of flooding particularly in the areas most at risk.

The project recommendations are divided into three (3) geographic focus areas. The Eastwood Lake subwatershed is divided into East and West focus areas and the third area is for the portion of the Booker Creek watershed outside of the Eastwood Lake subwatershed. While the focus of this study is to improve infrastructure within the Eastwood Lake subwatershed, over 75% of the drainage area contributing to the overall watershed is outside of the Eastwood Lake subwatershed. Therefore, potential projects were evaluated within the Booker Creek watershed to determine if strategically increasing flood storage in the upper portions of the watershed could potentially impacts peak flows in the downstream in the Eastwood Lake subwatershed.

Overall Booker Creek Watershed

The New Parkside Drive, Martin Luther King Jr. Boulevard, and Piney Mountain Road flood storage projects were recommended as part of the Lower Booker Creek Subwatershed Study dated September 2018. Summaries of those (3) projects are also included in this Study because they will impact flows and water surface elevations in the Eastwood Lake subwatershed.

New Parkside Drive

The proposed 7.5-acre project includes excavating material in the Town-owned property behind the New Parkside Drive culvert in the Booker Creek Headwaters subwatershed. Stormwater would temporarily fill the floodplain storage area during a storm event and slowly discharge through the existing culvert, which could reduce the 25-year peak flow at that location by as much as 90%. In combination with the other proposed storage areas, the New Parkside Drive project can have significant benefits of reducing downstream flows in the Eastwood Lake subwatershed. The Town could also consider providing connectivity between the proposed project and Homestead Park along with implementing additional passive recreational facilities in the New Parkside Project.

Martin Luther King Jr. Boulevard
The proposed 2.5-acre project is located on private property along Martin Luther King Jr. Boulevard near the intersection with Homestead Road. The project includes acquisition of the property north of Orange United Methodist Church as well as obtaining an easement on the church property. The proposed project site contains regulatory floodplains, stream buffers, and a sanitary sewer outfall, making future development of the property challenging. The project consists of excavation to increase the floodplain storage along the upper portion of Booker Creek and provide a temporary ponded area. The project would lower the 25-year peak flow by approximately 7% at North Lakeshore Drive and would result in greater downstream flow reductions if constructed in combination with the other proposed flood storage areas.

Piney Mountain Road
The proposed 5.5-acre project is located on Town-owned property upstream of Piney Mountain Road approximately 0.5 miles east of Martin Luther King Jr. Boulevard. It is located within the Eastwood Lake subwatershed. Significant excavation would be required to provide temporary storage upstream of Piney Mountain Road during storm events. Passive recreational amenities could be added to the project if desired to enhance pedestrian connectivity in the community. The drainage area for this location is over 2 square miles. Given the relatively low surface area to drainage area ratio, the proposed project has a greater impact with slowing the timing of the runoff downstream than providing significant peak reduction at the site.

The combined impact of the three (3) storage areas listed above results in an 11% reduction in the 25-year peak flow immediately downstream of the Eastwood Lake dam and a corresponding 0.4-foot reduction in the 25-year peak water surface elevation at that location.

Eastwood Lake West

The Eastwood Lake West portion of the study consists of the area immediately downstream of the confluence between Crow Branch and Booker Creek (Lake Ellen outlet) to just downstream of Piney Mountain Road. The infrastructure in the area consists predominantly of open systems with culvert crossings that drain to Booker Creek and eventually to Eastwood Lake. A variety of projects are proposed in this area including floodplain culverts, secondary system improvements, stream stabilization, and neighborhood retrofits.

Piney Mountain Road
The existing bridge at Piney Mountain Road is in good condition but it is overtopped during the 10-year event. Since the bridge has no known structural issues, it is recommended that it be left in place and a floodplain culvert be installed to increase the level of service. Installing a 7′ x 5′ reinforced concrete box floodplain culvert would provide a 25-year level of service based on future built-out conditions assuming New Parkside Drive, Martin Luther King Jr. Boulevard, and Piney Mountain Road storage areas are constructed as well.

Secondary Drainage Improvements
In addition to the primary system improvement at Piney Mountain Road, secondary drainage system improvements are recommended downstream of Woodshire Lane behind Huntington Road as well as improvement of a secondary culvert under Piney Mountain Road. Proposed improvements include replacing existing culverts with larger capacity pipes and spot streambank stabilization. Utility conflicts will need to be resolved during design and implementation of these projects particularly for the culvert project under Piney Mountain Road.

Water Quality Projects
Multiple opportunities exist in the subwatershed to improve the water quality, which will aid the Town in complying with the Jordan Lake Rules. Stream stabilization projects are recommended downstream of Lake Ellen Drive (Project 3 – Lake Ellen 1) and adjacent to Piney Mountain Road and Huntington Drive (Project 1 – Woodshire 2 and Project 2 – Woodshire 3).

Portions of the Eastwood Road – Johnson Farm, Coker Woods West, and Forest Lake neighborhoods ranked high for the potential of green infrastructure retrofits. Possible components of retrofits in these areas could include green street features such as grass swales, grass medians, bioretention bump outs, inlet treatment, residential rain gardens, and disconnection of downspouts. The Town should consider engaging the Homeowners' Associations (HOAs) for high ranking neighborhoods to determine if interest exists for pilot green infrastructure retrofits.

Eastwood Lake East

The Eastwood Lake East portion of the study consists of the area between Piney Mountain Road and the outlet of Eastwood Lake which includes portions of the Coker Hills, Coker Woods West, and Lake Forest subdivisions. Most of the drainage infrastructure in this portion of the subwatershed consists of open channels with culvert crossings that drain directly to Eastwood Lake. The open channels typically enter the lake around the perimeter downstream of the Eastwood Lake forebay. Some closed infrastructure does exist in this portion of the subwatershed, typically for street drainage. There are no proposed primary system improvements in this portion of the subwatershed.

Secondary Drainage Improvements
Secondary drainage improvements are recommended at the following locations:

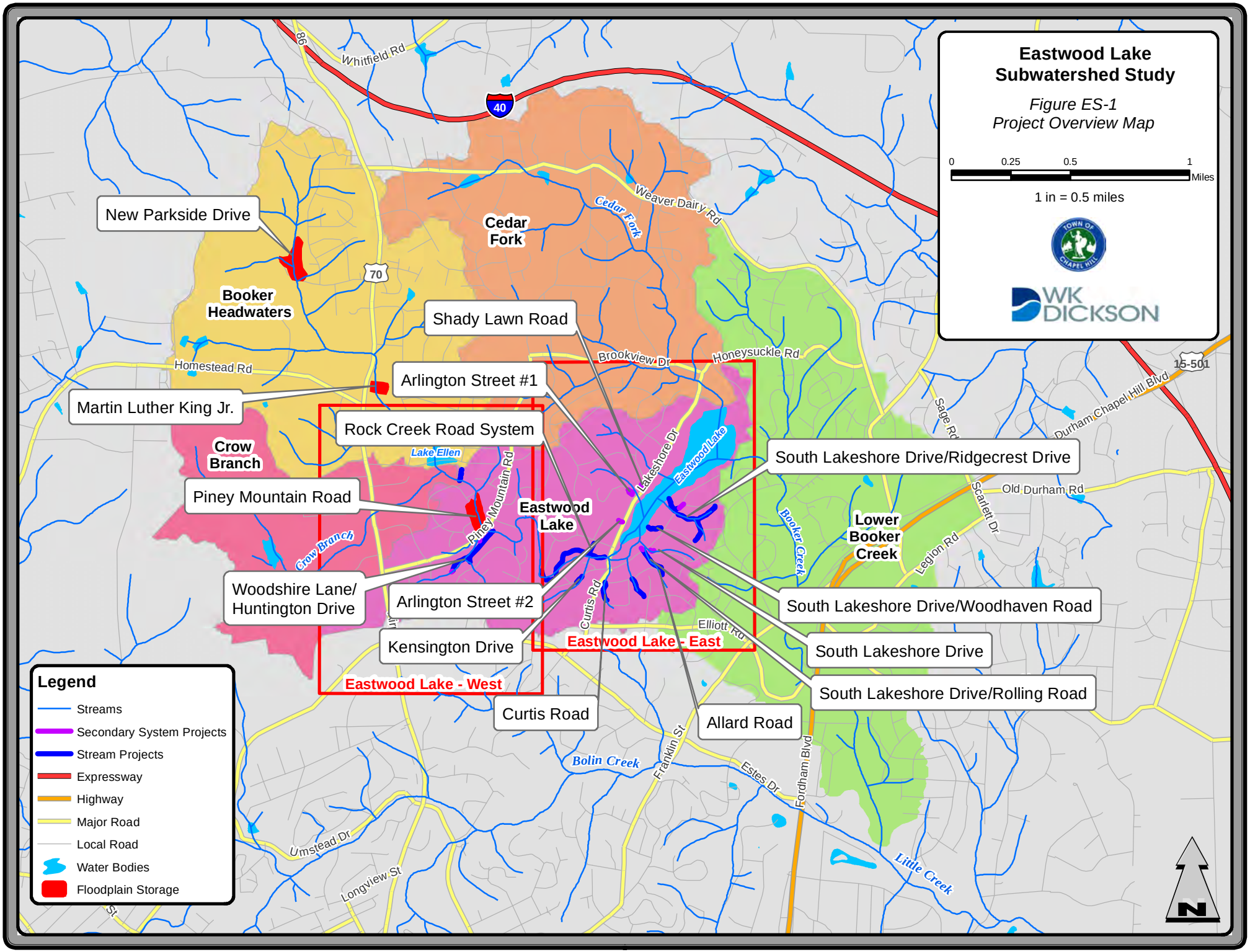
- Shady Lawn Road near its intersection with North Lakeshore Drive;
- Arlington Street near its intersection with North Lakeshore Drive;
- Ridgecrest Drive at intersection with South Lakeshore Drive;
- Rolling Road just upstream of South Lakeshore Drive; and
- South Lakeshore Drive between Rolling Road and Curtis Road.

Each of the recommended projects was based on feedback from residents and Town staff that flooding has repetitively occurred in these locations. Proposed improvements include replacing existing pipes with larger capacity pipes, rerouting drainage to the ROW as applicable, and adding inlet capacity. Utility conflicts will need to be resolved during design and implementation of these projects.

Water Quality Projects

Stream stabilization projects are recommended for the channel sections along Kensington Drive, adjacent to Rock Creek Road, between Curtis Road and Lyons Road, adjacent to Allard Road, downstream of Woodhaven Road, adjacent to Rolling Road, and between Ridgecrest and Woodhaven Road. The Ridgecrest Road, Rolling Road, and Allard Road stabilization projects should be combined with the proposed secondary system drainage improvements listed above.

Portions of the Coker Woods West, Lake Forest, and Coker Hills neighborhoods ranked high for the potential of green infrastructure retrofits. Possible components of retrofits in these areas could include green street features such as grass swales, grass medians, bioretention bump outs, inlet treatment, residential rain gardens, and disconnection of downspouts. The Town should consider engaging the HOAs for high ranking neighborhoods to determine if interest exists for pilot green infrastructure retrofits.


Eastwood Lake
Subwatershed Study
Figure ES-1
Project Overview Map
0
0.25
0.5
1
Miles
1 in = 0.5 miles
New Parkside Drive
Booker
Headwaters
Cedar
Fork
Shady Lawn Road
Arlington Street #1
Martin Luther King Jr.
Rock Creek Road System
Crow
Branch
Piney Mountain Road
Eastwood
Lake
South Lakeshore Drive/Ridgecrest Drive
Lower
Booker
Creek
Woodshire Lane/
Huntington Drive
Arlington Street #2
Kensington Drive
Eastwood Lake - East
Eastwood Lake - West
Curtis Road
Allard Road
South Lakeshore Drive/Woodhaven Road
South Lakeshore Drive
South Lakeshore Drive/Rolling Road
Legend
Streams
Secondary System Projects
Stream Projects
Expressway
Highway
Major Road
Local Road
Water Bodies
Floodplain Storage
Whitfield Rd
Weaver Dairy Rd
Cedar Fork
Homestead Rd
Brookview Dr
Honeysuckle Rd
Durham Chapel Hill Blvd
Lake Ellen
Piney Mountain Rd
Crow Branch
Lakeshore Dr
Eastwood Lake
Booker Creek
Old Durham Rd
Scarlett Dr
Legion Rd
Curtis Rd
Elliott Rd
Bolin Creek
Franklin St
Estes Dr
Fordham Blvd
Little Creek
Umstead Dr
Longview St
Sage Rd
15-501
40
70
86
N

Prioritization and Recommendations

To appropriately allocate Town resources, the flood reduction projects listed above were prioritized based on the following categories as described in Appendix L:

- Public health and safety
- Severity of street flooding
- Cost effectiveness
- Effect of improvements
- Project dependency
- Water quality – SCM
- Open channel – erosion control
- Implementation constraints
- Grant funding
- Constructability

Costs for the proposed floodplain storage areas identified in the Lower Booker Creek Subwatershed Study are included in the capital project list in that Study regardless of where they are located in the overall Booker Creek watershed. Table ES-1 shows the proposed prioritizations for the Primary Flood Reduction Improvements. The total cost for all the recommended primary and secondary system capital improvements in the Eastwood Lake subwatershed is approximately $1,561,900.

In addition to the proposed capital projects, Section 5 and Appendix I discuss the maintenance requirements for the aging infrastructure. The Town should consider proactively maintaining the infrastructure before failure which will provide long term savings. More detailed condition assessment can be completed in the future to better prioritize and plan maintenance needs.

Based on the existing flooding in the watershed, it is highly recommended the Town strongly review any rezoning requests that will increase the impervious area and determine if additional stormwater measures are required. It is also highly recommended that the Town require green infrastructure and low impact development to the extent possible for both new development and redevelopment to promote infiltration and minimize increases to peak flow and volumes.

Table ES-1: Flood Reduction Project Prioritization – Primary Systems

Prioritization	Project	Cost
1	Piney Mountain Road Culvert	$456,800
	Total	$456,800

Table ES-2: Flood Reduction Project Prioritization – Secondary Systems

Prioritization	Project	Cost
1	South Lakeshore Drive/Ridgecrest Drive System	$125,200
2	South Lakeshore Drive/Rolling Road System	$216,800
3	Arlington Street #1 System	$104,400
4	Woodshire Lane/Huntington Road	$372,300
5	Shady Lawn Road System	$153,300
6	Arlington Street #2 System	$133,100
	Total	$1,105,100

Stream Stabilization and Water Quality Projects

Stream stabilization projects, neighborhood retrofits, and outfall retrofits are not separately prioritized; however, those projects that can be incorporated into flood reduction projects should be scheduled with those projects. The anticipated cost range for stream stabilization projects is $3.5 million to $6.2 million depending on the required measures and design specifics. The anticipated total cost for outfall retrofits is $750,000 based on literature values for similar projects. The stream stabilization and water quality projects will add approximately $5.7 million to the total costs ($1,561,900) for the recommended primary and secondary system capital improvements.

Neighborhood retrofits and stream stabilization projects on private property will be heavily dependent on community acceptance and willingness to participate. It is recommended that the Town consider a pilot neighborhood retrofit project to encourage green infrastructure both in public rights-of-way and on private property. Neighborhood retrofits can improve the aesthetics, provide traffic calming, improve water quality and help meet requirements of the Jordan Lake rules, and reduce the quantity of stormwater runoff. While individual retrofits will not have a significant impact on flooding, the cumulative impact of these practices throughout a community and watershed can be significant. Outfall retrofit priorities will likely be adjusted with project opportunities such as grant funding or availability of property.

INTRODUCTION

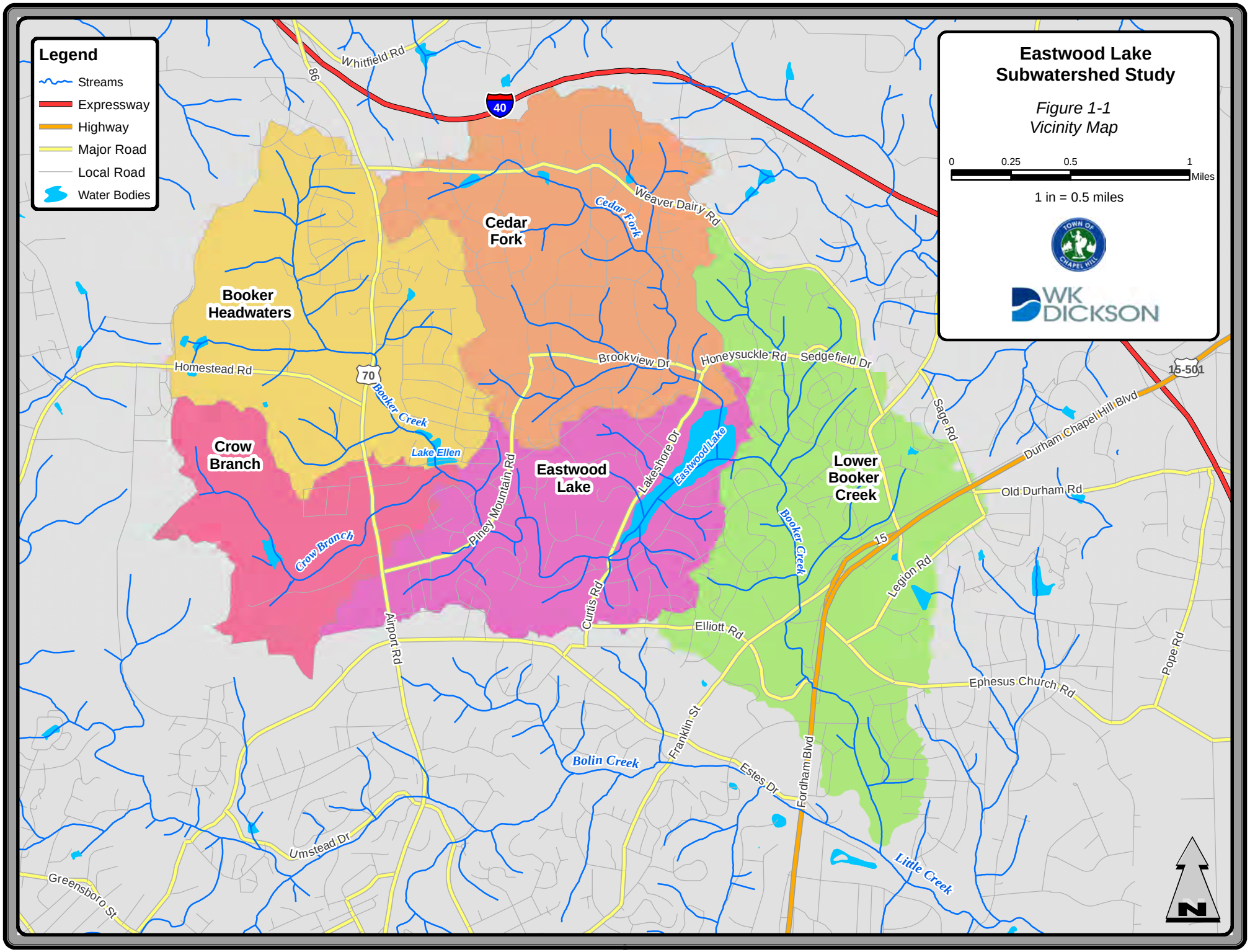
1.1 PROJECT DESCRIPTION

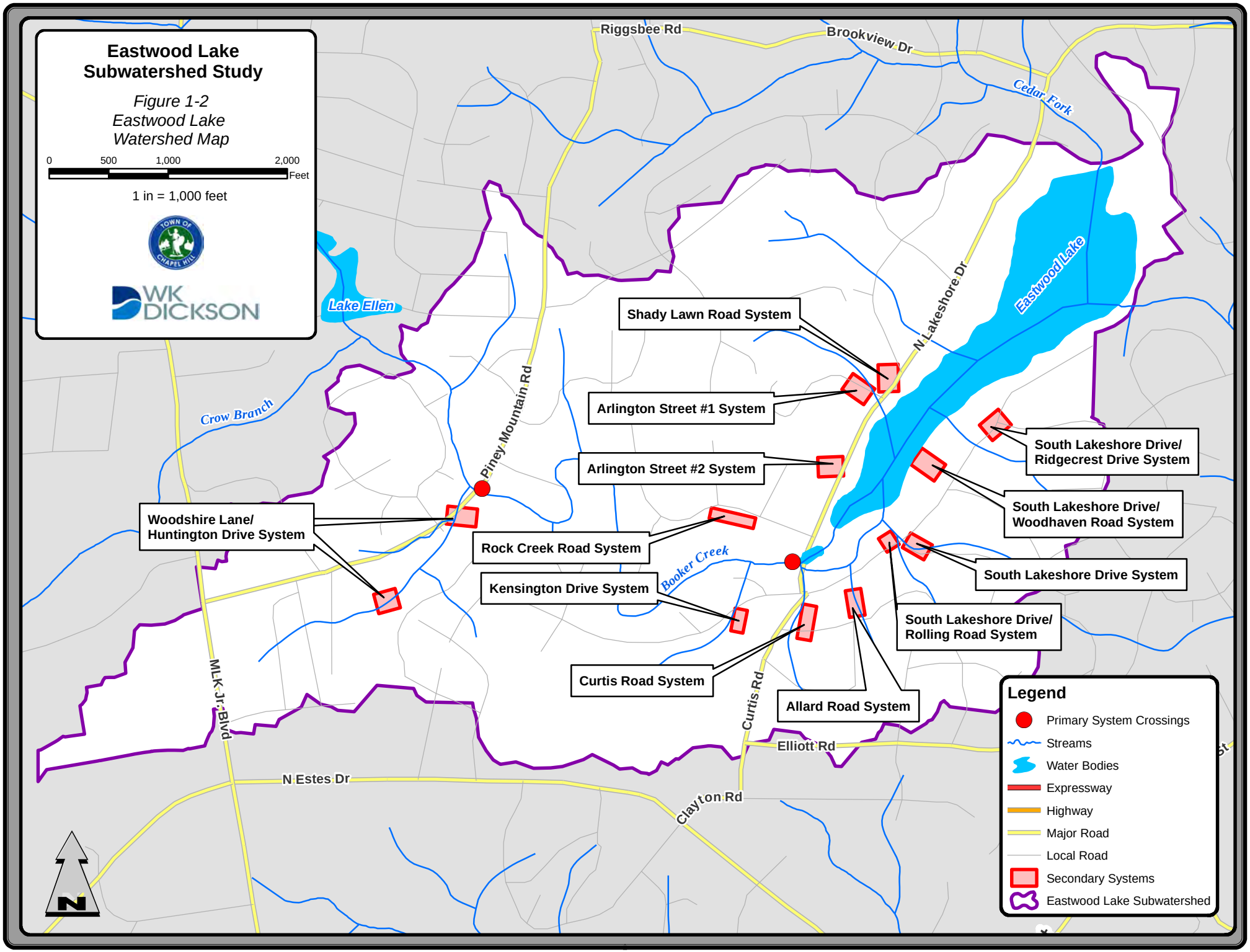
The Town of Chapel Hill retained WK Dickson to complete a Subwatershed Study and Plan for the Eastwood Lake subwatershed. As shown in Figure 1-1, the Eastwood Lake subwatershed is located in the north central portion of Chapel Hill and generally drains west to east through Eastwood Lake. The 1.1 square mile Eastwood Lake subwatershed is located within the 6.3 square mile Booker Creek watershed, upstream of the Lower Booker Creek subwatershed. As noted in the Executive Summary, the continued development of Subwatershed Studies is a strategic initiative as part of the Town's Stormwater Program Master Plan Goals (2) addressing stormwater quantity, (3) addressing stormwater quality, and (4) protecting and restoring natural stream corridors. To assist in achieving these goals, WK Dickson completed a stormwater inventory of both infrastructure and natural features within the Eastwood Lake subwatershed.

The Subwatershed Study includes an evaluation of the segment of Booker Creek from the Eastwood Lake dam at the downstream end to its confluence with Crow Branch at the upstream end. Additionally, twelve (12) conveyance systems that drain to the main creek were evaluated. For the purposes of this report, Booker Creek will be noted as the primary system and the conveyance systems will be noted as secondary systems. A project area map showing the Eastwood Lake subwatershed and the conveyance systems evaluated as part of this Study is included as Figure 1-2. Detailed hydraulic analysis included the following:

- Primary System – Booker Creek
    - North Lakeshore Drive Bridge
    - Piney Mountain Road Bridge

- Secondary Systems
    - Shady Lawn Road System
    - Arlington Street #1 System
    - Arlington Street #2 System
    - Rock Creek Road Closed System
    - South Lakeshore Drive/Ridgecrest Drive System
    - South Lakeshore Drive/Woodhaven Road System
    - South Lakeshore Drive/Rolling Road System
    - South Lakeshore Drive System
    - Allard Road System
    - Curtis Road System
    - Woodshire Lane/Huntington Drive System
    - Kensington Drive System


Legend
Streams
Expressway
Highway
Major Road
Local Road
Water Bodies
Eastwood Lake Subwatershed Study
Figure 1-1
Vicinity Map
0
0.25
0.5
1
Miles
1 in = 0.5 miles
WK DICKSON
Cedar Fork
Booker Headwaters
Crow Branch
Eastwood Lake
Lower Booker Creek
Whitfield Rd
40
86
Weaver Dairy Rd
Cedar Fork
Homestead Rd
70
Booker Creek
Lake Ellen
Brookview Dr
Honeysuckle Rd
Sedgefield Dr
15-501
Sage Rd
Durham Chapel Hill Blvd
Old Durham Rd
Piney Mountain Rd
Lakeshore Dr
Eastwood Lake
Crow Branch
Curtis Rd
Airport Rd
Elliott Rd
Booker Creek
15
Legion Rd
Pope Rd
Ephesus Church Rd
Franklin St
Bolin Creek
Estes Dr
Fordham Blvd
Umstead Dr
Greensboro St
Little Creek
N


Eastwood Lake
Subwatershed Study
Figure 1-2
Eastwood Lake
Watershed Map
0
500
1,000
2,000
Feet
1 in = 1,000 feet
WK DICKSON
Riggsbee Rd
Brookview Dr
Cedar Fork
Lake Ellen
Eastwood Lake
N Lakeshore Dr
Shady Lawn Road System
Arlington Street #1 System
Arlington Street #2 System
South Lakeshore Drive/
Ridgecrest Drive System
South Lakeshore Drive/
Woodhaven Road System
South Lakeshore Drive System
South Lakeshore Drive/
Rolling Road System
Allard Road System
Curtis Road System
Kensington Drive System
Rock Creek Road System
Woodshire Lane/
Huntington Drive System
Crow Branch
Piney Mountain Rd
Booker Creek
MLK Jr Blvd
Curtis Rd
Elliott Rd
N Estes Dr
Clayton Rd
Legend
Primary System Crossings
Streams
Water Bodies
Expressway
Highway
Major Road
Local Road
Secondary Systems
Eastwood Lake Subwatershed

1.2 DESIGN STANDARDS AND CRITERIA

The following design storms were used to evaluate the performance of the primary and secondary systems in this Subwatershed Study:

- 10-year storm event – piped conveyance systems and local roadway bridges and culverts;
- 25-year storm event – minor thoroughfare (collector and arterial roadways) bridges and culverts;
- 50-year storm event – bridges, box culverts, and stream crossings;
- 100-year storm event – regulatory floodway; and
- 100-year storm event – structural flooding of homes.

Table 1-1 shows the applicable design storm for the project areas evaluated as part of this Subwatershed Study. The corresponding rainfall depths for the design storms are included in Appendix A.

Table 1-1: Project Area Design Standards and Criteria

Drainage Type	Design Storm (years)	Project Area
Piped Conveyance Systems Local Roadway Crossings	10	• Woodshire Lane/Huntington Drive • Shady Lawn Road • Arlington Street #1 and #2 • Rock Creek Road • Kensington Drive • Curtis Road • Allard Road • South Lakeshore Drive/Rolling Road • South Lakeshore Drive • South Lakeshore Drive/Woodhaven Road • South Lakeshore Drive/Ridgecrest Drive
Minor Thoroughfare (Collector and Arterial Roadway) Crossings	25	• None
Regulatory Floodway	100	• North Lakeshore Drive (Booker Creek) • Piney Mountain Road (Booker Creek)

EXISTING WATERSHED CONDITIONS

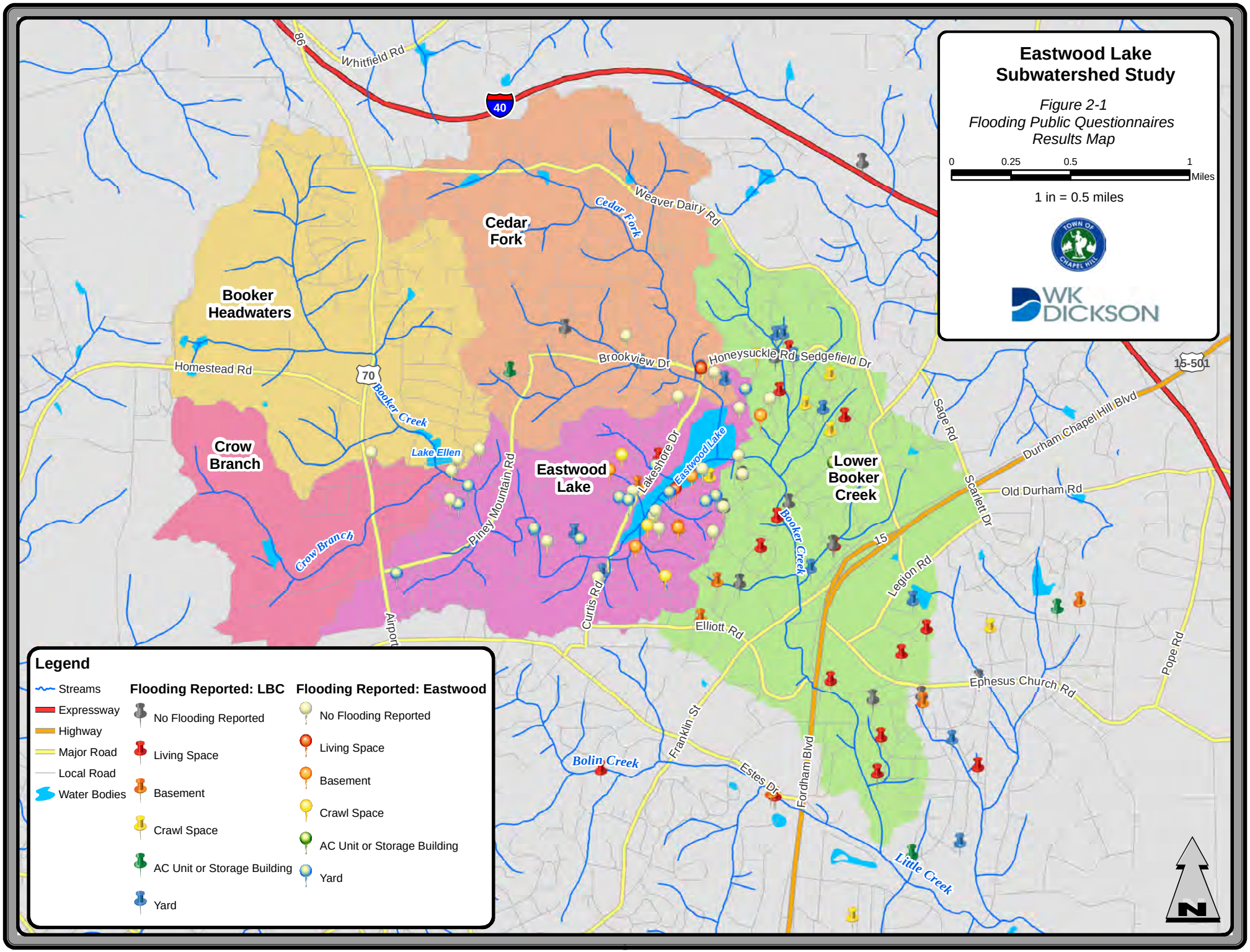
2.1 CITIZEN INPUT

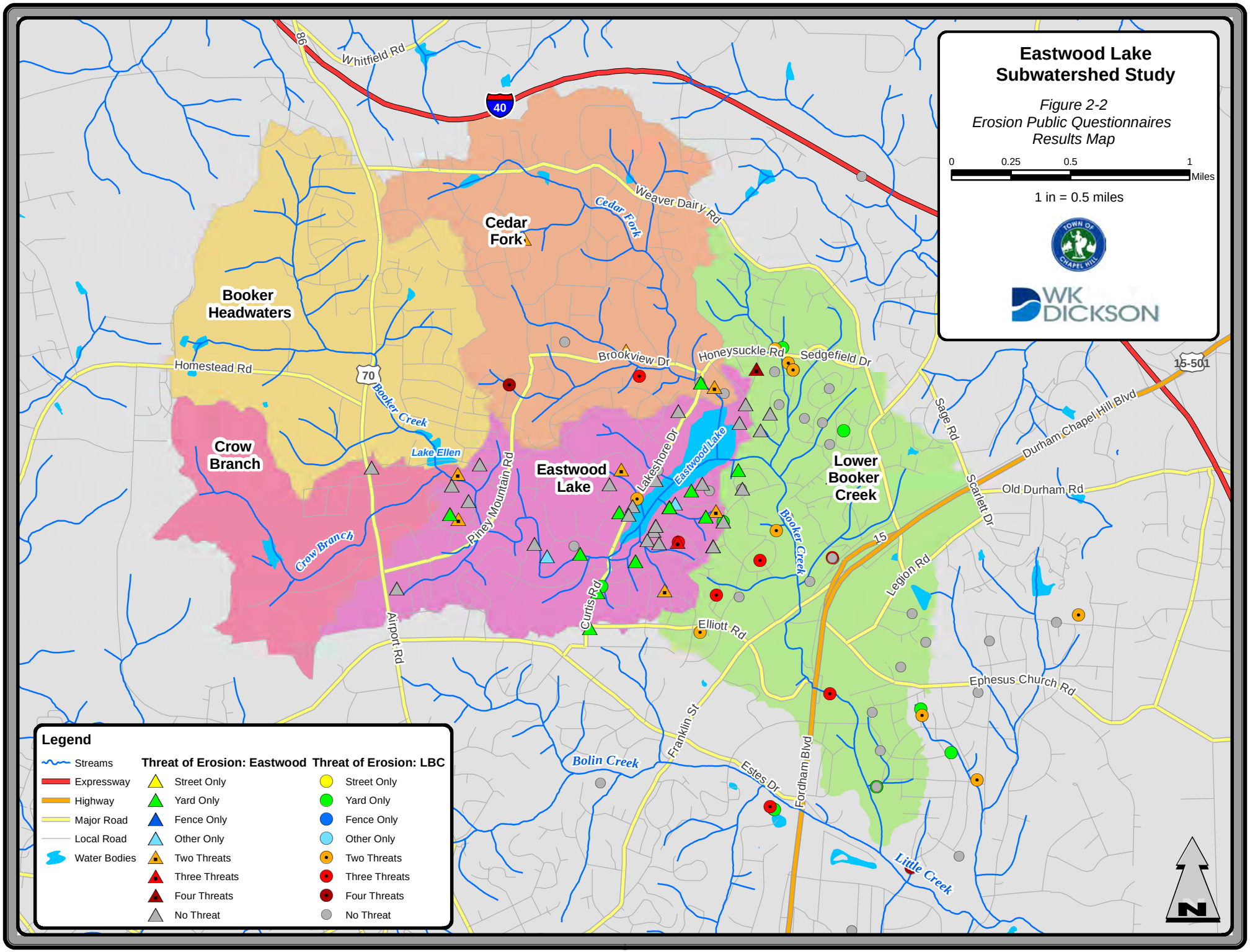
The Subwatershed Study included a citizen input component to solicit feedback and information regarding stormwater impacts and future stormwater management in the Town. Important steps in public outreach were taken by WK Dickson within the Booker Creek watershed through the use of direct mail questionnaires, web-based applications, and public meetings. In May 2017, WK Dickson distributed questionnaires to property owners in the Eastwood Lake subwatershed requesting feedback on erosion and flooding.

Fifty-four (54) total responses were received for consideration. Thirty-three (33) of the fifty-four (54) respondents were located within the Eastwood Lake subwatershed. Half of the total respondents (27) indicated experiencing some type of flooding at least once a year. In addition to the responses received as part of the Eastwood Lake subwatershed, nine (9) completed questionnaires were received from residents within the Eastwood Lake subwatershed during the previously completed Lower Booker Creek Subwatershed Study. Six (6) of those nine (9) responses indicated some level of property flooding. The questionnaire results were georeferenced using the address of the questionnaire respondent. Figures 2-1 and 2-2 show response locations from both the Lower Booker Creek Subwatershed Study and the Eastwood Lake Subwatershed Study. A sample questionnaire and the tabulated results are provided in Appendix D.

Other opportunities for obtaining citizen input included setting up an online website specifically for this project, outreach to local groups and events, stakeholder interviews, and public meetings. The first Eastwood Lake public meeting was held on June 1, 2017 to introduce the project and facilitate further feedback from the public. The initial public feedback was critical to identifying flood-prone areas and validating model results. A follow-up meeting was held on December 7, 2017 to share results of the Subwatershed Study with the public. Each meeting provided opportunities for residents to speak with Town staff or representatives from WK Dickson. The results and comments from the citizens' input contributed significantly to the identification and prioritization of problem areas, and validation of model results. Minutes from these meetings are included in Appendix D.

As selected projects proceed into design and construction, continuous citizen input will be critical to the success of the projects. Additional public meetings and individual property owner meetings will help educate property owners on the benefits of the proposed projects as well as the temporary and permanent impacts from construction.


Eastwood Lake Subwatershed Study
Figure 2-1
Flooding Public Questionnaires Results Map
0 0.25 0.5 1 Miles
1 in = 0.5 miles
WK DICKSON
Booker Headwaters
Cedar Fork
Crow Branch
Eastwood Lake
Lower Booker Creek
Whitfield Rd
Weaver Dairy Rd
Cedar Fork
Homestead Rd
Brookview Dr
Honeysuckle Rd
Sedgefield Dr
Booker Creek
Lake Ellen
Piney Mountain Rd
Lakeshore Dr
Eastwood Lake
Sage Rd
Durham Chapel Hill Blvd
Old Durham Rd
Scarlett Dr
Legion Rd
Elliott Rd
Curtis Rd
Airport
Crow Branch
Bolin Creek
Franklin St
Estes Dr
Fordham Blvd
Ephesus Church Rd
Pope Rd
Little Creek
Legend
Streams
Expressway
Highway
Major Road
Local Road
Water Bodies
Flooding Reported: LBC
No Flooding Reported
Living Space
Basement
Crawl Space
AC Unit or Storage Building
Yard
Flooding Reported: Eastwood
No Flooding Reported
Living Space
Basement
Crawl Space
AC Unit or Storage Building
Yard
N


Eastwood Lake Subwatershed Study
Figure 2-2
Erosion Public Questionnaires Results Map
0 0.25 0.5 1 Miles
1 in = 0.5 miles
WK DICKSON
Booker Headwaters
Cedar Fork
Crow Branch
Eastwood Lake
Lower Booker Creek
Whitfield Rd
Weaver Dairy Rd
Homestead Rd
Brookview Dr
Honeysuckle Rd
Sedgefield Dr
Sage Rd
Durham Chapel Hill Blvd
Old Durham Rd
Scarlett Dr
Legion Rd
Elliott Rd
Ephesus Church Rd
Airport Rd
Curtis Rd
Piney Mountain Rd
Lakeshore Dr
Franklin St
Fordham Blvd
Estes Dr
Cedar Fork
Booker Creek
Lake Ellen
Eastwood Lake
Crow Branch
Bolin Creek
Little Creek
Legend
Streams
Expressway
Highway
Major Road
Local Road
Water Bodies
Threat of Erosion: Eastwood
Street Only
Yard Only
Fence Only
Other Only
Two Threats
Three Threats
Four Threats
No Threat
Threat of Erosion: LBC
Street Only
Yard Only
Fence Only
Other Only
Two Threats
Three Threats
Four Threats
No Threat

2.2 WATERSHED CHARACTERISTICS

The entire Booker Creek watershed is approximately 4,000 acres (~6.3 square miles). It is divided into five (5) separate subwatersheds: Booker Headwaters, Crow Branch, Cedar Fork, Eastwood Lake, and Lower Booker Creek. The Eastwood Lake subwatershed is approximately 700 acres (1.1 square miles). As shown in Figure 1-2, the downstream boundary of the subwatershed is the outlet of the Eastwood Lake dam and the upstream boundary condition is just east of the confluence between Booker Creek and Crow Branch (south of the Lake Ellen outlet). Land in the Eastwood Lake subwatershed is predominately built-out as shown on the Existing Conditions Land Use Map (Appendix C-2). Likewise, the overall Booker Creek watershed is mostly built-out with portions of the Crow Branch and Booker Headwaters subwatersheds not currently being developed to their zoned uses. The existing land use in the overall Booker Creek watershed, as well as the Eastwood Lake subwatershed, is primarily residential (See Tables 2-1 through 2-4). As described in detail in Appendix A, the existing land use is based off of actual impervious coverages provided by the Town and ground-truthed by the WK Dickson team. The percentage of directly connected impervious was estimated based on EPA guidance for the 2010 NPDES MS4 permits in Massachusetts (www3.epa.gov/region1/npdes/stormwater/ma/MADCIA.pdf).

Future conditions land use was adjusted based on Town zoning, feedback from Town planning staff, review of upcoming development projects (http://www.townofchapelhill.org/town-hall/departments-services/planning-and-sustainability/development), analysis of Town focus areas, and assumptions related to redevelopment. There is approximately 7% of the Booker Creek watershed that is classified as a development opportunity area including the Blue Hill District (formerly Ephesus-Fordham area) and Northern Area Task Force focus area. It should be noted that the existing land use for the Blue Hill District (formerly Ephesus-Fordham area) is commercial and rights-of way, while the Northern Area Task Force has open space, office, and mixed use. The Carolina North plan was also incorporated into the future development plan. The proposed development for Carolina North is required to provide detention for up to the 50-year storm event, so that peak flows should not exceed pre- development conditions for storms equal to or less than the 50-year event. Finally, it is acknowledged that single lot redevelopment can have impacts on the future hydrology as well. It is difficult to know the extent of this redevelopment and if the redevelopment will significantly increase the percent impervious; however, assumptions were included in the future conditions land use to account for some redevelopment of small houses particularly on larger lots unless the lots were within a protected community, such as Coker Hills. See Appendix A for details.

Table 2-1: Overall Booker Creek Watershed Existing Land Use

Land Use Category	Area (acres)
Commercial	20
Office/Institutional/Mixed Used	239
High Density Residential	167
Medium Density Residential	453
Low Density Residential	2,175
Parks/Open Space	543
Right-of-Way	133
Development Opportunity Area*	292

*Includes Northern Area Task Force and Ephesus-Fordham areas

Table 2-2: Overall Booker Creek Watershed Future Land Use

Land Use Category	Area (acres)
Commercial	142
Office/Institutional/Mixed Used	239
High Density Residential	209
Medium Density Residential	486
Low Density Residential	2,229
Parks/Open Space	278
Right-of-Way	133
University	306

Table 2-3: Eastwood Lake Subwatershed Existing Land Use

Land Use Category	Area (acres)
Office/Institutional/Mixed Used	46
High Density Residential	34
Medium Density Residential	14
Low Density Residential	598
Parks/Open Space	6
Right-of-Way	7

Table 2-4: Eastwood Lake Subwatershed Future Land Use

Land Use Category	Area (acres)
Office/Institutional/Mixed Used	28
High Density Residential	34
Medium Density Residential	14
Low Density Residential	598
Right-of-Way	7
University	24

The soils within the Booker Creek watershed are predominately NRCS hydrologic groups B (52%) and D (27%); similarly, in the Eastwood Lake subwatershed 54% of the soils are NRCS hydrologic group B and 20% hydrologic group D. See Appendix C-4 for a soils map of the Booker Creek watershed.

2.3 EXISTING CONDITIONS SURVEY AND FIELD DATA COLLECTION

Stormwater utility infrastructure throughout the subwatershed was collected by WK Dickson personnel to compile a GIS stormwater inventory database for the Town. This was accomplished by using survey grade Global Positioning Systems (GPS) as the primary means of data capture to locate the x, y, and z coordinates of each visible stormwater system structure. Conventional surveying techniques were used to obtain attributes including but not limited to size, material, slope, and length. The data were collected using horizontal datum NAD 1983 and vertical datum NAVD 1988. A total of 504 closed system structures and 26,904 linear feet of pipe was collected as part of the inventory. Tables 2-5 and 2-6 summarize the inventory collected in the Eastwood Lake subwatershed.

Table 2-5: Inventory Summary – Closed System Structures

Structure Type	Number Surveyed
Drop Inlet	34
Junction Box	32
Pipe End	180
Pond Structure	3
Slab Top Inlet	15
Catch Basin	213
Underground Pipe Junction	3
Difficult Access	24

Table 2-6: Inventory Summary – Pipes*

Size	Length (Linear Feet)
12″ Diameter	428
15″ Diameter	12,295
18″ Diameter	4,136
24″ Diameter	4,127
30″ Diameter	796
36″ Diameter	1,291
42″ Diameter	416
48″ Diameter	207
'Other' Diameter	2,571

*Lengths provided do not include 'mismatched' pipe ends (637 linear feet). Mismatched pipe ends are those where the measured upstream end of the pipe differs from the downstream end.

Data were obtained for those open channels required to complete connectivity for modeling purposes. Attributes such as shape, lining type, bed type, flow, bottom width, top width, and bank heights were collected for 102 open channel sections totaling 6.5 miles in length. For those sections of open channel where more detailed information was required for model input, cross sections were surveyed. Data, including elevations for the top of the bank, bottom of bank, and channel centerline, were obtained at twenty-one (21) cross sections throughout the Eastwood Lake subwatershed to supplement the existing FEMA cross section data.

EXISTING WATERSHED ANALYSIS

3.1 PRIMARY SYSTEM HYDROLOGIC AND HYDRAULIC ANALYSES

3.1.1 HYDROLOGY

The purpose of the hydrologic analysis is to estimate the magnitude of selected frequency floods for the Eastwood Lake subwatershed. However, to estimate floods in the Eastwood Lake subwatershed, the entire Booker Creek watershed must be hydrologically evaluated. The USACE HEC-HMS program was selected to model the primary systems. HEC-HMS simulates the surface runoff response to precipitation for an interconnected system of surfaces, channels, and ponds. Input data for the HEC-HMS model were developed using topographic, land use, and soils maps in GIS to delineate and calculate the basin areas and NRCS hydrologic parameters. For each delineated sub-basin in the Booker Creek watershed the percent of impervious cover was calculated. Detailed descriptions of the model parameters can be found in Appendices A and B.

The HEC-HMS model offers a variety of methods for simulating the rainfall-runoff response, hydrograph development, channel and pond routing. The selection of methods for the analyses is based on the study objectives, data availability, and watershed characteristics. The precipitation data for the 24-hour duration, Type II storm were used to represent the synthetic rainfall event. The Type II storm was selected based on the location of the Town of Chapel Hill. The geographic boundaries for the different NRCS rainfall distributions are shown on Figure B-2 of the NRCS document, Urban Hydrology for Small Watersheds, dated June 1986 and commonly referred to as TR-55 (See Appendix A). The NRCS curve number approach was selected to calculate runoff volumes from the precipitation data, and the sub-basin unit hydrographs for these flood volumes were developed using the NRCS lag times.

Peak flows for the primary systems were developed for the 2-, 10- , 25- , 50- and 100-year storm events. The existing conditions flows were developed assuming attenuation occurs at the following locations:

- Booker Headwaters
  - Martin Luther King Jr. Boulevard
  - Lake Ellen
- Crow Branch
  - Horace Williams Airport Pond
- Cedar Fork
  - Kenmore Road
  - Brookview Drive

- Eastwood Lake
  - Piney Mountain Road
  - Eastwood Lake

- Lower Booker Creek
  - East Franklin Street (Booker Creek)
  - Highway 15-501/Fordham Boulevard (Booker Creek)
  - Foxcroft Drive (Dobbins Reach)
  - Summerfield Crossing (Dobbins Reach)
  - Weir East of Red Bud Lane (Sierra Reach)

Storage routing was modeled just upstream of the culverts listed above because of the large storage volume available behind the pipe's entrance. The culverts that have not been included provide little to no accessible storage volume in the area upstream of its respective crossing. The results of the hydrologic model used as input for HEC-RAS are summarized in Table 3-1. A hard copy of the HEC-HMS output is included as Appendix H. The CD found in Appendix J contains this digital information.

Table 3-1: Existing Conditions Flows from HEC-HMS for Eastwood Lake Subwatershed

HEC-HMS Node	Road Name / Location	HEC-RAS Station	Storm Event				
			2-year (cfs)	10-year (cfs)	25-year (cfs)	50-year (cfs)	100-year (cfs)
ADD-CB-BH	Confluence of Crow Branch and Booker Creek	21577	505	1,018	1,318	1,600	1,837
Piney Mountain Rd – Booker Ck	Piney Mountain Road	20223	566	1,022	1,373	1,661	1,899
ADD-EL-50	Upstream of Eastwood Lake	16524	603	1,059	1,419	1,714	1,950
N Lakeshore Dr – Booker Ck	North Lakeshore Drive	15024	615	1,070	1,431	1,728	1,964
Eastwood Lake	Downstream of Eastwood Lake	11352	668	1,641	2,217	2,614	2,850

3.1.2 HYDRAULICS

The purpose of the hydraulic analysis is to determine an existing level of flooding for the storm drainage network and to develop proposed solutions to mitigate flooding. The USACE HEC-RAS program was selected to model the primary systems to remain consistent with the existing FEMA modeling. HEC-RAS calculates water surface profiles for steady, gradually varied flow in channels and floodplains. The standard backwater analysis for sub-critical flow was modeled for the Eastwood Lake subwatershed. The model calculates the effect of obstructions, such as culverts, and building structures in the channel and floodplain on the water surface profile. The

hydraulic computations are based on the solution of a one-dimensional energy equation with energy loss due to friction evaluated by Manning's equation. Input data for HEC-RAS include the following:

- Cross-section geometry of the channel and floodplain;
- Roughness coefficients to describe characteristics of the channel and floodplain;
- Size, shape, and characteristics of culverts and roadways along the stream reach; and
- Energy loss coefficients for flow in the channel and at roadway crossings.

Channel cross sections utilized in the HEC-RAS model were based on the existing FEMA cross sections and WK Dickson surveyed cross sections. The channel cross sections were merged with State LiDAR data to develop cross sections spanning the entire floodplain area.

The starting water surface elevations for the Eastwood Lake HEC-RAS model were determined based on values calculated in the models prepared for the Lower Booker Creek Subwatershed Study.

Hydraulic Performance

Two (2) roadway crossings were analyzed for flooding potential of the primary system. Descriptions of the existing primary system crossings analyzed are summarized in Table 3-2. Pictures 3-1 and 3-2 of this report provide visual images of the primary system bridge crossings.

Table 3-2: Existing Condition of Primary System Crossings

Location	Size/Material	Condition
North Lakeshore Drive	Bridge	Good
Piney Mountain Road	Bridge	Good

Picture 3-1: North Lakeshore Drive Bridge

Picture 3-2: Piney Mount Road bridge

The 2-, 10-, 25-, 50- and 100-year existing conditions flood elevations for the primary system crossings are identified in Table 3-3. The minimum elevations at the top of the road for each crossing are also listed in Table 3-3. The two (2) bridges in the Eastwood Lake subwatershed are not meeting the desired 100-year level of service. North Lakeshore Drive and Piney Mountain

Road are both operating at a 10-year level of service. Both crossings were reconstructed in 2001 following storm damage in late 2000.

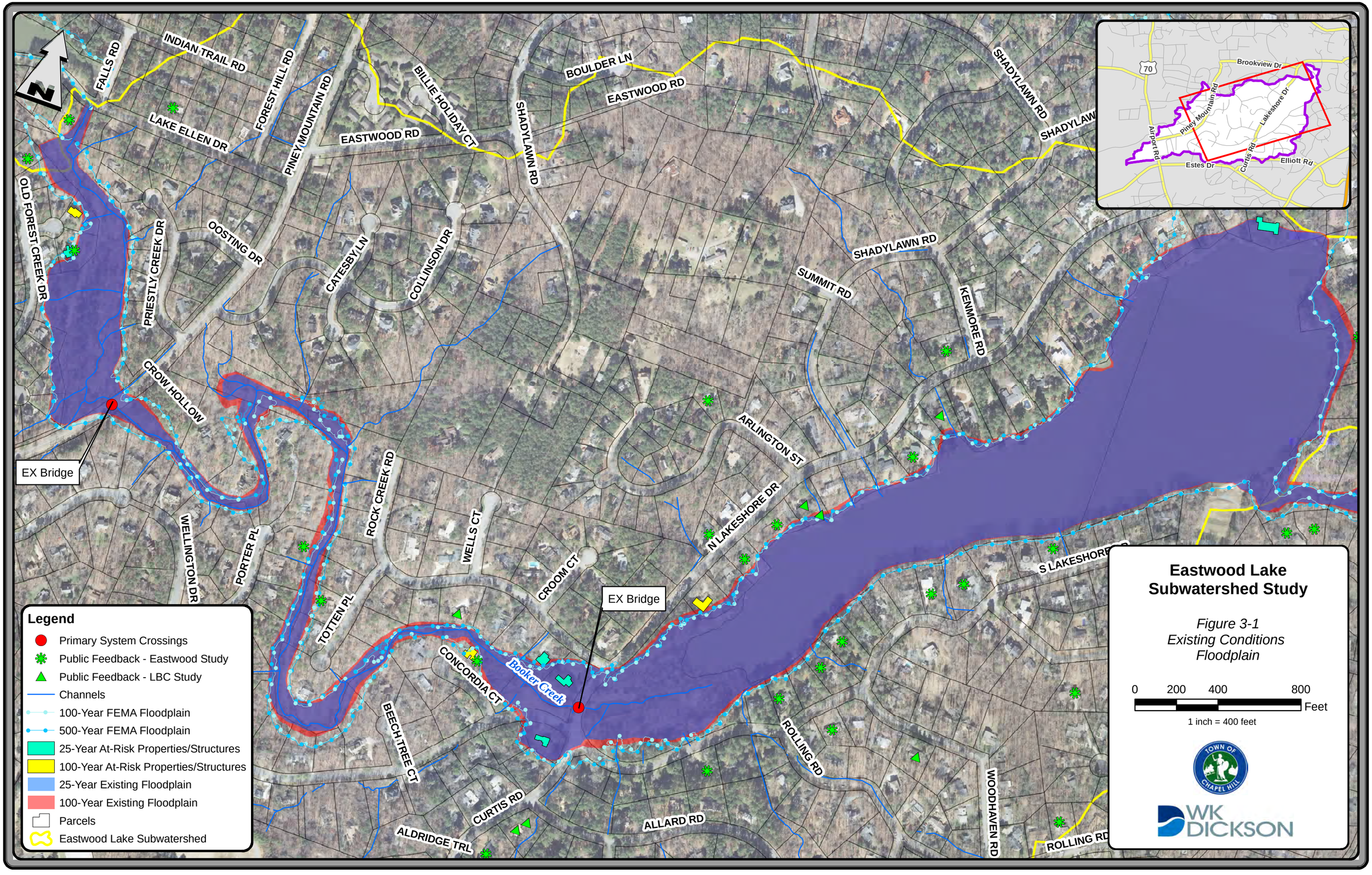
Table 3-3: Hydraulic Performance for Existing Conditions Roadway Flooding

Location	Minimum Elevation at Top of Road (feet NAVD)	Desired Level of Service (Year)	Calculated Water Surface Elevations (feet NAVD)				
			2-year flood	10-year flood	25-year flood	50-year flood	100-year flood
BOOKER CREEK							
North Lakeshore Drive	301.63	100	298.73	301.06	**302.31**	**302.52**	**302.61**
Piney Mountain Road	385.66	100	378.56	383.64	**386.70**	**387.32**	**387.72**

*Bold text indicates the existing water surface has exceeded the rim elevation at the road thereby causing flooding.
**Green shade indicates crossing meets desired level of service. Red shade indicates crossing does not meet desired level of service.

In addition to evaluating the roadway crossings, an evaluation was performed to determine the residences along the primary system stream that are at risk of flooding during the 25- and 100-year storm event. The existing 25- and 100- year floodplains for these streams are shown in Figure 3-1. The mapped floodplains are based on HEC-RAS model results developed as part of this subwatershed plan and may differ from the published FEMA floodplains. For flood insurance purposes, the effective FEMA floodplain should be referenced. For buildings outside of the 100-year effective FEMA floodplain, property owners must determine if purchasing flood insurance is necessary. The Town is not responsible for determining if flood insurance is required or for notifying property owners of the potential risk of flooding.

As shown in Tables B-14 and B-15 of Appendix B, six (6) structures along Booker Creek were identified for being at risk of flooding in the 25-year storm event and an additional two (2) structures for the 100-year event. Existing conditions model results were validated with the feedback received during the outreach process. Model parameters were adjusted as appropriate to more closely match the results from the models to observed conditions. See Appendix B for more details on the validation process.


FALLS RD
INDIAN TRAIL RD
FOREST HILL RD
PINEY MOUNTAIN RD
BILLIE HOLIDAY CT
BOULDER LN
EASTWOOD RD
SHADYLAWN RD
LAKE ELLEN DR
EASTWOOD RD
OLD FOREST CREEK DR
PRIESTLY CREEK DR
OOSTING DR
CATESBY LN
COLLINSON DR
SHADYLAWN RD
SUMMIT RD
KENMORE RD
CROW HOLLOW
ARLINGTON ST
EX Bridge
WELLINGTON DR
PORTER PL
ROCK CREEK RD
WELLS CT
CROOM CT
N LAKESHORE DR
S LAKESHORE
TOTTEN PL
EX Bridge
CONCORDIA CT
Booker Creek
BEECH TREE CT
CURTIS RD
ALLARD RD
ROLLING RD
WOODHAVEN RD
ALDRIDGE TRL
ROLLING RD
70
Brookview Dr
Piney Mountain Rd
Lakeshore Dr
Airport Rd
Estes Dr
Curtis Rd
Elliott Rd
Legend
Primary System Crossings
Public Feedback - Eastwood Study
Public Feedback - LBC Study
Channels
100-Year FEMA Floodplain
500-Year FEMA Floodplain
25-Year At-Risk Properties/Structures
100-Year At-Risk Properties/Structures
25-Year Existing Floodplain
100-Year Existing Floodplain
Parcels
Eastwood Lake Subwatershed
Eastwood Lake Subwatershed Study
Figure 3-1
Existing Conditions
Floodplain
0
200
400
800
Feet
1 inch = 400 feet
TOWN OF CHAPEL HILL
WK DICKSON

3.2 SECONDARY SYSTEM HYDROLOGIC AND HYDRAULIC ANALYSES

While Booker Creek is the primary source of flooding within the watershed, undersized systems can also lead to building and roadway flooding. Based on the questionnaire responses, public meetings, and feedback from Town staff, eleven (11) secondary systems were identified for further evaluation. The secondary systems evaluated are:

- Shady Lawn Road System;
- Arlington Street #1 System;
- Arlington Street #2 System;
- Rock Creek Road Closed System;
- South Lakeshore Drive/Ridgecrest Drive System;
- South Lakeshore Drive/Woodhaven Road System;
- South Lakeshore Drive/Rolling Road System;
- South Lakeshore Drive System;
- Allard Road System;
- Curtis Road System; and
- Woodshire Lane/Huntington Drive System.

3.2.1 HYDROLOGY

Two (2) models were used in the hydrologic evaluation of the secondary systems: EPA Storm Water Management Model (SWMM) and Hydraflow Storm Sewers. For the larger more complex secondary systems (Shady Lawn Road, Arlington #1, Arlington #2, South Lakeshore Drive/Ridgecrest Drive, South Lakeshore Drive/Woodhaven Road, South Lakeshore Drive/Rolling Road, South Lakeshore Drive, Allard Road, Curtis Road, and Woodshire Lane/Huntington Drive), SWMM was selected as the hydrologic and hydraulic model. Smaller systems that were completely closed systems including Rock Creek Road were modeled using Rational flow calculations within Hydraflow Storm Sewers. A detailed description about the hydrologic modeling methodology used for the systems analyzed as part of this report is included in Appendix A.

3.2.2 HYDRAULICS

Shady Lawn Road System

The Shady Lawn Road system collects drainage from approximately 16 acres including a portion of the Lake Forest subdivision. The system consists of two (2) parallel systems that run along each side of Shady Lawn Road. The system along the eastern side of the road consists of 15" and 18" RCPs. The 18" RCP outlets to a roadside ditch with a 1-foot high bank, a 2-foot bottom width, and a 2.5-foot top width. The eastern system (15" RCP) crosses North Lakeshore Drive before discharging to a channel section between 2000 and 2004 North Lakeshore Drive that enters Eastwood Lake.

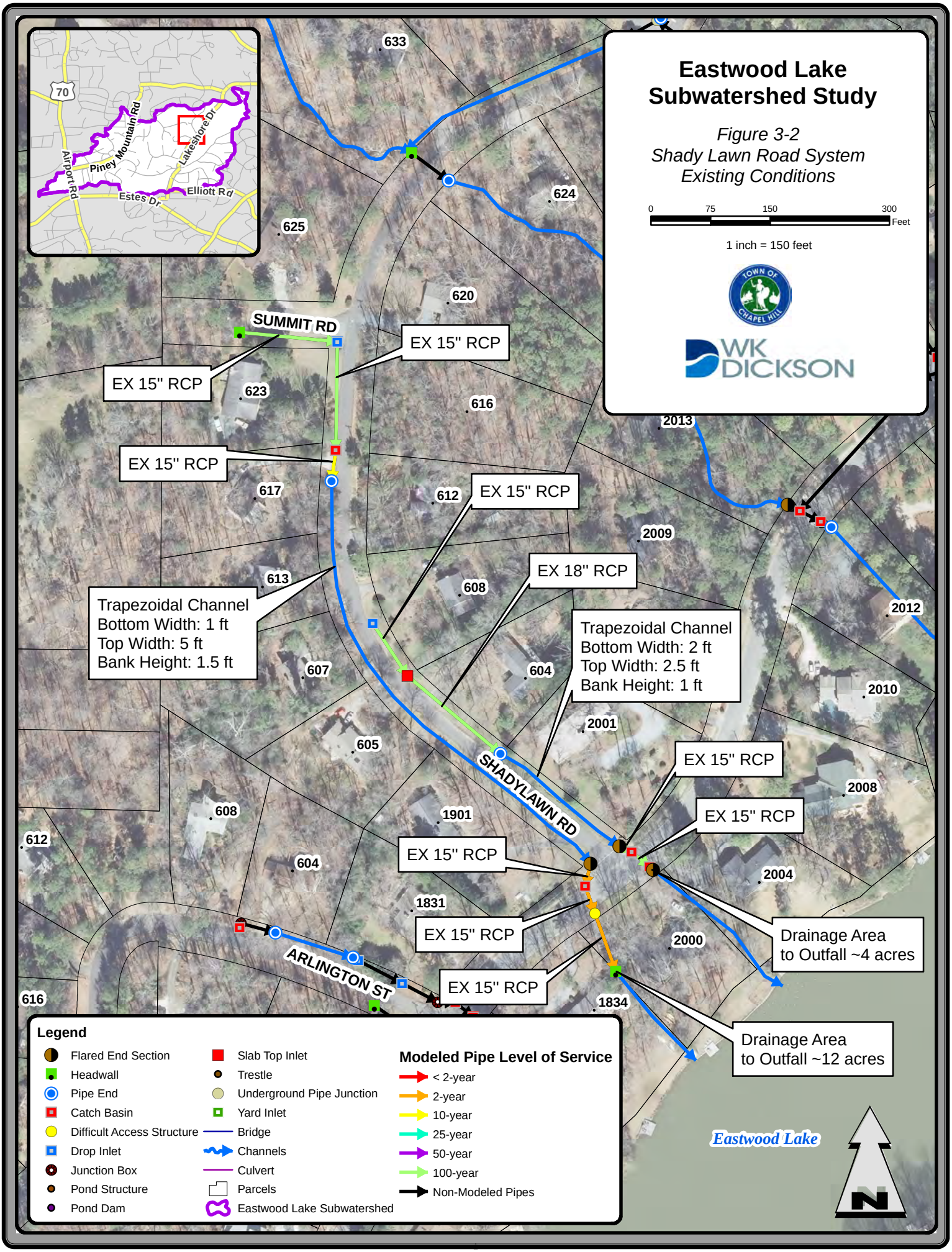
The conveyance system along the western side of the road starts further north along Summit Road prior to its intersection with Shady Lawn Road. The closed segment of the system is comprised of 15" RCPs connected by a roadside ditch with a 1.5-foot high bank, a 1-foot bottom width, and a 5-foot top width. Similar to the western system, the eastern system crosses North Lakeshore Drive, discharges to a channel section and outlets to Eastwood Lake. There is one (1) report of flooding adjacent to the Shady Lawn Road system. The resident at 2008 North Lakeshore Drive has reported experiencing yard flooding approximately once a year.

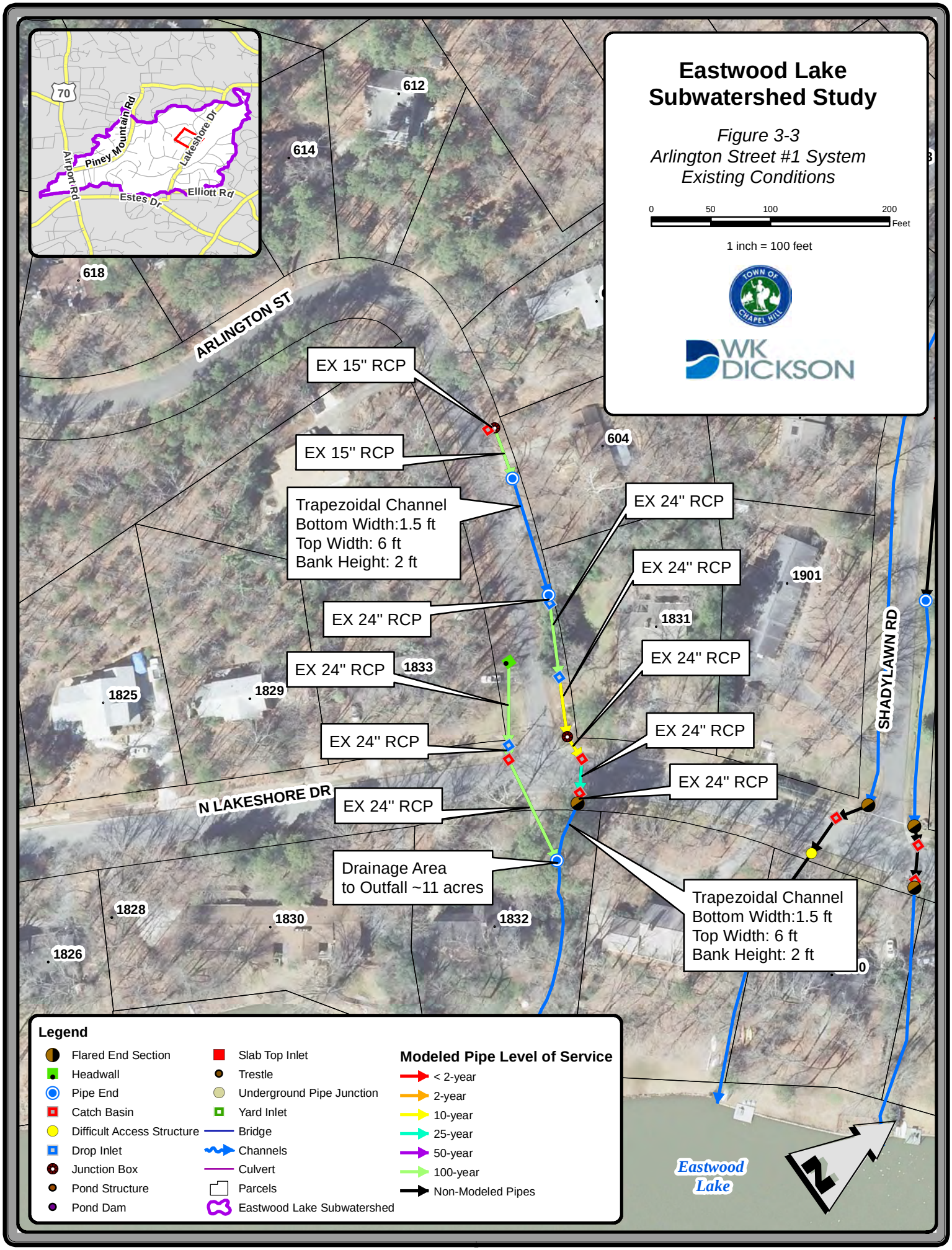
Figure 3-2 shows the level of service being provided by the existing closed system. Nearby non-modeled pipes are shown on the figure; however, they were not included in the model because they are not connected to the Shady Lawn Road System. The model results show most of the existing system is operating above the desired 10-year level of service. The entire system along the eastern side of the road is meeting a 10-year level of service while the lower portion of the western system including the 15" RCP crossing North Lakeshore Drive is operating at or below a 2-year level of service. This can be attributed to the existing pipes being undersized and unable to accommodate the amount of flow it is currently receiving from the drainage area.

Arlington Street #1 System

The Arlington Street #1 System collects drainage from 10.5 acres in the Pine Knob and Lake Forest subdivisions. It discharges to a channel section that outlets to Eastwood Lake. The conveyance system is comprised of 15" and 24" RCPs. Based on data collected during the inventory, the pipes are in good condition. The closed system (24" RCP) crosses North Lakeshore Drive in two (2) locations.

Figure 3-3 shows the level of service being provided by the existing closed system. Nearby non-modeled pipes are shown on the figure; however, they were not included in the model because they are not connected to the Arlington Street #1 System. The model results show that the existing system is operating above the desired 10-year level of service. There are three (3) reports of flooding adjacent to this system. The resident at 1832 North Lakeshore Drive has reported experiencing yard and basement flooding two to three times a year. The resident attributed this to the pipe becoming clogged with leaves and debris. Consequently, the property owner had a special grate installed to mitigate the flooding. The resident at 1831 North Lakeshore Drive reported significant yard flooding during storm events. A small channel conveys runoff behind the house to Arlington Street; however, when the runoff volume exceeds the channel capacity, the overflow inundates the front yard of the property. The resident at 612 Arlington Street has also reported yard, basement, and crawl space flooding two to three times a year. The property is located at the bottom of the hill with no infrastructure in place to capture the runoff.


Eastwood Lake Subwatershed Study
Figure 3-2
Shady Lawn Road System
Existing Conditions
0 75 150 300 Feet
1 inch = 150 feet
TOWN OF CHAPEL HILL
WK DICKSON
70
Piney Mountain Rd
Lakeshore Dr
Airport Rd
Estes Dr
Elliott Rd
633
624
625
620
SUMMIT RD
EX 15" RCP
EX 15" RCP
623
616
2013
EX 15" RCP
617
612
EX 15" RCP
2009
EX 18" RCP
613
608
2012
Trapezoidal Channel
Bottom Width: 1 ft
Top Width: 5 ft
Bank Height: 1.5 ft
Trapezoidal Channel
Bottom Width: 2 ft
Top Width: 2.5 ft
Bank Height: 1 ft
607
604
2010
2001
605
SHADYLAWN RD
EX 15" RCP
2008
608
1901
EX 15" RCP
612
EX 15" RCP
604
2004
1831
EX 15" RCP
2000
Drainage Area
to Outfall ~4 acres
ARLINGTON ST
EX 15" RCP
616
1834
Drainage Area
to Outfall ~12 acres
Eastwood Lake
Legend
Flared End Section
Headwall
Pipe End
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Pond Structure
Pond Dam
Slab Top Inlet
Trestle
Underground Pipe Junction
Yard Inlet
Bridge
Channels
Culvert
Parcels
Eastwood Lake Subwatershed
Modeled Pipe Level of Service
< 2-year
2-year
10-year
25-year
50-year
100-year
Non-Modeled Pipes
N


Eastwood Lake Subwatershed Study
Figure 3-3
Arlington Street #1 System
Existing Conditions
0 50 100 200 Feet
1 inch = 100 feet
WK DICKSON
70
Piney Mountain Rd
Lakeshore Dr
Airport Rd
Estes Dr
Elliott Rd
612
614
618
604
1901
1831
1833
1825
1829
1828
1830
1832
1826
ARLINGTON ST
N LAKESHORE DR
SHADYLAWN RD
EX 15" RCP
EX 15" RCP
Trapezoidal Channel
Bottom Width:1.5 ft
Top Width: 6 ft
Bank Height: 2 ft
EX 24" RCP
EX 24" RCP
EX 24" RCP
EX 24" RCP
EX 24" RCP
EX 24" RCP
EX 24" RCP
EX 24" RCP
Drainage Area
to Outfall ~11 acres
Trapezoidal Channel
Bottom Width:1.5 ft
Top Width: 6 ft
Bank Height: 2 ft
Eastwood Lake
N
Legend
Flared End Section
Headwall
Pipe End
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Pond Structure
Pond Dam
Slab Top Inlet
Trestle
Underground Pipe Junction
Yard Inlet
Bridge
Channels
Culvert
Parcels
Eastwood Lake Subwatershed
Modeled Pipe Level of Service
< 2-year
2-year
10-year
25-year
50-year
100-year
Non-Modeled Pipes

Arlington Street #2 System

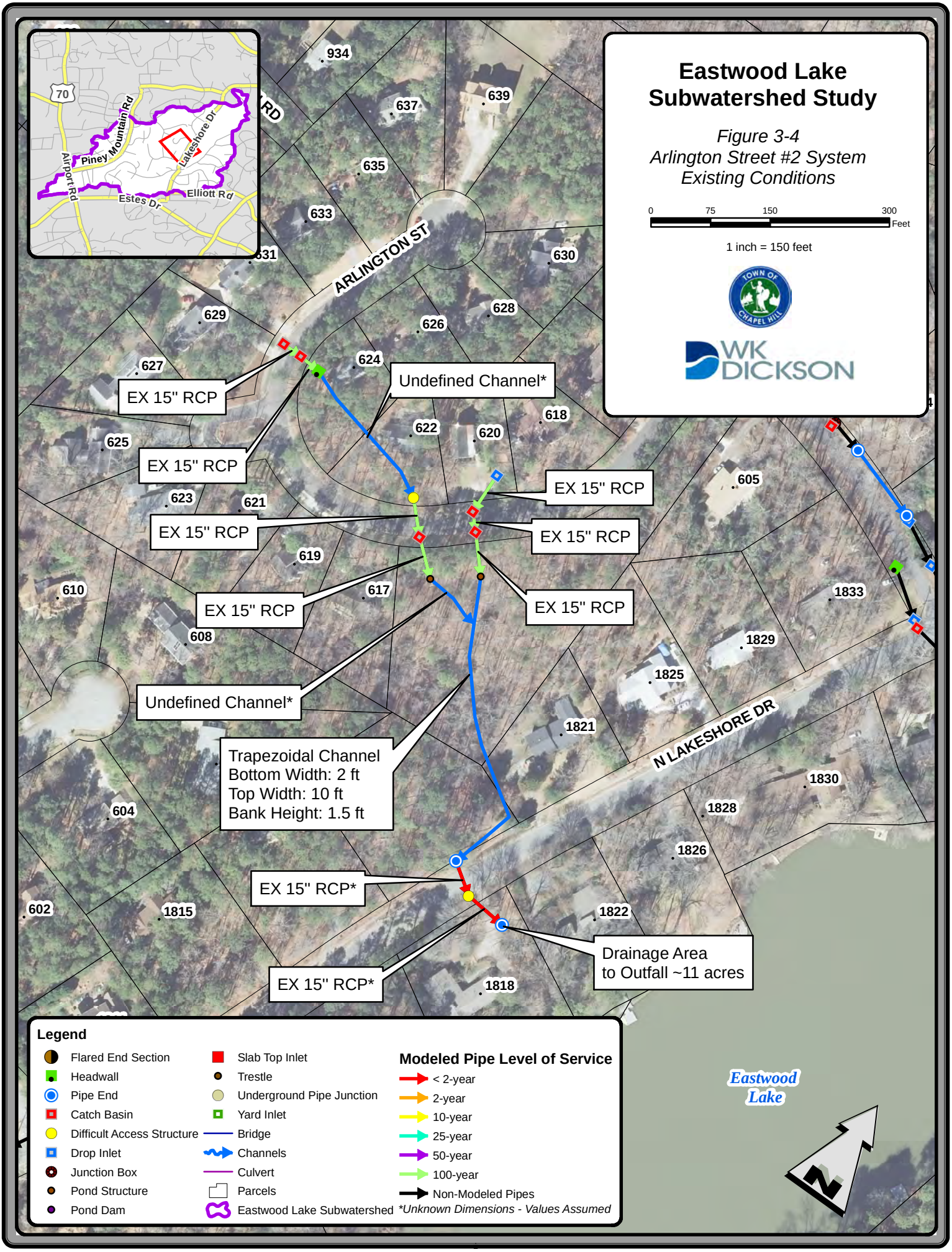
The Arlington Street #2 System collects drainage from approximately 11 acres in the Pine Knob, Lake Forest, and Cooker Woods West subdivisions. The conveyance system is comprised of 15" RCPs connected by small channel sections. The upper portion of the system carries drainage from the Arlington Road cul-de-sac through a series of yards before carrying drainage across Arlington Road. The lower portion of the system is composed of open channel on the upstream and downstream side of North Lakeshore Drive crossing. There are two (2) reports of flooding adjacent to this system. The resident at 1821 North Lakeshore Drive has reported experiencing yard flooding two to three times a year while the resident at 1826 North Lakeshore Drive reports less frequent yard flooding, less than once a year.

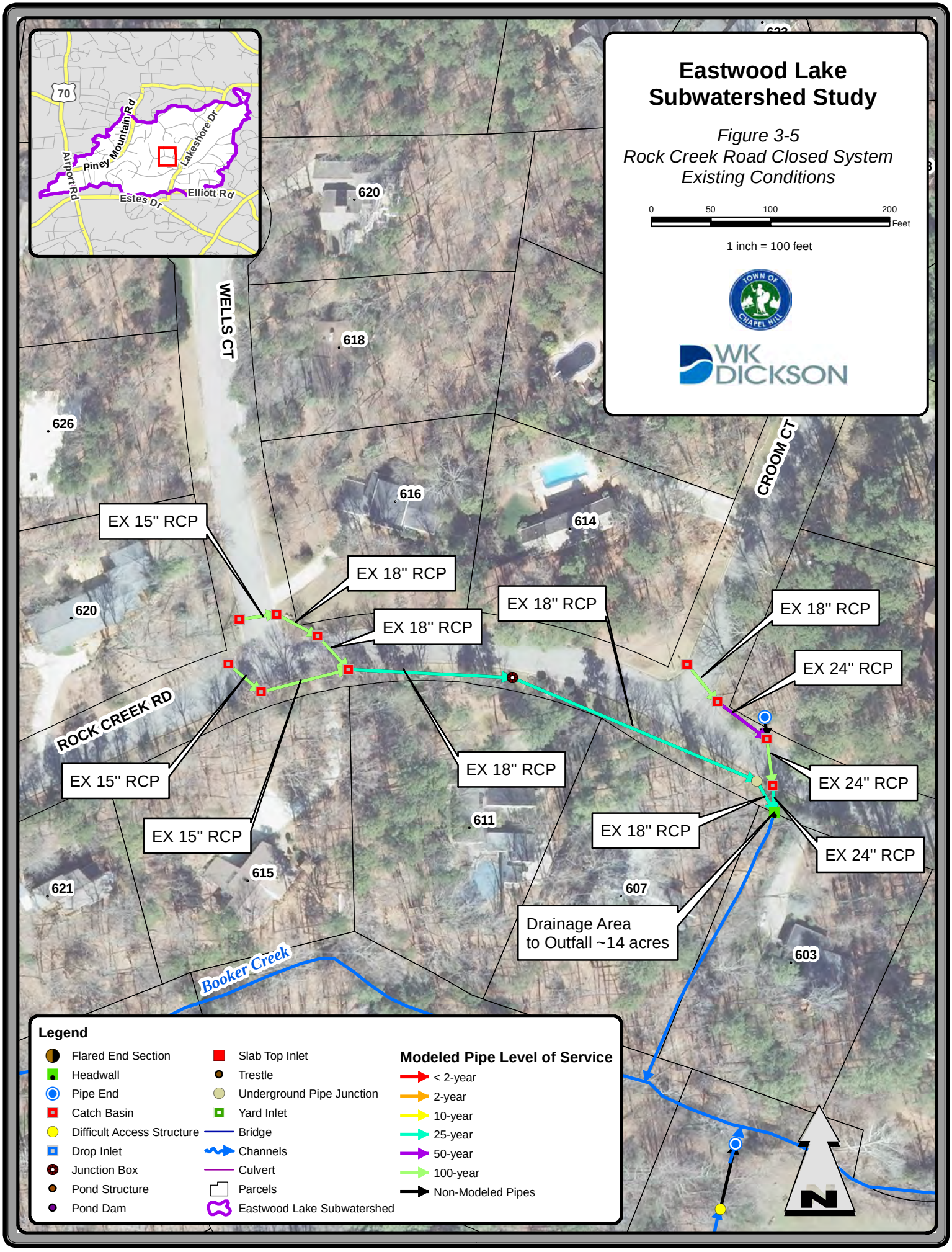
Figure 3-4 shows the level of service being provided by the existing closed system. Nearby non-modeled pipes are shown on the figure; however, they were not included in the model because they are not connected to the Arlington Street #2 System. The model results show the majority of the existing system is exceeding the desired 10-year level of service. The existing 15" RCP segments that cross North Lakeshore Drive are operating below a 2-year level of service, assuming full capacity in the pipe. In addition to being undersized the pipes were half buried when visited during the field inventory. The majority of the upstream Pine Knob subdivision drain to a channel that outlets to the 15" RCP at North Lakeshore Drive.

Rock Creek Road Closed System

The Rock Creek Road System collects drainage from approximately 14 acres in the Coker Woods West subdivision and adjacent residential parcels. It discharges to an open channel section located between 603 and 607 Rock Creek Road with a 2.5-foot high bank, a 4-foot bottom width, and a 4.5-foot top width before discharging to Booker Creek. The conveyance system is comprised of RCPs ranging in size from 15 to 24 inches and is in good condition based on data collected during inventory, with the exception of the cracked endwall at the outfall. The outfall pipes are also significantly perched. The resident located at 615 Rock Creek Road has observed yard and street flooding several times per year as well as intersection flooding at North Lakeshore Drive and Rock Creek Road.

Figure 3-5 shows the level of service being provided by the existing closed system. Nearby non-modeled pipes are shown on the figure; however, they were not included in the model because they are outside of the modeling limits for the Rock Creek Road System. The model results show the existing system is operating above the desired 10-year level of service. However, there are segments of the system where the hydraulic grade line surcharges the pipe. The terrain is steep in this area and the properties south of Rock Creek Road are lower in elevation than the street, so if water overtops the curb or flows into a driveway, properties are at risk of flooding. No infrastructure exists between Wells Court and Totten Place, which also could contribute to the reported flooding.


Eastwood Lake Subwatershed Study
Figure 3-4
Arlington Street #2 System
Existing Conditions
0 75 150 300 Feet
1 inch = 150 feet
ARLINGTON ST
N LAKESHORE DR
EX 15" RCP
EX 15" RCP
Undefined Channel*
EX 15" RCP
EX 15" RCP
EX 15" RCP
EX 15" RCP
EX 15" RCP
Undefined Channel*
Trapezoidal Channel
Bottom Width: 2 ft
Top Width: 10 ft
Bank Height: 1.5 ft
EX 15" RCP*
EX 15" RCP*
Drainage Area
to Outfall ~11 acres
Eastwood Lake
Legend
Flared End Section
Headwall
Pipe End
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Pond Structure
Pond Dam
Slab Top Inlet
Trestle
Underground Pipe Junction
Yard Inlet
Bridge
Channels
Culvert
Parcels
Eastwood Lake Subwatershed
Modeled Pipe Level of Service
< 2-year
2-year
10-year
25-year
50-year
100-year
Non-Modeled Pipes
*Unknown Dimensions - Values Assumed


Eastwood Lake Subwatershed Study
Figure 3-5
Rock Creek Road Closed System
Existing Conditions
0 50 100 200 Feet
1 inch = 100 feet
TOWN OF CHAPEL HILL
WK DICKSON
70
Piney Mountain Rd
Lakeshore Dr
Airport Rd
Estes Dr
Elliott Rd
WELLS CT
CROOM CT
ROCK CREEK RD
620
618
626
616
614
620
611
615
621
607
603
EX 15" RCP
EX 18" RCP
EX 18" RCP
EX 18" RCP
EX 18" RCP
EX 24" RCP
EX 24" RCP
EX 24" RCP
EX 15" RCP
EX 15" RCP
EX 18" RCP
EX 18" RCP
Drainage Area
to Outfall ~14 acres
Booker Creek
Legend
Flared End Section
Headwall
Pipe End
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Pond Structure
Pond Dam
Slab Top Inlet
Trestle
Underground Pipe Junction
Yard Inlet
Bridge
Channels
Culvert
Parcels
Eastwood Lake Subwatershed
Modeled Pipe Level of Service
< 2-year
2-year
10-year
25-year
50-year
100-year
Non-Modeled Pipes
N

South Lakeshore Drive/Ridgecrest Drive System

The South Lakeshore Drive/Ridgecrest Drive System collects drainage from approximately 23 acres from the Lake Forest subdivision. It discharges to Eastwood Lake between the properties located at 1917 and 1921 South Lakeshore Drive. The conveyance system is comprised of a 24" RCP that crosses South Lakeshore Drive and a 15" RCP that crosses the intersection of Ridgecrest Drive and South Lakeshore Drive. These culverts are connected by open channel sections that have a 3-foot high bank, a 3-foot bottom width, and a 7-foot top width. A section of the channel connecting the system is undefined, it is a shallow path that is not clearly defined but it has been included for model connectivity. Based on data collected during the inventory, the pipes are in good condition. The stream has significant bank erosion and a limited buffer resulting in sediment loads to Eastwood Lake.

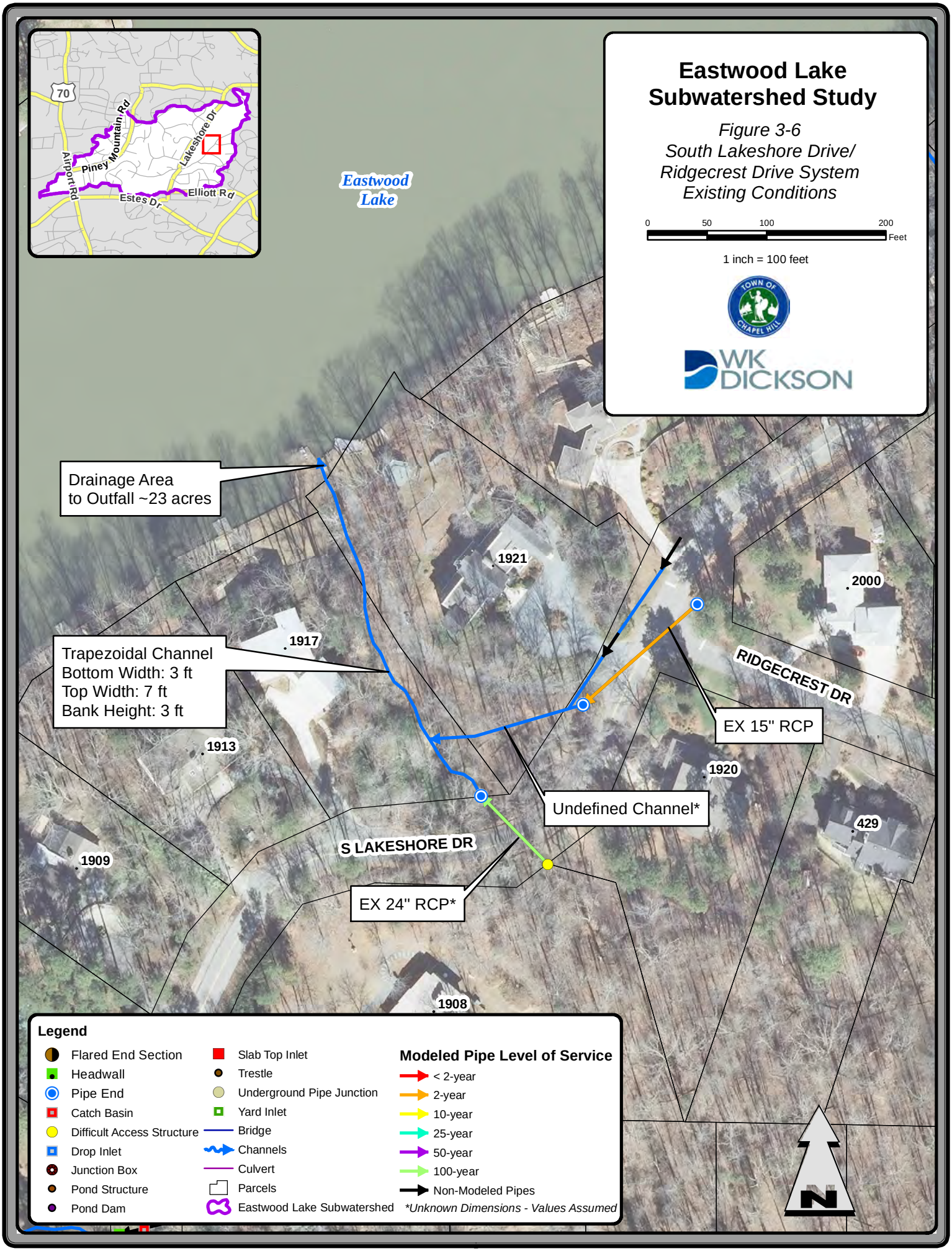
Figure 3-6 shows the level of service being provided by the existing closed system. Nearby non-modeled pipes are shown on the figure; however, they were not included in the model because they are outside of the modeling limits for the South Lakeshore Drive/Ridgecrest Drive System. The model results show that while the majority of the existing system is operating above the desired 10-year level of service, the segment of 15" RCP is only performing at a 2-year level of service. The upstream end of the 24" RCP was covered in debris during the field collection and will require cleaning and maintenance to provide the intended level of service. The neighboring residents at 1917 and 1921 South Lakeshore Drive both report experiencing yard flooding 2 to 3 times per year.

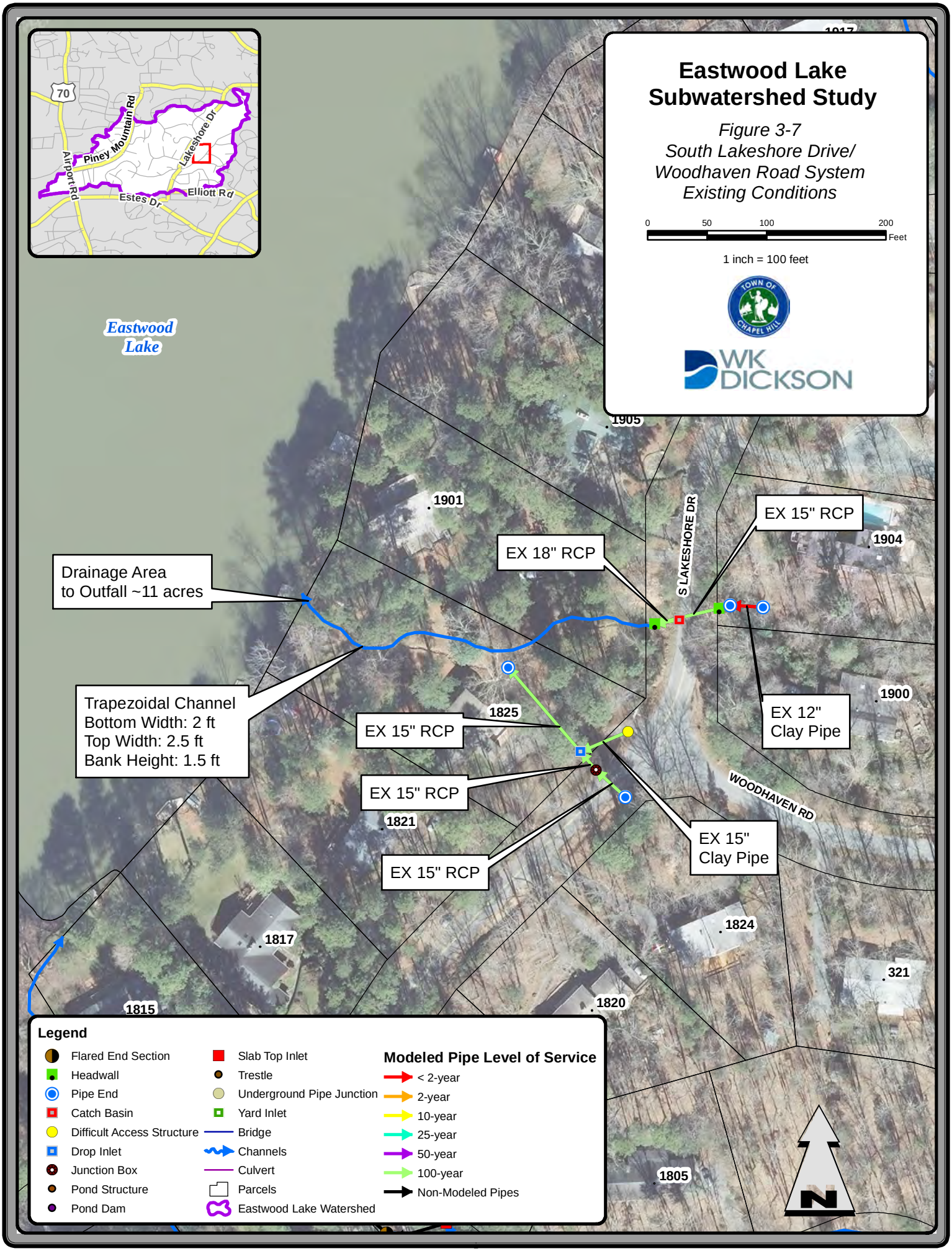
South Lakeshore Drive/Woodhaven Road System

The South Lakeshore Drive/Woodhaven Road System collects drainage from approximately 11 acres in the Lake Forest subdivision. It discharges to a channel section located between 1825 and 1901 South Lakeshore Drive before it outlets to Eastwood Lake. The conveyance system is comprised of clay pipe and RCPs ranging in size from 12- to 18-inches. The closed system (15" RCP) crosses South Lakeshore Drive at two (2) locations. The channel located between 1825 and 1901 South Lakeshore Drive has significant bank erosion and a limited buffer resulting in sediment loads to Eastwood Lake.

Figure 3-7 shows the level of service being provided by the existing closed system. The model results show that there is only one (1) segment of the existing system operating below the desired 10-year level of service. The remainder of the existing conveyance system including the sections that cross South Lakeshore Drive are exceeding the 10-year level of service.

There is one (1) report of flooding adjacent to this system. The resident at 1825 South Lakeshore Drive has reported experiencing yard flooding at 2 to 3 times a year. This occurs during heavy rainfalls when the water runs down Woodhaven Road into the driveway and yard at base of the roadway. Previously, the resident at 1901 South Lakeshore Drive experienced similar yard flooding. A section of curb and gutter was installed along the front of the property to convey the runoff.


Eastwood Lake Subwatershed Study
Figure 3-6
South Lakeshore Drive/
Ridgecrest Drive System
Existing Conditions
0
50
100
200
Feet
1 inch = 100 feet
TOWN OF CHAPEL HILL
WK DICKSON
70
Piney Mountain Rd
Airport Rd
Lakeshore Dr
Estes Dr
Elliott Rd
Eastwood Lake
Drainage Area to Outfall ~23 acres
Trapezoidal Channel
Bottom Width: 3 ft
Top Width: 7 ft
Bank Height: 3 ft
1921
2000
1917
1913
1920
429
1909
1908
RIDGECREST DR
S LAKESHORE DR
EX 15" RCP
Undefined Channel*
EX 24" RCP*
Legend
Flared End Section
Headwall
Pipe End
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Pond Structure
Pond Dam
Slab Top Inlet
Trestle
Underground Pipe Junction
Yard Inlet
Bridge
Channels
Culvert
Parcels
Eastwood Lake Subwatershed
Modeled Pipe Level of Service
< 2-year
2-year
10-year
25-year
50-year
100-year
Non-Modeled Pipes
*Unknown Dimensions - Values Assumed
N


Eastwood Lake Subwatershed Study
Figure 3-7
South Lakeshore Drive/
Woodhaven Road System
Existing Conditions
0
50
100
200
Feet
1 inch = 100 feet
TOWN OF CHAPEL HILL
WK DICKSON
70
Piney Mountain Rd
Airport Rd
Lakeshore Dr
Estes Dr
Elliott Rd
Eastwood Lake
Drainage Area to Outfall ~11 acres
Trapezoidal Channel
Bottom Width: 2 ft
Top Width: 2.5 ft
Bank Height: 1.5 ft
EX 18" RCP
EX 15" RCP
EX 15" RCP
EX 15" RCP
EX 15" RCP
EX 12" Clay Pipe
EX 15" Clay Pipe
S LAKESHORE DR
WOODHAVEN RD
1905
1901
1904
1900
1825
1821
1824
1817
1815
1820
321
1805
Legend
Flared End Section
Headwall
Pipe End
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Pond Structure
Pond Dam
Slab Top Inlet
Trestle
Underground Pipe Junction
Yard Inlet
Bridge
Channels
Culvert
Parcels
Eastwood Lake Watershed
Modeled Pipe Level of Service
< 2-year
2-year
10-year
25-year
50-year
100-year
Non-Modeled Pipes
N

South Lakeshore Drive/Rolling Road System

The South Lakeshore Drive/Rolling Road System collects drainage from approximately 38 acres from sections of the Lake Forest, Vernon Hills, and Coker Hills subdivision. It discharges to an open channel section before it outlets to Eastwood Lake. The conveyance system is comprised of 24" RCPs crossing Rolling Road and South Lakeshore Drive. Based on data collected during the inventory, the pipes are in good condition. These pipes are connected by open channel sections that have bank heights ranging from 1 to 3.5 feet with bottom widths ranging from 2.5 to 4 feet and top widths ranging from 3.8 to 8 feet. The channel upstream of the 24" crossing at South Lakeshore Drive has significant bank erosion.

Figure 3-8 shows the level of service being provided by the existing system. Nearby non-modeled pipes are shown on the figure; however, they were not included in the model because they are not connected to the South Lakeshore Drive/Rolling Road System. The model results show that the existing system is operating below a 2-year level of service, which is less than the desired 10-year level of service. The residents at 1817 and 1820 South Lakeshore Drive both reported flooding. The resident at 1817 South Lakeshore Drive experiences yard, crawl space, and storage building/shed flooding less than once a year. The property owner installed a French drain to alleviate the flooding. The resident at 1820 South Lakeshore Drive reported street flooding.

South Lakeshore Drive System

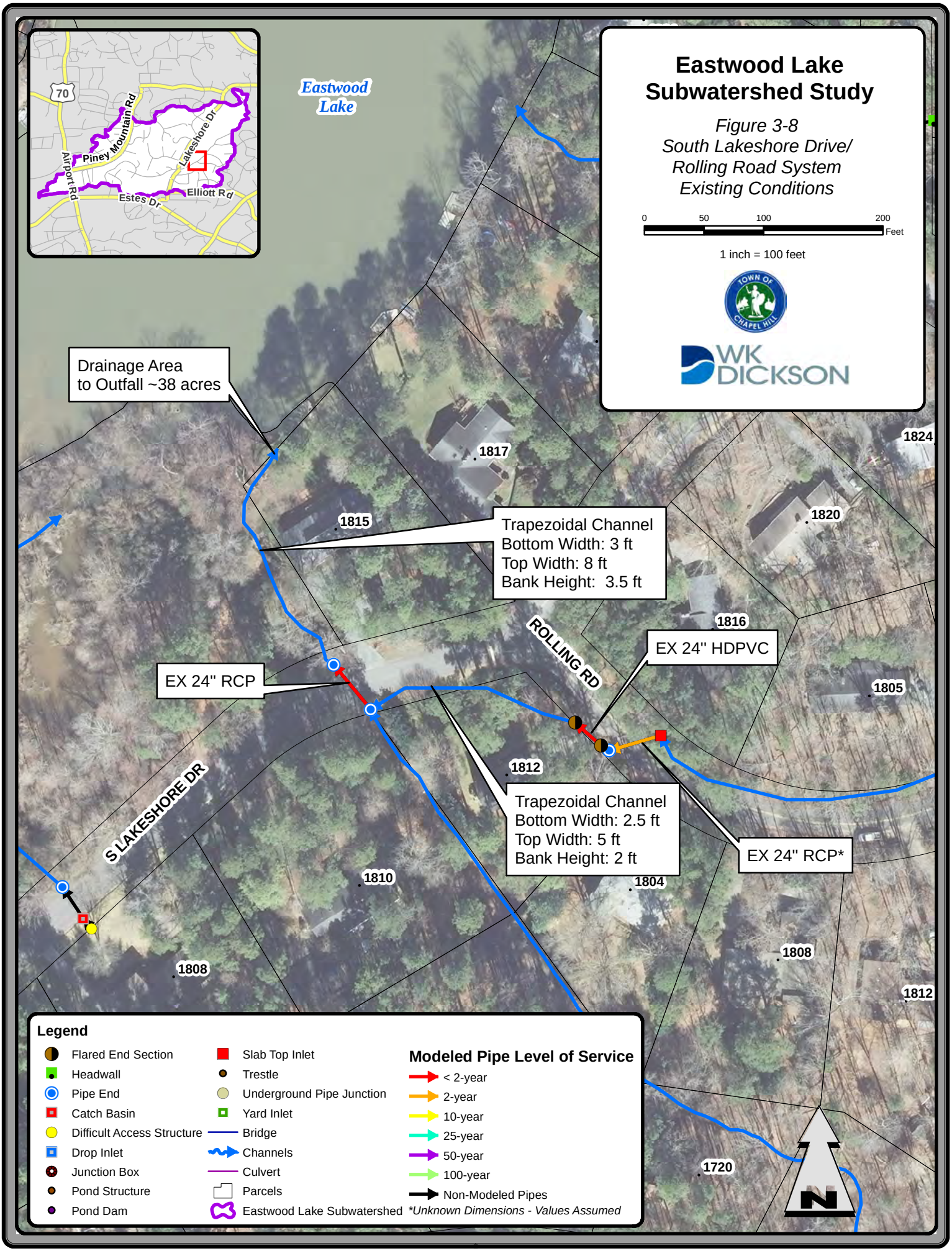
The South Lakeshore Drive System collects drainage from approximately 2 acres from a section of the Coker Hills subdivision. It is a small system that begins in front of 1808 South Lakeshore Drive and consists of an 18" RCP. The system terminates at an open channel section that has a 1.5-foot high bank, a 6-foot bottom width, and an 8-foot top width. The resident at 1808 South Lakeshore Drive reports experiencing basement flooding less than once a year and yard flooding more than three times per year. In the back yard, the water comes down from Allard Road. Occasionally, the front yard will also flood from the runoff coming from the Rolling Road/South Lakeshore Drive intersection.

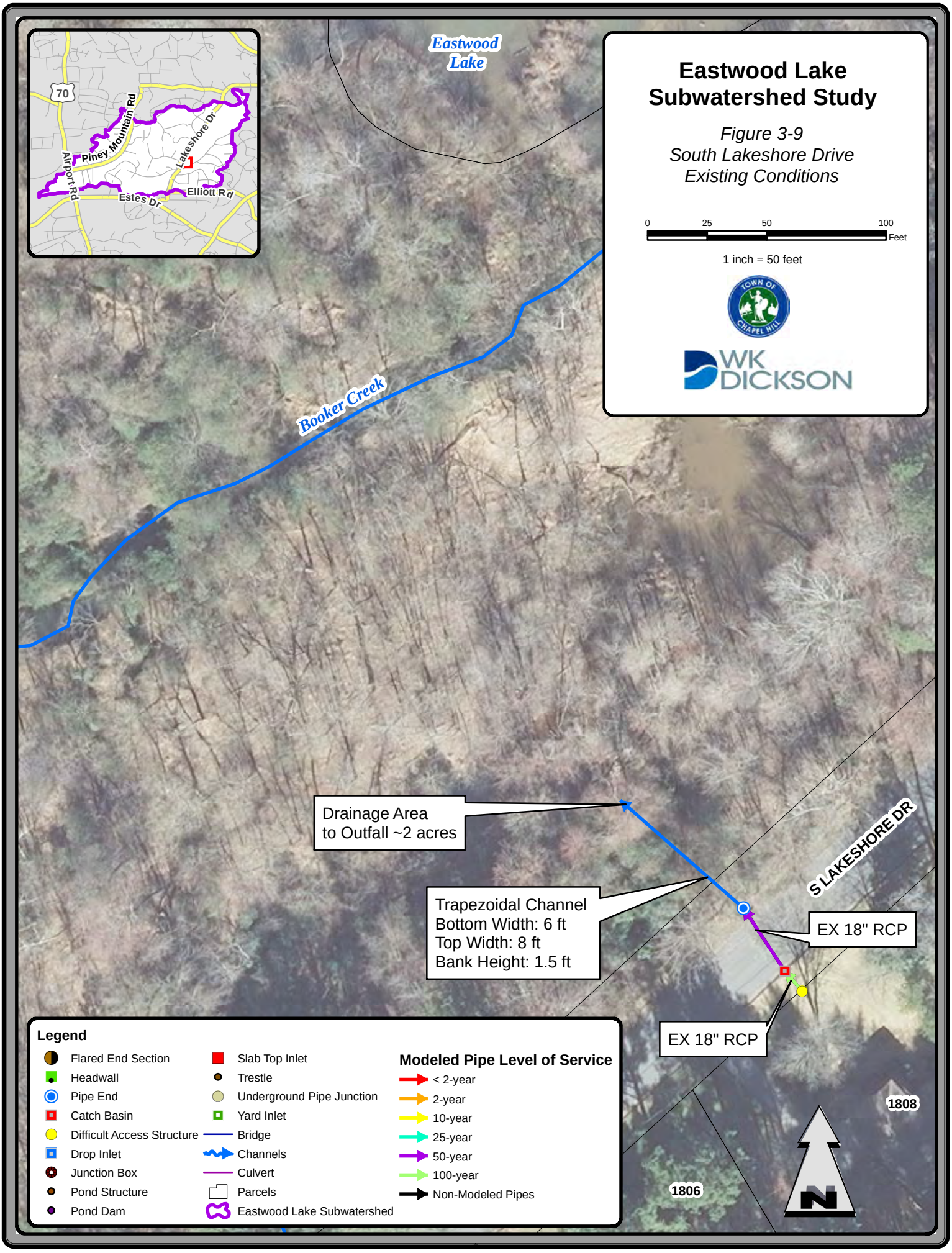
Figure 3-9 shows the level of service being provided by the existing closed system. The model results show that the existing system is operating above the desired 10-year level of service.

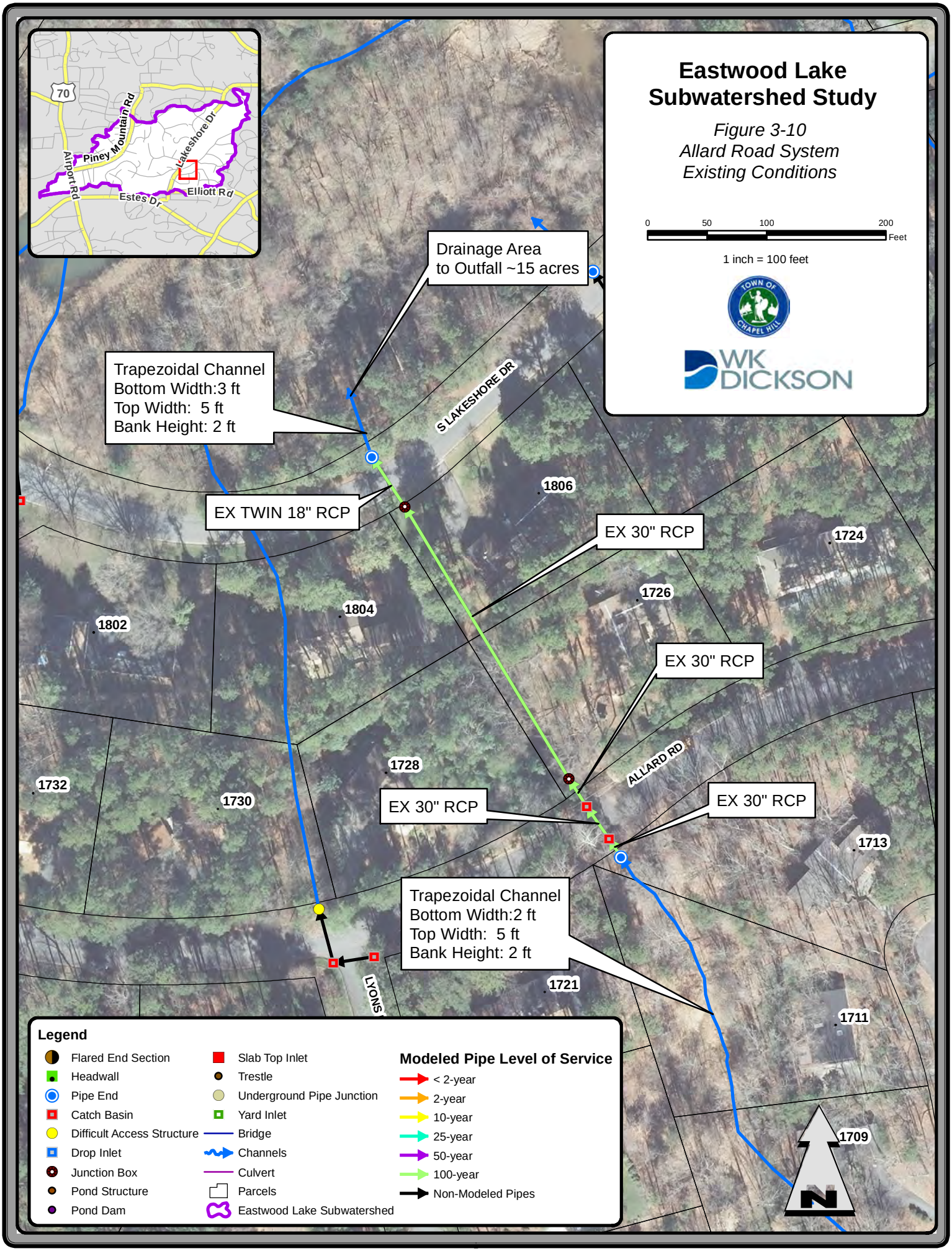
Allard Road System

The Allard Road System collects drainage from approximately 15 acres of the Coker Hills subdivision. It is comprised of 18" and 30" RCPs. The portion of the system being analyzed begins on the upstream side of the Allard Road crossing adjacent to 1713 Allard Road. The conveyance system continues through private properties, 1726 Allard Road and 1806 South Lakeshore Drive, before traversing South Lakeshore Drive (twin 18" RCPs). The system outfalls to an open channel section that discharges to Booker Creek. The open channel upstream of the 30" pipes has streambank erosion.

Figure 3-10 shows the level of service being provided by the existing closed system. The model results show that the existing system is exceeding the desired 10-year level of service.


Eastwood Lake Subwatershed Study
Figure 3-8
South Lakeshore Drive/
Rolling Road System
Existing Conditions
0 50 100 200 Feet
1 inch = 100 feet
Eastwood Lake
70
Piney Mountain Rd
Airport Rd
Lakeshore Dr
Estes Dr
Elliott Rd
Drainage Area to Outfall ~38 acres
Trapezoidal Channel
Bottom Width: 3 ft
Top Width: 8 ft
Bank Height: 3.5 ft
EX 24" RCP
EX 24" HDPVC
ROLLING RD
S LAKESHORE DR
Trapezoidal Channel
Bottom Width: 2.5 ft
Top Width: 5 ft
Bank Height: 2 ft
EX 24" RCP*
1824
1817
1815
1820
1816
1805
1812
1810
1804
1808
1808
1812
1720
Legend
Flared End Section
Headwall
Pipe End
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Pond Structure
Pond Dam
Slab Top Inlet
Trestle
Underground Pipe Junction
Yard Inlet
Bridge
Channels
Culvert
Parcels
Eastwood Lake Subwatershed
Modeled Pipe Level of Service
< 2-year
2-year
10-year
25-year
50-year
100-year
Non-Modeled Pipes
*Unknown Dimensions - Values Assumed
N


Eastwood Lake
Booker Creek
70
Piney Mountain Rd
Lakeshore Dr
Airport Rd
Estes Dr
Elliott Rd
Eastwood Lake Subwatershed Study
Figure 3-9
South Lakeshore Drive
Existing Conditions
0
25
50
100
Feet
1 inch = 50 feet
TOWN OF CHAPEL HILL
WK DICKSON
Drainage Area to Outfall ~2 acres
Trapezoidal Channel
Bottom Width: 6 ft
Top Width: 8 ft
Bank Height: 1.5 ft
S LAKESHORE DR
EX 18" RCP
EX 18" RCP
1808
1806
N
Legend
Flared End Section
Headwall
Pipe End
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Pond Structure
Pond Dam
Slab Top Inlet
Trestle
Underground Pipe Junction
Yard Inlet
Bridge
Channels
Culvert
Parcels
Eastwood Lake Subwatershed
Modeled Pipe Level of Service
< 2-year
2-year
10-year
25-year
50-year
100-year
Non-Modeled Pipes


Eastwood Lake Subwatershed Study
Figure 3-10
Allard Road System
Existing Conditions
0
50
100
200
Feet
1 inch = 100 feet
TOWN OF CHAPEL HILL
WK DICKSON
70
Piney Mountain Rd
Lakeshore Dr
Airport Rd
Elliott Rd
Estes Dr
Drainage Area to Outfall ~15 acres
Trapezoidal Channel
Bottom Width:3 ft
Top Width: 5 ft
Bank Height: 2 ft
S LAKESHORE DR
EX TWIN 18" RCP
EX 30" RCP
EX 30" RCP
EX 30" RCP
EX 30" RCP
ALLARD RD
Trapezoidal Channel
Bottom Width:2 ft
Top Width: 5 ft
Bank Height: 2 ft
LYONS
1802
1804
1806
1724
1726
1728
1730
1732
1713
1721
1711
1709
N
Legend
Flared End Section
Headwall
Pipe End
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Pond Structure
Pond Dam
Slab Top Inlet
Trestle
Underground Pipe Junction
Yard Inlet
Bridge
Channels
Culvert
Parcels
Eastwood Lake Subwatershed
Modeled Pipe Level of Service
< 2-year
2-year
10-year
25-year
50-year
100-year
Non-Modeled Pipes

Curtis Road System

The Curtis Road System collects drainage from approximately 24 acres including a portion of the Lake Forest, Coker Woods West, and Coker Hills subdivisions. The system starts at the intersection of North Elliott Road and Curtis Road. It continues along the Curtis Road ROW crossing Lyons Road, Allard Road, and South Lakeshore Drive. The conveyance system outfalls to an open channel system with a 2-foot high bank, a 3-foot bottom width, and a 6-foot top width. The open channel downstream of Allard Drive has streambank erosion. Ultimately, the Curtis Road System outlets to Booker Creek just upstream of the North Lakeshore Drive bridge. The closed system ranges in size from 15" to 36" RCPs.

Figure 3-11 shows the level of service being provided by the existing closed system. Non-modeled pipes are shown on the figure; however, they were not included in the model because they are outside of the modeling limits for the Curtis Road System. The model results show most of the existing system is operating at or above the desired 10-year level of service. Street flooding at the intersection of South Lakeshore Drive/Curtis Road/Kensington Drive/North Lakeshore Drive has been reported by several residents in the Eastwood Lake subwatershed.

Woodshire Lane/Huntington Drive System

The Woodshire Lane/Huntington Drive System collects drainage from approximately 67 acres including Shadowood Apartments, a portion of Timber Hollow Apartments, Coker Woods West, and Coker Woods subdivisions. The portion of the system being analyzed is comprised of 24" and 48" RCPs. It begins on the upstream side of the Woodshire Lane crossing between 105 and 107 Woodshire Lane. The system alternates between open channel and closed pipe through a common area of Coker Woods, a transmission line easement, and private property along Huntington Drive. The final segment (24" RCP) of the Woodshire Lane/Huntington Drive system crosses Piney Mountain Road before discharging to an open channel section. Ultimately, the system outlets to Booker Creek just upstream of the Piney Mountain Road bridge. The open channel is predominantly located in back yards with limited buffer resulting in streambank erosion along the stream.

Figure 3-12 shows the level of service being provided by the existing closed system. Non-modeled pipes are shown on the figure; however, they were not included in the model because they are outside of the modeling limits for the Woodshire Lane/Huntington Drive System. The model results show the upstream 48" RCPs are performing at the desired 10-year level of service. The lower section of the system, including the Piney Mountain Road crossing is operating at or below a 2-year level of service. The 24" RCP crossing under Piney Mountain Road is significantly smaller than the upstream 48" diameter pipes.

Eastwood Lake Subwatershed Study

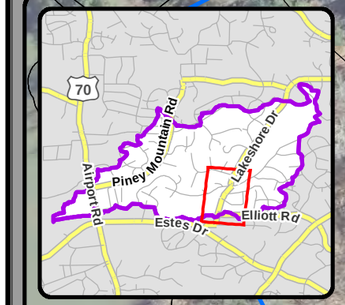
Figure 3-11
Curtis Road System
Existing Conditions

0 75 150 300 Feet

1 inch = 150 feet

TOWN OF CHAPEL HILL

WK DICKSON



Drainage Area to Outfall ~24 acres

EX 36" RCP

EX 30" RCP

EX 30" RCP

EX 36" RCP

EX 18" RCP

EX 18" RCP

EX 18" RCP

EX 18" RCP

EX 18" RCP

EX 15" RCP

EX 15" RCP

Trapezoidal Channel
Bottom Width: 5 ft
Top Width: 12 ft
Bank Height: 5 ft

Booker Creek

S LAKESHORE DR

N LAKESHORE DR

ALLARD RD

LYONS RD

N ELLIOTT RD

ROCK CREEK RD

CROOM CT

CONCORDIA CT

KENSINGTON DR

BEECH TREE CT

ALDRIDGE TRL

CURTIS RD

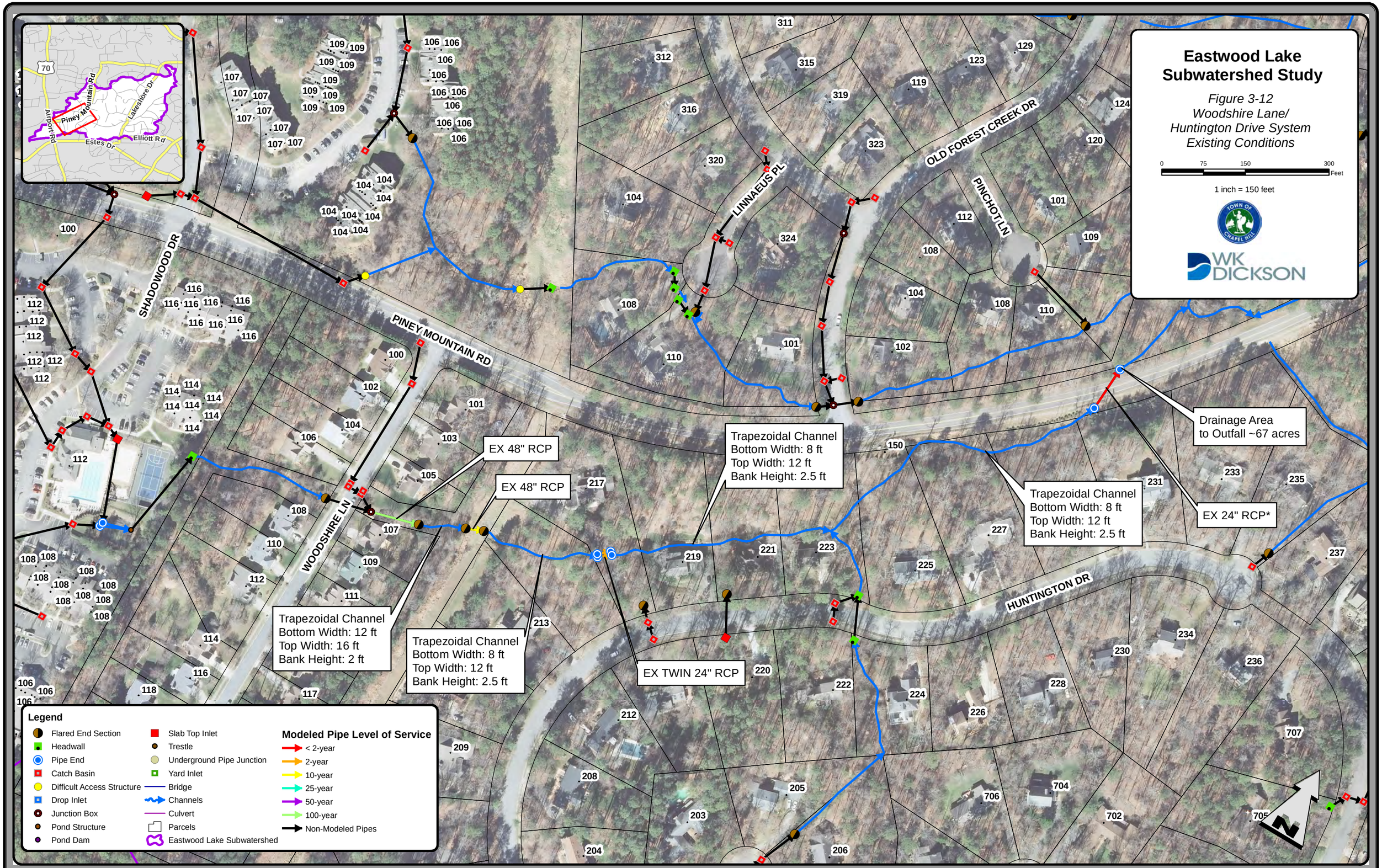
1808 1726 1806 1728 1804 1721 417 405 407 408 402 403 404 406 410 409 411 412 1727 1732 414 1811 1711 600 601 602 603 607 604 614 612 613 1001 623 625 616 1706 1704 1709 1707 1705 1703 611 1701 1603 1601 413 415 1600 410

Legend

- Flared End Section
- Headwall
- Pipe End
- Catch Basin
- Difficult Access Structure
- Drop Inlet
- Junction Box
- Pond Structure
- Pond Dam
- Slab Top Inlet
- Trestle
- Underground Pipe Junction
- Yard Inlet
- Bridge
- Channels
- Culvert
- Parcels
- Eastwood Lake Subwatershed

Modeled Pipe Level of Service

- < 2-year
- 2-year
- 10-year
- 25-year
- 50-year
- 100-year
- Non-Modeled Pipes


Eastwood Lake Subwatershed Study
Figure 3-12
Woodshire Lane/ Huntington Drive System Existing Conditions
0 75 150 300 Feet
1 inch = 150 feet
TOWN OF CHAPEL HILL
WK DICKSON
Drainage Area to Outfall ~67 acres
Trapezoidal Channel Bottom Width: 8 ft Top Width: 12 ft Bank Height: 2.5 ft
EX 24" RCP*
Trapezoidal Channel Bottom Width: 8 ft Top Width: 12 ft Bank Height: 2.5 ft
EX 48" RCP
EX 48" RCP
Trapezoidal Channel Bottom Width: 12 ft Top Width: 16 ft Bank Height: 2 ft
Trapezoidal Channel Bottom Width: 8 ft Top Width: 12 ft Bank Height: 2.5 ft
EX TWIN 24" RCP
PINEY MOUNTAIN RD
SHADOWOOD DR
WOODSHIRE LN
LINNAEUS PL
OLD FOREST CREEK DR
PINCHOT LN
HUNTINGTON DR
Piney Mountain Rd
Lakeshore Dr
Airport Rd
Estes Dr
Elliott Rd
70
Legend
Flared End Section
Headwall
Pipe End
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Pond Structure
Pond Dam
Slab Top Inlet
Trestle
Underground Pipe Junction
Yard Inlet
Bridge
Channels
Culvert
Parcels
Eastwood Lake Subwatershed
Modeled Pipe Level of Service
< 2-year
2-year
10-year
25-year
50-year
100-year
Non-Modeled Pipes
N

3.3 STREAM STABILITY FIELD ASSESSMENTS

The following overview and description of the Little Creek watershed, of which the Eastwood Lake sub-basin is tributary, are excerpted in part from a report by the North Carolina Department of Environment and Natural Resources, *Assessment Report - Biological Impairment in the Little Creek Watershed* (June 2003).

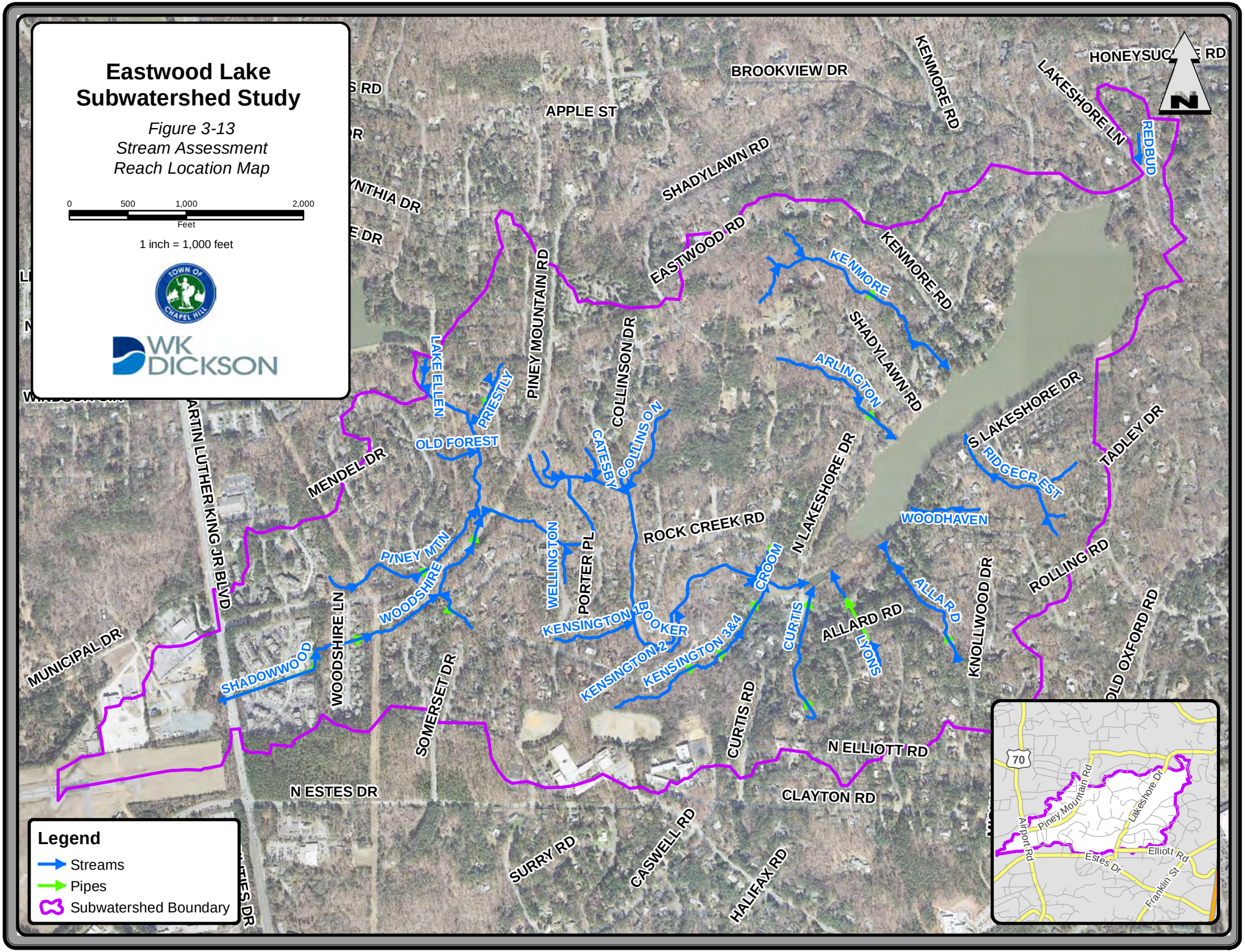
Located in Orange and Durham Counties, Little Creek flows into the New Hope arm of B. Everett Jordan Lake, draining a 24.6-square mile area in subbasin 03-06-06 of the Cape Fear River basin. Two (2) major tributaries, Booker Creek and Bolin Creek, drain the majority of the Little Creek catchment. The watershed includes extensive areas of residential and commercial development, as well as a portion of the campus of the University of North Carolina at Chapel Hill (UNC). As of 1999, impervious areas such as road and buildings covered approximately 15 percent of the study area. The upper three quarters of this area lies in the Carolina Slate Belt, and streams here exhibit the narrow valleys and rocky substrates associated with this geologic zone. Little Creek and the downstream reaches of Booker and Bolin Creek are located in a Triassic Basin and exhibit its characteristic broad floodplains and sandy substrates. Visual assessment suggests that most streams downstream of East Franklin Street were channelized (straightened and dredged) in the past. An Orange Water and Sewer Authority(OWASA) sewer easement follows Booker, Bolin and Little Creeks for much of their lengths.

3.3.1 BOOKER CREEK

The headwaters of Booker Creek rise southwest of the intersection of Martin Luther King Jr. Boulevard (NC 86) and Weaver Dairy Road in Chapel Hill. Booker Creek is joined by two (2) named tributaries: Cedar Fork and Crow Branch. The mainstem of Booker Creek has been dammed to create Lake Ellen (surface area of seven acres, built in 1961) and, further downstream, Eastwood Lake. Unlike Bolin Creek, which drains progressively more developed areas as it flows downstream, most of the Booker Creek watershed is heavily developed.

3.3.2 METHODS

The extent of intermittent and perennial streams was estimated in the Eastwood Lake subwatershed using U.S. Geological Survey (USGS) and Town of Chapel Hill GIS data. The identified reaches were assessed by physically walking the channels and making on-site observations. The goal of the stream walk was to identify points or reaches of streams within the Eastwood Lake subwatershed that may be contributing to the degradation of water quality, aquatic habitat, or stream stability. Stream assessment protocols utilized during the stream walk facilitated the categorization of the types of degradation encountered (e.g., eroding stream banks, eroding stream crossings or outfalls, channel head-cutting, impacted riparian buffers, poor instream habitat, etc.). The total length of stream channel assessed was nearly 32,000 linear feet, or approximately 6 miles (See Figure 3-13).


Eastwood Lake
Subwatershed Study
Figure 3-13
Stream Assessment
Reach Location Map
0
500
1,000
2,000
Feet
1 inch = 1,000 feet
TOWN OF CHAPEL HILL
WK DICKSON
BROOKVIEW DR
APPLE ST
KENMORE RD
LAKESHORE LN
REDBUD
SHADYLAWN RD
EASTWOOD RD
KENMORE
SHADYLAWN RD
ARLINGTON
PINEY MOUNTAIN RD
COLLINSON DR
LAKE ELLEN
PRIESTLY
OLD FOREST
MENDEL DR
MARTIN LUTHER KING JR BLVD
CATESBY
COLLINSON
S LAKESHORE DR
RIDGECREST
TADLEY DR
N LAKESHORE DR
WOODHAVEN
ROCK CREEK RD
PINEY MTN
WELLINGTON
PORTER PL
KENSINGTON 1
BOOKER
KENSINGTON 2
KENSINGTON 3&4
CROOM
CURTIS
ALLARD RD
LYONS
KNOLLWOOD DR
ROLLING RD
OLD OXFORD RD
MUNICIPAL DR
SHADOWWOOD
WOODSHIRE LN
SOMERSET DR
CURTIS RD
N ELLIOTT RD
N ESTES DR
CLAYTON RD
SURRY RD
CASWELL RD
HALIFAX RD
Legend
Streams
Pipes
Subwatershed Boundary
70
Piney Mountain Rd
Lakeshore Dr
Airport Rd
Elliott Rd
Estes Dr
Franklin St

As with the Lower Booker Creek subwatershed, two (2) assessment protocols were used to evaluate stream stability and stream and riparian corridor habitat. The first, focusing mainly on stream stability, was drawn from the *Unified Stream Assessment (USA) protocol, Manual 10,* a rapid assessment technique developed by the Center for Watershed Protection, to locate and evaluate problems and restoration opportunities within an urban stream corridor. The other protocol used was taken from the *EPA's Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish* (1999). Specifically, the Habitat Assessment and Physicochemical Parameters methodology described in this protocol was used. It focuses on stream and riparian buffer habitat quality, and utilizes visual observations recorded in the field. The paper forms from both these protocols were converted into electronic forms, and descriptive data, assessment scores, photographs and GPS locations were recorded in the field using electronic tablets.

3.3.3 UNIFIED STREAM ASSESSMENT (USA)PROTOCOL DESCRIPTION

Two (2) general types of data were collected for the USA assessment – reach (or stream segment) data and point data.

A separate form was used to document details of each of the following stream/watershed attributes for the USA assessments.

Form No.	Attribute Type	Attribute
1	Point	Stormwater outfalls - 12" and greater, unless smaller outfalls were encountered that were degrading water quality and needed to be documented
2	Point	Severe erosion - using visual estimates
3	Point	Impacted buffers
4	Point	Utilities in the stream corridor
5	Point	Stream crossings, including roadways and pedestrian paths
6	Reach	Reach level assessment

Reach data were generated for sections of stream that exhibited similar channel geomorphology, stability, or erosion characteristics. Consequently, stream segments of varying lengths were delineated in the field and existing conditions were recorded (Form 6). The data recorded on the actual forms included descriptive data, such as surrounding land use, size of dominant channel substrate, stream shading, and approximate bank heights. It also included numerical rating scores, ranging from 0-10 points for each bank, and 0-20 points for overall stream condition characteristics such as:

- Reach accessibility
- In-stream habitat
- Vegetative protection
- Bank erosion
- Floodplain connection

- Vegetated buffer width
- Floodplain vegetation
- Floodplain encroachment

Within each delineated reach, point data were recorded on separate forms (Forms 1 – 5) for each occurrence when one of the following attributes was observed:

- Stormwater outfalls greater than 12" in diameter, or smaller diameter outfalls that appeared to be impacting water quality
- Severe bank erosion
- Impacted buffers
- Utility impacts, such as sewer line crossings
- Stream crossings, such as roads

Point data forms included both descriptive data and numerical data. For stormwater outfalls (Form 1), descriptive data included on which side of the stream the outfall was located, the type of pipe and its material, its shape, condition, and descriptive characteristics of the pipe and flow such as odor, the presence of deposits or stains, and if benthic growth was present. The form also included a numeric evaluation of outfall discharge severity, from 0-5 points, that described the outfall discharge or flow color and smell.

In addition to descriptive and numerical data recorded for the USA assessment, GPS coordinates and a photo log of data collection locations were included also.

3.3.4 EPA RAPID BIOASSESSMENT PROTOCOL (RBP) DESCRIPTION

The Eastwood Lake subwatershed assessment also applied the Habitat Assessment and Physicochemical Parameters data collection methodology, from the EPA Rapid Bioassessment Protocol. The form for high gradient streams (mountain or piedmont regions) was used (Appendix K). Habitat attribute data collected, based on the RBP, included:

1. Epifaunal substrate/available cover
2. Embeddedness
3. Velocity/depth regime
4. Sediment deposition
5. Channel flow status
6. Channel alteration
7. Frequency of riffles/bends
8. Bank stability
9. Bank vegetative protection
10. Buffer width/condition

Each of the first seven (7) attributes were scored employing a point range of zero (0) to twenty (20) that the assessor could use to estimate the quality of that attribute observed, from poor (0) to optimal (20). The remaining three (3) attributes were assessed using point ranges from

one (1) to ten (10) (poor [1] - optimal [10]). For each reach, a habitat assessment score was generated, based on the points scored for each of the attributes.

Using both of the assessment protocols during the stream walks facilitated:

1. The documentation of observable stream channel and riparian buffer conditions along the targeted reaches.
2. Identification of stream channel and riparian buffer problem areas, such as high erosion areas or degraded outfalls, a description of the severity of the problem, and information that will help inform recommendations for correcting problems.
3. Compilation of sufficient data so that problems and potential solutions can be prioritized.

3.3.5 RESULTS AND DISCUSSION

The Eastwood Lake subwatershed was divided into forty-seven (47) individual reaches, based on

observations made in the field during stream assessment data collection and relatively similar channel characteristics. The scores for each reach were tabulated in the field for the USA stream stability and EPA habitat assessments.

USA Stream Stability Scores

There are four "Overall Stream Condition" categories for each parameter assessed in the USA Stream Stability protocol - Optimal, Suboptimal, Marginal, and Poor. The total maximum score for the USA stream stability protocol is 160 points. The point ranges for the respective categories are as follows:

Category	Point Range
Poor	0-47
Marginal	48-90
Suboptimal	91-133
Optimal	134-160

The protocol instructs users to compare the score of their project reaches to a "reference stream" or stable, high quality stream. A reasonable range for stream stability scores for a stable reference stream is 126-148 points, which encompasses the upper scores in the Suboptimal category, through the Optimal range.

The stability scores recorded in the field in the Eastwood Lake subwatershed ranged from 39-138 points, with a mean of 94.5 points. A summary of stream stability score statistics is included in Table 3-4.

Table 3-4: Statistical Summary of USA Stream Stability Scores

Mean	94.5
Standard Error	3.6
Median	91
Standard Deviation	25
Range	99
Minimum	39
Maximum	138
Number of Reaches	47

The average score of 94 points falls in the lower range of the suboptimal category, which in a highly developed watershed, is not unexpected. The wide range of scores, 39-138, indicates that there are streams in poor condition, but that there are also reaches that are in relatively stable and good condition.

The next step in the analysis process was to group the stream segments into low, medium and high score groups based on their respective score within the range of scores recorded in the field. The Jenks-Natural Breaks algorithm or method, a component of the ESRI GIS software, was used to determine the ranges.

From the ESRI ArcView website, the description of how the Jenks-Natural Breaks algorithm works is as follows. "Classes [or low, medium and high score groups for the stream stability scores] are based on natural groupings inherent in the data. ArcMap identifies break points by picking the class breaks that best group similar values and maximize the differences between classes. The features are divided into classes whose boundaries are set where there are relatively big jumps in the data values." And from the ESRI GIS Dictionary, the Jenks-Natural Breaks algorithm is described as follows: "A method of statistical data classification that partitions data into classes using an algorithm that calculates groupings of data values based on the data distribution. Jenks' optimization seeks to reduce variance within groups and maximize variance between groups."

The ranges for stream stability scores generated by the Jenks-Natural Breaks algorithm were:

Group	Range	Number of Reaches in Range	Total Length (ft)
Low	39-76	13 reaches	6,346
Medium	77-100	15 reaches	11,915
High	101-138	19 reaches	13,719
			Total: 31,980

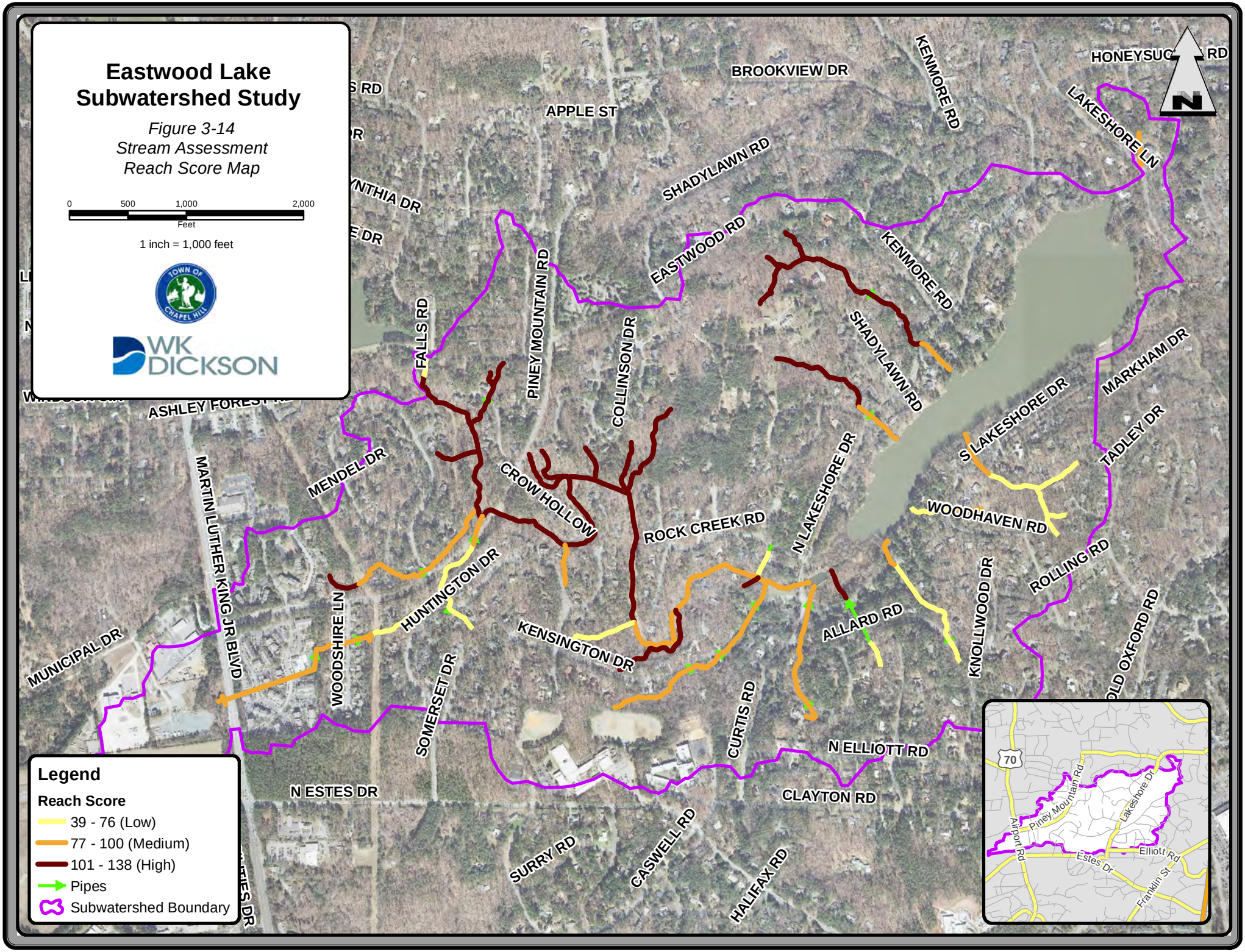
The reaches, color-coded by group, are illustrated in Figure 3-14. Approximately 20% of the total subwatershed stream length are in the Low group, approximately 37% are in the Medium group, and approximately 43% are in the High group.

From Figure 3-14, the distribution of low, medium and high scoring reaches is spread relatively evenly across the subwatershed, with no apparent pattern for any of the groups, except for the similarity in distribution of ratings with the habitat scores. The similarities in habitat and stability ratings for the streams indicate the close association aquatic habitat has with stream stability.

Not surprisingly, a comparison of the habitat and stability scores by reach confirms that in general, better habitat exists where there is higher stream stability. The absence of good habitat in less stable reaches provides an opportunity to improve habitat, and potentially improve water quality assessment scores that could move surface water in the watershed towards meeting compliance standards.

During the field survey, fourteen (14) reaches or sections of stream in the Eastwood Lake subwatershed were identified as candidates for stabilization, restoration, buffer improvements or a combination of these. These sites are at the field-identification stage, with design specifics evolving with future onsite analysis. Although not a part of this analysis, the low stability reach locations may be cross-referenced with parcel data to determine where low stability reaches intersect with HOA property to identify possible riparian buffer restoration projects.

The reaches identified as candidates for improvements are described in more detail in Section 6.1.


Eastwood Lake
Subwatershed Study
Figure 3-14
Stream Assessment
Reach Score Map
0
500
1,000
2,000
Feet
1 inch = 1,000 feet
WK DICKSON
BROOKVIEW DR
APPLE ST
KENMORE RD
LAKESHORE LN
SHADYLAWN RD
EASTWOOD RD
PINEY MOUNTAIN RD
FALLS RD
COLLINSON DR
MARKHAM DR
TADLEY DR
S LAKESHORE DR
N LAKESHORE DR
WOODHAVEN RD
ROLLING RD
KNOLLWOOD DR
ASHLEY FOREST RD
MENDEL DR
MARTIN LUTHER KING JR BLVD
CROW HOLLOW
ROCK CREEK RD
HUNTINGTON DR
WOODSHIRE LN
KENSINGTON DR
ALLARD RD
MUNICIPAL DR
SOMERSET DR
CURTIS RD
N ELLIOTT RD
N ESTES DR
CLAYTON RD
SURRY RD
CASWELL RD
HALIFAX RD
Legend
Reach Score
39 - 76 (Low)
77 - 100 (Medium)
101 - 138 (High)
Pipes
Subwatershed Boundary
70
Piney Mountain Rd
Lakeshore Dr
Airport Rd
Elliott Rd
Estes Dr
Franklin St

EPA Habitat Assessment Scores

The EPA Habitat Assessment and Physiochemical Parameters methodology protocol utilized does not require comparison of scores to a reference reach score range. Alternatively, there are four "Condition" categories for each parameter assessed in the protocol; they are the same as those used in the USA Stream Stability protocol - Optimal, Suboptimal, Marginal, and Poor. The total maximum score for the EPA protocol is 200 points. The point ranges for the respective categories is as follows:

Category	Point Range
Optimal	166-200
Suboptimal	103-165
Marginal	60-102
Poor	0-59

The stability scores recorded in the field in the Eastwood Lake subwatershed ranged from 48-169 points, with a mean of 113.3 points. A summary of stream stability score statistics is included in Table 3-5.

Table 3-5: Statistical Summary of EPA Habitat Assessment Scores

Mean	113.3
Standard Error	34.1
Median	117
Standard Deviation	27.9
Range	121
Minimum	48
Maximum	169
Number of Reaches	47

The average score of 113 points falls is just above the mid-point of the total point scale and falls within the lower 25% of the suboptimal category, reflecting the high level of development present in the subwatershed. The wide range of scores, 48-169, indicates that there are streams in poor condition, but that there are also areas that are stable and in good condition, as were documented with the reach stability scores.

It is important to note that piped sections of stream in the Shadowwood (approximately 850 feet) and Lyons (approximately 250 feet) reaches were not included in the Jenks-Natural Breaks categorization procedure. This was because, based on the protocol, it was determined that their habitat scores were essentially zero. If these reaches are included in the habitat analysis, they skew the resulting grouping values downward substantially and bias the assessment of the majority of the subwatershed's channel length, which is not piped.

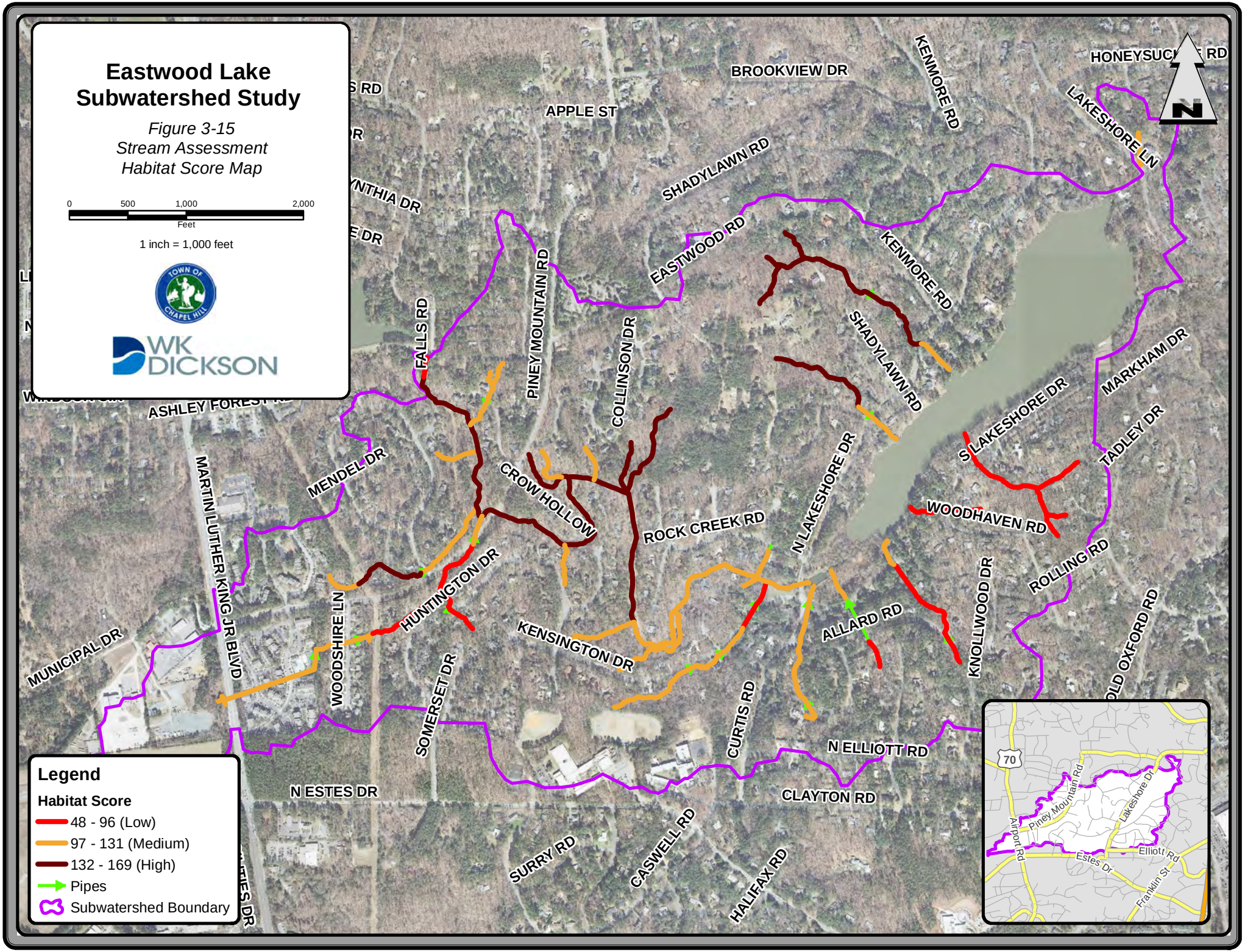
The ranges for habitat scores generated by the Jenks-Natural Breaks algorithm were:

Group	Range	Number of Reaches in Range	Total Length (ft)
Low	48 – 96	14 reaches	6,471*
Medium	97 – 131	22 reaches	14,637
High	132 – 169	11 reaches	10,872
			Total: 31,980

*Piped stream sections not include in length.

The reaches, color-coded by group, are illustrated in Figure 3-15.

From Figure 3-15, no distinct patterns are evident in the distribution of Low, Medium and High scoring reaches across the subwatershed. However, based on the scores, the large impervious surface area associated with the apartment complex on Martin Luther King, Jr. Boulevard apparently has affected the aquatic habitat in the unnamed tributary flowing from the Carolina North property to Booker Creek. The low scores associated with the tributaries to the west of Eastwood Lake, that flow down very steep slopes, suggest that they are impacted by the combination of stormwater runoff generated by development and the steep topography. There is a long section of Booker Creek channel in the upper part of the subwatershed that is rated High, and downstream of it the largest group of Medium rated channel occurs, upstream of Eastwood Lake. There is a relatively short but very incised and eroded section of channel located upstream of this High-rated reach, just downstream of Lake Ellen. There is a continuing source of a large amount of sediment from the high, collapsing stream banks that have developed from erosion in this location.


Eastwood Lake
Subwatershed Study
Figure 3-15
Stream Assessment
Habitat Score Map
0
500
1,000
2,000
Feet
1 inch = 1,000 feet
WK DICKSON
BROOKVIEW DR
APPLE ST
KENMORE RD
HONEYSUCKLE RD
LAKESHORE LN
SHADYLAWN RD
EASTWOOD RD
KENMORE RD
FALLS RD
PINEY MOUNTAIN RD
COLLINSON DR
SHADYLAWN RD
MARKHAM DR
S LAKESHORE DR
TADLEY DR
ASHLEY FOREST RD
MENDEL DR
MARTIN LUTHER KING JR BLVD
CROW HOLLOW
ROCK CREEK RD
N LAKESHORE DR
WOODHAVEN RD
ROLLING RD
HUNTINGTON DR
WOODSHIRE LN
KENSINGTON DR
ALLARD RD
KNOLLWOOD DR
OLD OXFORD RD
MUNICIPAL DR
SOMERSET DR
CURTIS RD
N ELLIOTT RD
N ESTES DR
CLAYTON RD
SURRY RD
CASWELL RD
HALIFAX RD
Legend
Habitat Score
48 - 96 (Low)
97 - 131 (Medium)
132 - 169 (High)
Pipes
Subwatershed Boundary
70
Piney Mountain Rd
Lakeshore Dr
Airport Rd
Elliott Rd
Estes Dr
Franklin St

3.4 OUTFALL ANALYSIS

A desktop assessment was conducted for the Eastwood Lake subwatershed to evaluate stormwater outfalls for retrofit potential. The assessment involved automated processes performed with GIS, as well as application of engineering judgment to screen and prioritize outfalls with the highest potential for retrofitting. The results of the analysis are intended to guide future field evaluation efforts by directing attention to outfalls for which retrofitting is likely feasible, complexity, costs and impacts are minimized, and benefits are maximized. The analysis evaluated factors including hydraulics, access, earthwork requirements, property ownership, impacts to utilities, traffic, and existing forested areas, as well as the benefits of impervious area treated and subwatershed treatability. Additional validation was provided through comparison of information gathered on specific outfalls from the physical stream assessment that took place in the watershed. Retrofitting existing outfalls is one of several strategies often implemented as part of a comprehensive watershed restoration plan. Providing detention and/or treatment for stormwater at an outfall can reduce pollutant loads and improve downstream hydrology.

3.4.1 PROCESS

The desktop assessment followed a four-step process. The first step established the dataset of outfalls to consider for analysis. The second step analyzed each outfall for a set of evaluation factors. The third step involved scoring the outfalls based on a system of points assigned to each evaluation factor and creating a prioritized list. Field work and public input identified two (2) additional sites that were added to the outfalls prioritized list. The final step was to produce summary profiles for the top ten (10) scoring outfalls and the two (2) added opportunities.

To ensure quality assurance and verify the scoring process, over ten percent of the outfalls analyzed were independently verified. Further, the outfall opportunities comprising the top quartile of ranked sites were field verified.

The following sections describe the first three steps of the process. The results section, Section 3.4.2, provides the full list of prioritized outfalls as well as the summary profiles for the top outfalls identified by this process.

Dataset of Outfalls for Analysis

GIS data documenting the location of storm sewer system pipes and outfalls were collected as part of the stormwater inventory. The initial dataset containing 204 pipe ends was sorted to include only pipe ends designated as "outgoing" or "ingoing." "Ingoing" outfalls were not explicitly included in the analysis; however, in specific instances retrofits were investigated or sited at "ingoing" outfall. The resulting outfalls were then visually evaluated to exclude those serving as the downstream end of a single segment culvert.

Additionally, certain outfalls serving as a pass-through for perennial stream flows were excluded. This was determined by outfall location along a stream line, the presence of an upstream "incoming" pipe end along the same stream line, and stream order combined with pipe diameter.

Stream order is the commonly used classification system of stream channels, where the uppermost perennial streams in a watershed are classified as first order. When two first order streams flow together, the stream classification becomes second order, and when two second order streams flow together the classification becomes third order, etc. For pass-through outfalls along first order streams, the outfalls were included in the analysis. All pass-through outfalls along second order streams were excluded. The final dataset analyzed included 141 "outgoing" and "ingoing" outfalls.

Evaluation Factors and Outfall Analysis

A set of evaluation factors was developed in order to score and prioritize the outfalls. The factors were selected to consider feasibility, complexity, costs, impacts, and benefits of each potential outfall retrofit and include:

- Hydraulics Feasibility
- Need for Additional Infrastructure
- Accessibility
- Property Ownership
- Earthwork
- Utility Conflicts
- Traffic Impacts
- Tree Impacts
- Impervious Cover Treated
- SCM Area to Drainage Area Ratio

The first screening evaluation factor, Hydraulic Feasibility, is a fatal flaw test. If an outfall fails this factor, it is excluded from further analysis. A description of each factor is provided along with details of how the factor was evaluated in Table 3-6.

Table 3-6: Factor Description and Evaluation

Hydraulic Feasibility Hydraulic feasibility looks at whether diversion or redirection of flow to an outfall retrofit is possible/practical. Hydraulic feasibility is evaluated by engineering judgment based on outfall invert elevation and surrounding elevations, constraints on the SCM footprint placement, and any other aspects of the outfall hydraulics which may make retrofitting the outfall infeasible. This factor is assigned a result of either feasible or infeasible. Analysis continues for feasible outfalls. Outfalls determined to be infeasible for retrofitting are excluded from further analysis and a note is made documenting the reason for infeasibility.
Additional Infrastructure Additional infrastructure looks at the how flow will be diverted from the outfall to the SCM. This factor relates to complexity and cost with retrofits requiring additional infrastructure to be more complex and likely more costly. This factor is evaluated by approximating the distance from the outfall to the SCM footprint into three categories: 0 ft, <100ft, and >100ft.

Accessibility

Accessibility looks at the relative ease of accessing the site for retrofit construction and maintenance. This factor is related to complexity, costs, and impacts. Accessibility is evaluated by engineering judgment and divided into three categories: Easy, Medium, and Hard. Looking at the most likely access route to the SCM footprint the following aspects are considered:

1. Is distance to the SCM over 100-ft from access point?
2. Is access over steep terrain?
3. Will access result in additional tree impacts?
4. Will access require a property agreement separate from the SCM footprint agreement?

If the answer to all the above questions is no, then access is rated as easy. A positive answer to one of the questions results in a rank of medium. A positive answer to two or more questions results in a rank of hard. If access is through an existing cleared easement, questions 3 and 4 are not considered.

Property Ownership

Property ownership looks at the type of entity that owns the land where the SCM footprint would be located. This factor is related to complexity and cost with retrofits on private lands likely requiring additional efforts and costs to develop agreements with the landowner(s) compared with public lands. This factor is evaluated by identifying the parcel(s) that contain the SCM footprint and the associated owner. Property ownership is assigned into one of six categories: Public, Rights-of-Way (ROW), Commercial, Homeowners' Association (HOA), Mixed (any combination of the other categories), Private Residential. While commercial, HOA and mixed are recorded as different categories, they are scored the same as described in the following section.

Earthwork

Earthwork looks at the amount of excavation that will be required to implement an outfall retrofit SCM. This factor relates to feasibility and cost with greater excavation resulting in higher costs. It is evaluated using ArcGIS to calculate the average elevation of the SCM footprint. The diversion elevation is then subtracted from the calculated average and the difference recorded as the result. The larger the number, the more excavation is required, driving cost higher, and lowering the category score.

Utilities

Utilities look at the possibility of impacts to existing utilities including water, sewer, telecom, optic fiber and overhead electrical. This factor relates to impacts, complexity, and cost with outfall retrofits impacting utilities likely to be more complex and more costly to implement. Utility impacts are evaluated by engineering judgment and divided into three categories: None, Possible, and Expected. An outfall is designated as having Expected utility impacts when the SCM footprint or additional infrastructure overlays a utility. Impacts are classified as Possible if the SCM footprint is within 5-ft of a utility or the access path crosses overhead electrical. Otherwise, impacts are classified as None.

Traffic

Traffic looks at the possibility of impacts to traffic patterns during outfall retrofit construction. This factor relates to impacts, complexity, and cost with outfall retrofits impacting traffic likely to be more complex and more costly to implement. Traffic impacts are evaluated by engineering judgment and divided into three categories: Low, Medium, and High. An outfall is designated as having High traffic impacts if access to the SCM footprint would require altering existing traffic patterns on a public, non-residential street. Impacts are classified as Medium when access to the SCM footprint would require altering existing traffic patterns on a private or residential street. Otherwise, impacts are classified as Low.

Tree Impacts

Tree impacts look at the loss of trees that would result from clearing and grubbing to implement the outfall retrofit. This factor relates to feasibility, impacts, and complexity with more opposition anticipated for outfall retrofits impacting more trees. Tree impacts are evaluated by engineering judgment to estimate the percent of tree cover within the SCM footprint and divided into three categories: Minimal, Moderate, and Significant. Impacts of less than or equal to 30% of the tree cover are classified as Minimal. Impacts between 30% and 70% are classified as Moderate and impacts greater than or equal to 70% are classified as Significant.

Impervious Cover Treated

Impervious cover treated looks at the area of impervious surface within the drainage area to the outfall. This factor relates to benefits with outfall retrofits treating more impervious cover being more desirable. This factor is evaluated using ArcGIS to delineate the drainage area and then calculate the impervious cover within the drainage area. The area in acres is recorded as the result.

SCM Area to Drainage Area Ratio

The SCM area to drainage area ratio looks at treatability. The ratio approximates the extent to which the outfall retrofit can receive and treat the water quality volume from the watershed. This factor relates to feasibility and benefits of the outfall with a higher ratio being more desirable. This factor is evaluated using ArcGIS to delineate and calculate the drainage area in acres and as well as the area of the SCM footprint in acres. The ratio is recorded as the result.

Outfalls were analyzed in a systematic way to assess the information required to make a determination for each evaluation factor. For each outfall, a map was developed showing relevant information such as outfall invert, upstream pipe network, elevation contours, property ownership of surrounding properties (within a 100-foot radius of each outfall), utilities, upstream pipe slope, and aerial imagery. This map was then used to carry out an initial desktop engineering evaluation.

The engineering evaluation first screened for hydraulic feasibility. For all outfalls deemed feasible, a stormwater control measure retrofit footprint was then sketched and a likely access path drawn. The following principles guided the siting of proposed SCM footprint.

1. Steep areas should be avoided in favor of flatter areas. Generally, the proposed retrofit footprint should span only 1-2 of the 2-foot contours.
2. While a proposed retrofit may be placed in a floodplain, a 30-foot offset from the stream bank should be maintained.

3. Proposed retrofit should avoid utilities as much as possible.
4. No proposed retrofit should average more than 15 feet higher than the invert of the stormwater pipe at the diversion point (i.e., the elevation and location where flow is split and the design volume is diverted to the treatment SCM).
5. The retrofit footprint area should be limited to a maximum of 4-5% of the contributing drainage area.

Once the footprint and access were drawn, the following information was assessed and recorded:

- Proposed diversion invert
- Distance from diversion point to retrofit footprint
- Access: distance, steepness, tree cover, property ownership
- Property ownership
- Location of utilities in relationship to footprint and access
- Potential traffic impacts at access point
- Percent tree coverage in SCM footprint
- Pipe slope of the immediately upstream pipe segment
- Other notes including if the outfall is located near an existing SCM, and any other significant aspects relating to the outfall not otherwise recorded.

Following the engineering evaluation, the footprint was digitized in ArcGIS. Geoprocessing was used to calculate the area of the retrofit footprint, average elevation of the retrofit footprint, drainage area to the outfall, and impervious cover within the drainage area.

Together the desktop engineering evaluation and ArcGIS geoprocessing provided all necessary information to make a determination for each factor.

Outfall Scoring Points System

To develop the system for scoring the outfalls, factors were first assigned to a tier. Tier assignment was based on evaluating the relative importance of the factor in determining the potential for retrofitting. Tier 1 factors were most important and each allotted a possible fifteen (15) points. Next, Tier 2 factors were allotted a possible twelve (12) points each, and finally Tier 3 factor point ranges varied from ten (10) to two (2) points maximum. The total points possible is 100. Factors and the point system are shown in Table 3-7 along with how the points are divided among categories. For two Tier 1 factors and a Tier 2 factor for which specific numeric values were calculated rather than using pre-established thresholds, categories are based on the distribution of values within the dataset (Top third, Middle third, Bottom third) to allow for more direct comparison between outfall retrofit opportunities. Also, hydraulic feasibility is not assigned to a tier or allotted points as it is the initial screening factor.

Table 3-7: Factors and Scoring

Factor	Points Possible	Scoring Division	Points by Category
Hydraulic Feasibility	**NA**	Feasible	Continue
		Infeasible	Stop
Tier 1			
Earthwork	**15**	Top third	15
		Middle third	10
		Bottom third	5
Accessibility	**15**	Easy	15
		Medium	10
		Hard	5
SCM Area to Drainage Area Ratio	**15**	Top third	15
		Middle third	10
		Bottom third	5
Tier 2			
Property Ownership	**12**	Public	12
		ROW	10
		HOA or Commercial or Mixed	8
		Private Residential	4
Impervious Cover Treated	**12**	Top third	12
		Middle third	8
		Bottom third	2
Utilities	**12**	None	12
		Possible	8
		Expected	4
Tier 3			
Tree Impacts	**10**	Minimal, <=30% forested	10
		Moderate, >30%, <=70%	5
		Significant >70%	2
Additional Infrastructure	**5**	No	5
		Yes, <100ft	3
		Yes, >100ft	2
Traffic	**4**	Low	4
		Medium	2
		High	0
Total Points Possible	**100**		

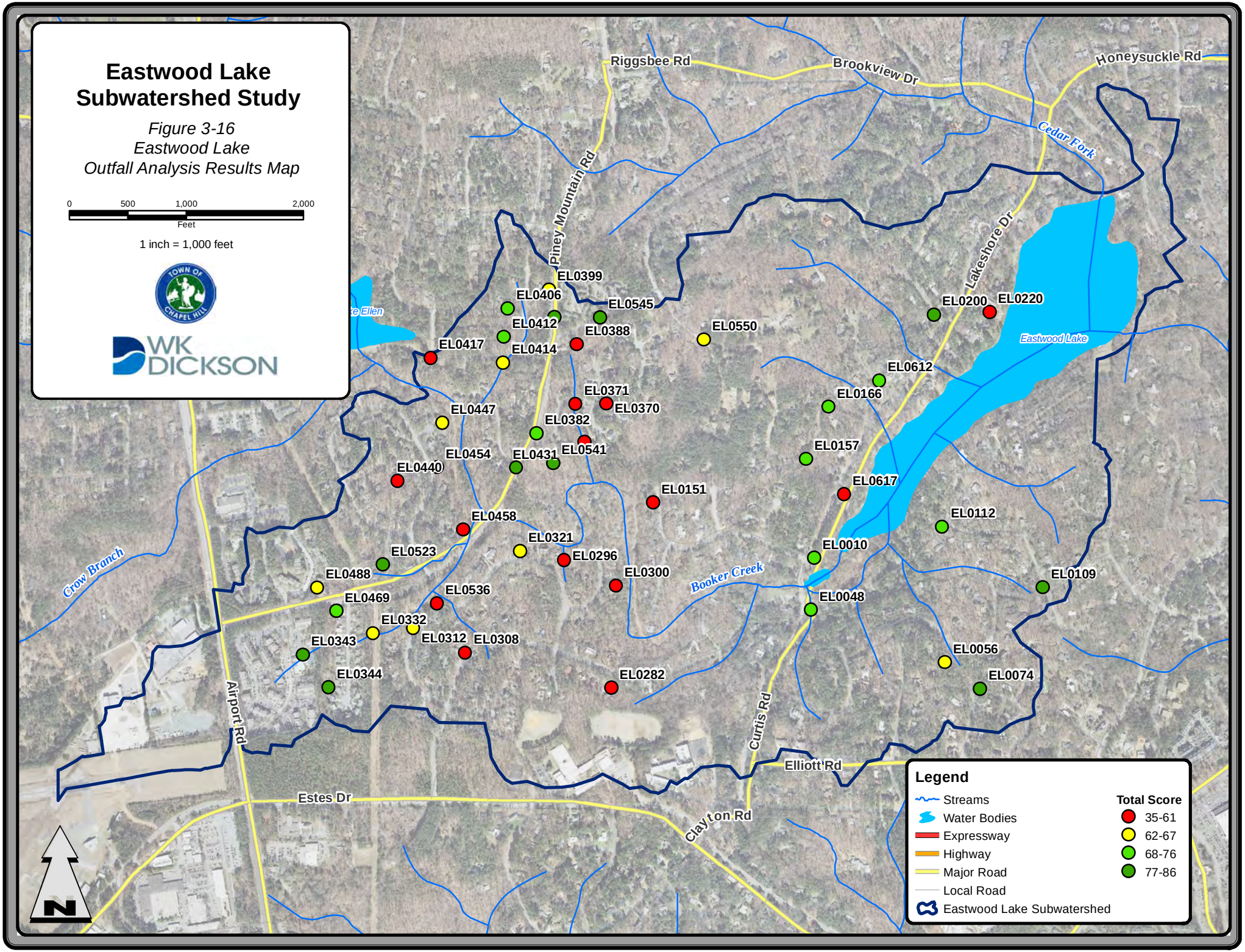
3.4.2 RESULTS

The analysis protocol was applied to the full set of 141 outfalls in Eastwood Lake subwatershed. Of the 141 outfalls, ninety-seven (97) were deemed to be infeasible due to hydraulic feasibility and thus dropped from further consideration. The remaining forty-four (44) outfalls were analyzed and ranked. Scores ranged from thirty-five (35) to eighty-six (86) and were statistically broken into quartiles (See Table 3-8 and Figure 3-16). The top ten (10) sites, representing the top quartile, were field verified to screen for fatal flaws not considered in the desktop analysis due to the limitations inherent to that process.

In addition to the top ten (10) sites identified by this analysis, two (2) additional sites (EL0157/EL0162 and EL0520) identified during the field review and public input processes are considered suitable candidates based on additional information gathered. Individual maps for the highest-ranking outfalls, after further individual analysis and refinement, are provided in Section 6.2.1.

Table 3-8: Summary Ranking of Outfalls for Eastwood Lake

	Earthwork	Retrofit Area to Drainage Area Ratio	Accessibility	Property Ownership	Impervious Cover Treated	Utilities	Tree Impacts	Additional Infrastructure	Traffic	Total Score
EL0431	15	15	15	10	4	12	10	5	0	86
EL0389	15	10	10	10	8	12	10	5	2	82
EL0541	10	15	15	10	4	12	10	5	0	81
EL0109	15	15	15	10	4	8	10	3	0	80
EL0343	15	5	15	4	12	12	10	5	2	80
EL0344	15	5	15	4	12	12	10	5	2	80
EL0074	15	10	15	8	12	12	2	3	2	79
EL0545	10	15	15	4	4	12	10	5	4	79
EL0200	10	15	15	10	4	8	10	5	0	77
EL0523	15	15	15	4	4	12	5	5	2	77
EL0010	15	15	15	8	4	12	2	3	2	76
EL0412	15	5	15	10	12	8	5	5	0	75
EL0382	15	15	15	10	4	8	2	5	0	74
EL0112	10	10	15	10	4	8	10	5	0	72
EL0469	15	10	10	8	8	12	2	5	2	72
EL0048	10	10	10	8	12	12	2	3	4	71
EL0157	5	15	10	8	12	12	2	5	2	71
EL0166	5	10	15	10	4	12	10	5	0	71
EL0612	5	15	15	10	8	2	10	5	0	70
EL0406	10	5	15	10	8	8	10	3	0	69
EL0332	10	5	15	8	8	12	2	3	4	67
EL0454	15	5	5	8	12	12	5	3	2	67
EL0488	10	5	10	8	12	12	2	5	2	66
EL0447	15	10	5	8	8	12	2	3	2	65
EL0056	5	15	15	4	8	8	2	3	4	64
EL0414	5	5	15	10	12	12	2	3	0	64
EL0312	10	10	10	4	8	12	2	5	2	63
EL0321	10	10	10	4	8	12	2	5	2	63
EL0399	10	10	10	10	4	12	2	5	0	63
EL0550	10	5	15	4	4	8	10	5	2	63
EL0220	15	5	10	4	8	2	10	5	2	61
EL0388	5	15	10	10	4	8	2	3	2	59
EL0458	5	15	10	4	4	12	2	5	2	59
EL0380	15	5	10	4	4	12	2	3	2	57
EL0371	15	5	5	4	8	12	2	3	2	56
EL0300	5	15	5	4	8	12	2	2	2	55
EL0417	10	10	10	4	8	8	2	3	0	55
EL0151	5	15	10	4	8	2	2	5	2	53
EL0296	10	5	10	4	12	2	2	5	2	52
EL0617	5	5	10	4	12	8	2	2	2	50
EL0370	5	5	5	4	12	12	2	3	2	50
EL0440	10	10	5	4	4	8	2	5	2	50
EL0536	5	5	10	4	4	12	2	5	2	49
EL0308	10	10	5	4	8	2	2	3	2	46
EL0282	5	10	5	4	4	0	2	3	2	35


Eastwood Lake
Subwatershed Study
Figure 3-16
Eastwood Lake
Outfall Analysis Results Map
0
500
1,000
2,000
Feet
1 inch = 1,000 feet
TOWN OF CHAPEL HILL
WK DICKSON
Riggsbee Rd
Brookview Dr
Honeysuckle Rd
Cedar Fork
Piney Mountain Rd
Lakeshore Dr
Eastwood Lake
Crow Branch
Booker Creek
Airport Rd
Estes Dr
Clayton Rd
Curtis Rd
Elliott Rd
EL0399
EL0406
EL0545
EL0412
EL0388
EL0550
EL0200
EL0220
EL0417
EL0414
EL0612
EL0166
EL0371
EL0370
EL0447
EL0382
EL0541
EL0157
EL0454
EL0431
EL0440
EL0617
EL0151
EL0112
EL0458
EL0321
EL0010
EL0523
EL0296
EL0488
EL0300
EL0109
EL0536
EL0048
EL0469
EL0332
EL0312
EL0308
EL0343
EL0056
EL0344
EL0282
EL0074
Legend
Streams
Water Bodies
Expressway
Highway
Major Road
Local Road
Eastwood Lake Subwatershed
Total Score
35-61
62-67
68-76
77-86
N

3.5 NEIGHBORHOOD ANALYSIS

A desktop assessment was conducted on the Eastwood Lake subwatershed to evaluate single-family neighborhoods for green infrastructure retrofitting potential. The focus of the desktop analysis was on opportunities within the rights-of-way. Identifying individual lot opportunities such as downspout disconnection or driveway retrofits was not carried out, as these are better suited for windshield or related field investigations. Using GIS data provided by the Town of Chapel Hill and other sources, forty-nine (49) neighborhoods throughout the entire Booker Creek watershed were evaluated based on the following physical parameters: average lot size, road slope, road width, total road length and rights-of-way width (See Table 3-9). These parameters were chosen to identify neighborhoods that provide the greatest potential for green infrastructure projects. Representative projects that can be implemented at the neighborhood scale within the rights-of-way include vegetated swales (aka bioswales), rain gardens, permeable pavement/pavers, and bioretention cells. These stormwater control measures slow down and treat the stormwater runoff from the roadways, driveways and other impervious surfaces. They provide habitat to important pollinator species and birds, and they can be used for neighborhood safety measures such as traffic calming when implemented strategically.

3.5.1 PROCESS

A GIS neighborhood layer was developed by filtering the tax parcel layer to include neighborhoods comprised of single-family homes with an average lot size greater than 0.25 acres. A minimum average lot size of 0.25 acres was targeted as a reasonable lower end to provide adequate space for commonly used linear green infrastructure stormwater control measures, assuming each home had a driveway. For the forty-nine (49) neighborhoods included in the analysis, the neighborhood average lot size ranges from 0.25 acres to 0.95 acres with a mean value of 0.50 acres. The scoring for this parameter is defined as follows (See Exhibit 3-1): a score of one (1) indicates an average lot size between 0.25 acres and 0.33 acres; a score of three (3) indicates an average lot size between 0.34 acres and 0.50 acres; a score of five (5) indicates an average lot size between 0.51 acres and 0.75 acres; and a score of seven (7) indicates an average lot size above 0.75 acres.

Road slope was evaluated along discrete road centerline segments using a GIS surface dataset. A weighted average of these segments was computed to determine the average road slope for the neighborhood as a whole. The neighborhood was then given a score based on this average road slope. Road segments with slopes greater than 4% are considered unsuitable for traditional green infrastructure stormwater control measures due to the high shear stresses and flow velocities associated with concentrated stormflows. The flatter the road slope, the more suitable for green infrastructure stormwater control measures. For the forty-nine (49) neighborhoods included in the analysis, the averaged road slopes ranged from 1.1% to 8.6% with a mean value of 4.4%. The scoring for this parameter is defined as follows (See Exhibit 3-2): a score of one (1) indicates an average road slope above 4.5%; a score of three (3) indicates an average between 3.5% and 4.4%;

a score of five (5) indicates an average road slope between 2.0% and 3.5%; and a score of seven (7) indicates an average road slope below 2%.

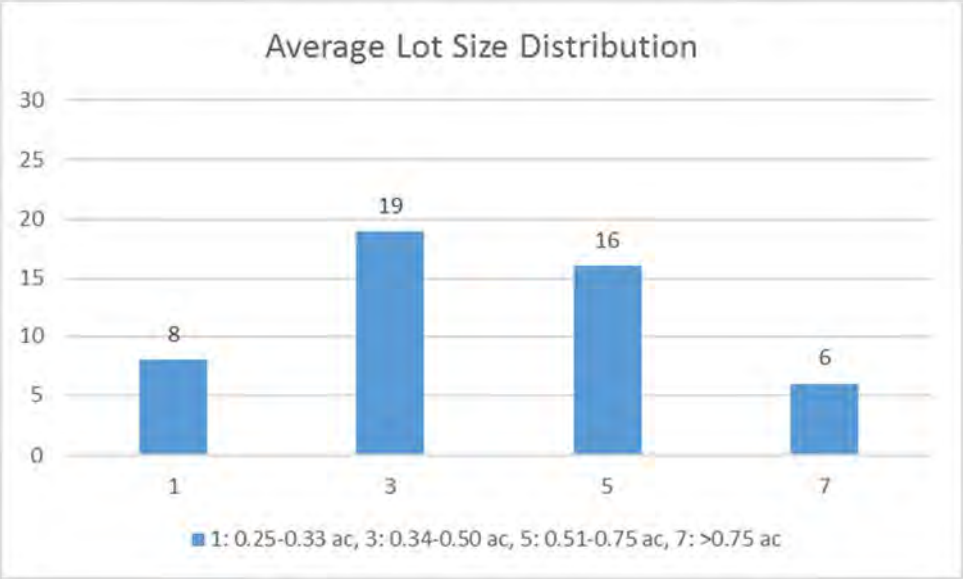


Exhibit 3-1: Average Lot Size Distribution

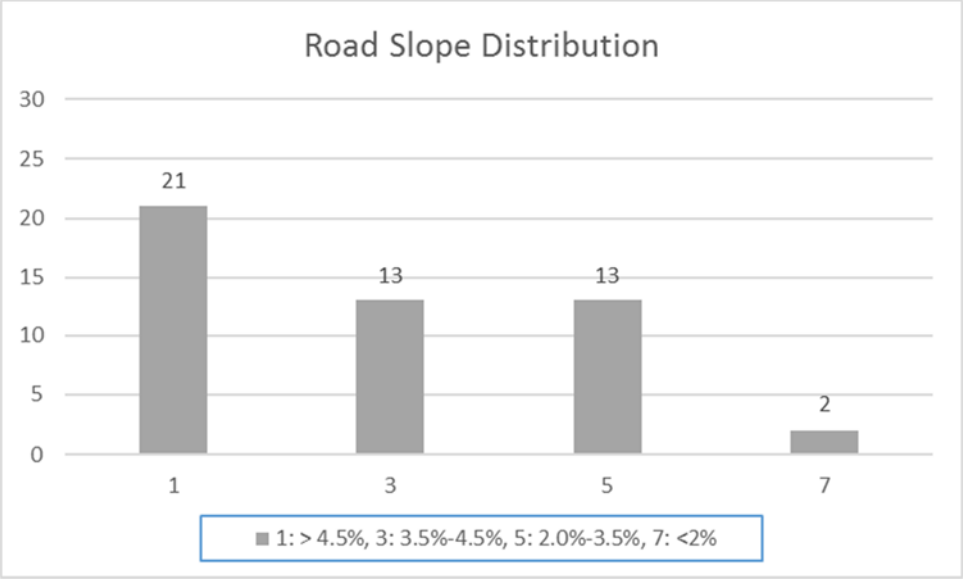


Exhibit 3-2: Road Slope Distribution

Road width was computed in GIS using the impervious layer polygon for discrete road segments. A weighted average of these road widths was computed to determine the average road width for each neighborhood. The neighborhood was then given a score based on this average road width. The scores seek to reflect the potential for installation of "bumpouts" on overwide streets (See Picture 3-3). A minimum street width is nine (9) feet for a one-way residential road and eighteen (18) feet for two-way residential road. For the forty-nine (49) neighborhoods included in the analysis, the neighborhood averaged road widths ranged from 7.8 feet to 36.9 feet with a mean value of 24.8 feet. The scoring for this parameter is defined as follows (See Exhibit 3-3): a score of one (1) indicates an average road width below twenty (20) feet; a score of three (3) indicates an average road width above thirty-one (31) feet as the street is likely to be used for parking; a score of five (5) indicates an average road width between twenty (20) feet and 24.9 feet; and a score of seven (7) indicates an average road width between twenty-five (25) feet and 30.9 feet.

Picture 3-3: Curb Extension Example

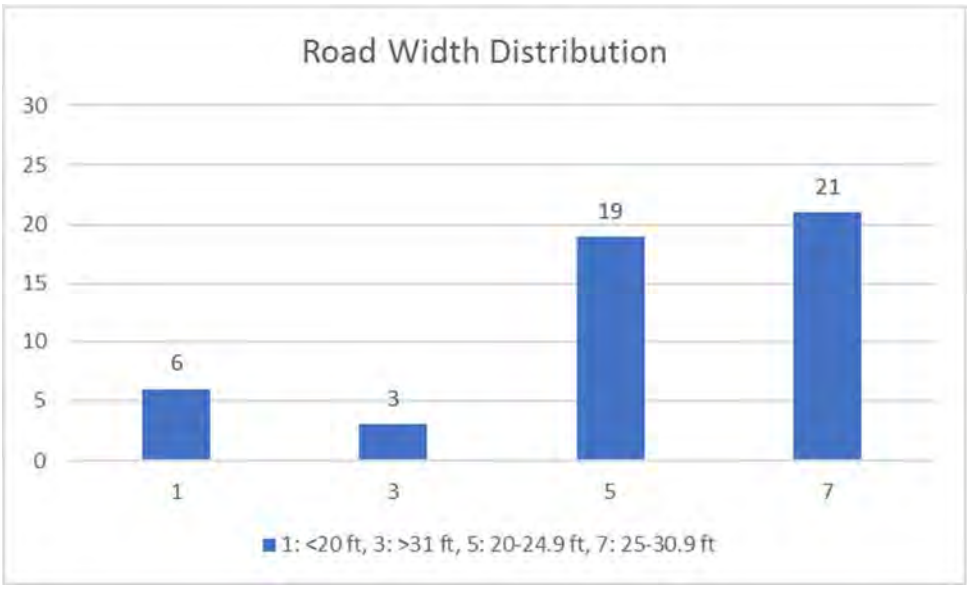


Exhibit 3-3: Road Width Distribution

A rights-of-way width layer was developed in GIS for this project. The rights-of-way area, for the purpose of this analysis, is considered to be the publicly owned space not occupied by a road, driveway, or sidewalk. The width of this area was computed in GIS for each discrete polygon. An average width was then computed for each neighborhood and used for scoring. A width less than six (6) feet is considered to be too limited for optimal surface based green infrastructure stormwater control measures. For the forty-nine (49) neighborhoods included in the analysis, the averaged rights-of-way widths ranged from 0.5 feet to 55.1 feet with a mean value of 14.4 feet. The scoring for this parameter is defined as follows (See Exhibit 3-4): a score of one (1) indicates an average right of way width below seven (7) feet; a score of three (3) indicates an average rights-of-way width between seven (7) feet and 11.9 feet; a score of five (5) indicates an average rights-of-way width between twelve (12) feet and 17.9 feet; and a score of seven (7) indicates an average rights-of-way width greater than eighteen (18) feet.

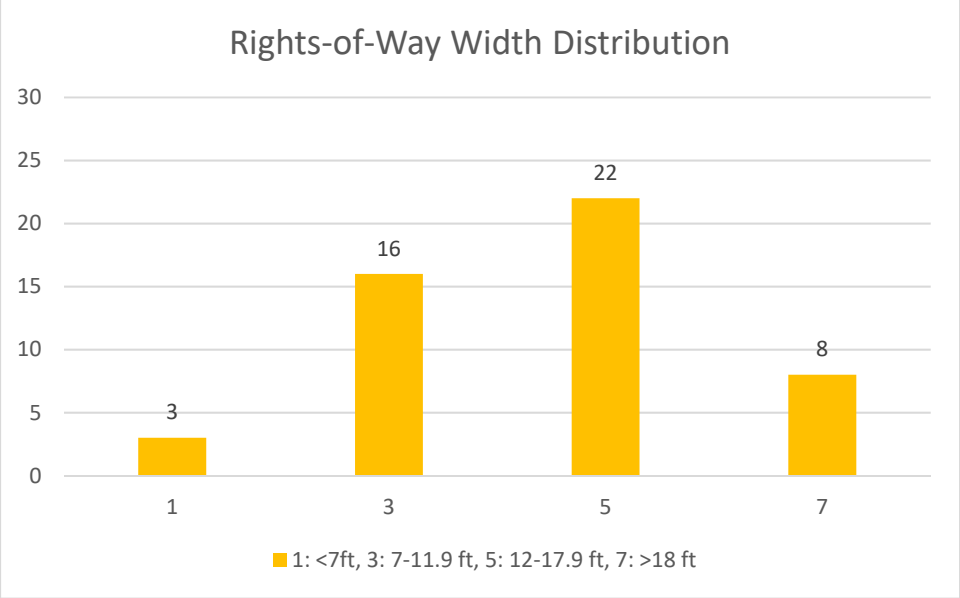


Exhibit 3-4: Rights-of-Way Width Distribution

Total road length was measured using the GIS roadway centerline layer. The length of all road segments within the neighborhood boundary were added together to determine the total road length for each neighborhood. Neighborhoods with more linear feet of roadway were given a higher score. For the forty-nine (49) neighborhoods included in the analysis, the total neighborhood road length ranged from 3 linear feet (for neighborhood most likely bisected by a subwatershed divide) to 15,723 linear feet with a mean value of 4,572 linear feet. The scoring for this parameter is defined as follows: a score of one (1) indicates a total road length below 1,000 linear feet; a score of three (3) indicates a total road length between 1,000 linear feet and 5,280 linear feet; a score of five (5) indicates a total road length between 5,281 linear feet and 12,000 linear feet; and a score of seven (7) indicates a total road length greater than 12,000. Exhibit 3-5 shows the score distribution of this parameter.

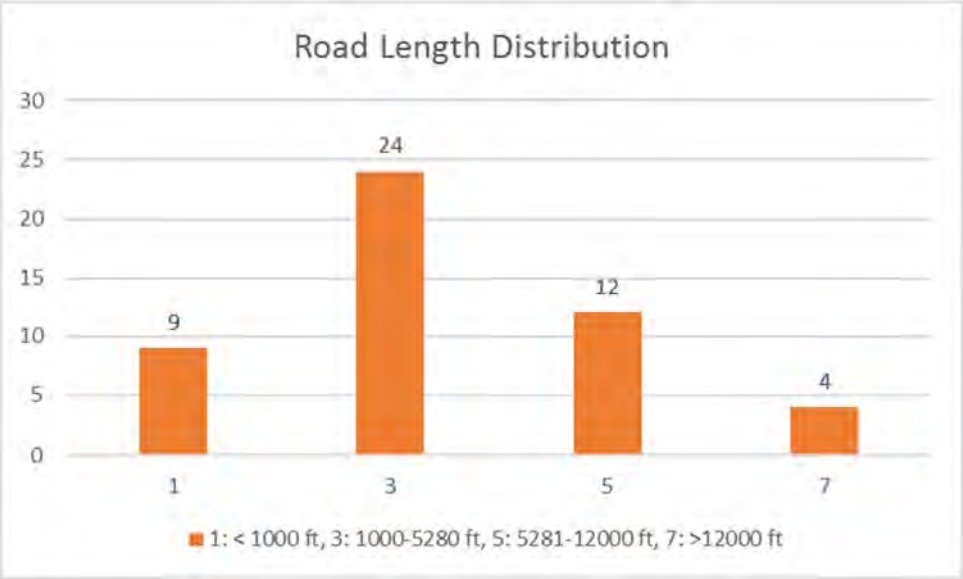


Exhibit 3-5: Road Length Distribution

3.5.2 RESULTS

The scores for each parameter were then added together to compute a final neighborhood score. These total scores were then compiled into four (4) ranking categories (poor, fair, good, very good) to represent the favorability of a neighborhood to retrofitting (See Exhibit 3-6 and Table 3-9). A ranking of poor indicates a total score below sixteen (16), meaning that the neighborhood is unsuitable for retrofit. A ranking of fair corresponds to a total score between seventeen (17) and twenty (20), indicating that the neighborhood most likely scored poorly in one (1) of the five (5) parameters. A ranking of good corresponds to a total score between twenty-one (21) and twenty-four (24), indicating that the neighborhood is likely to be a suitable candidate for retrofit projects. A ranking of very good corresponds to a total score of twenty-five (25) or more, indicating that a neighborhood scored well in all categories.

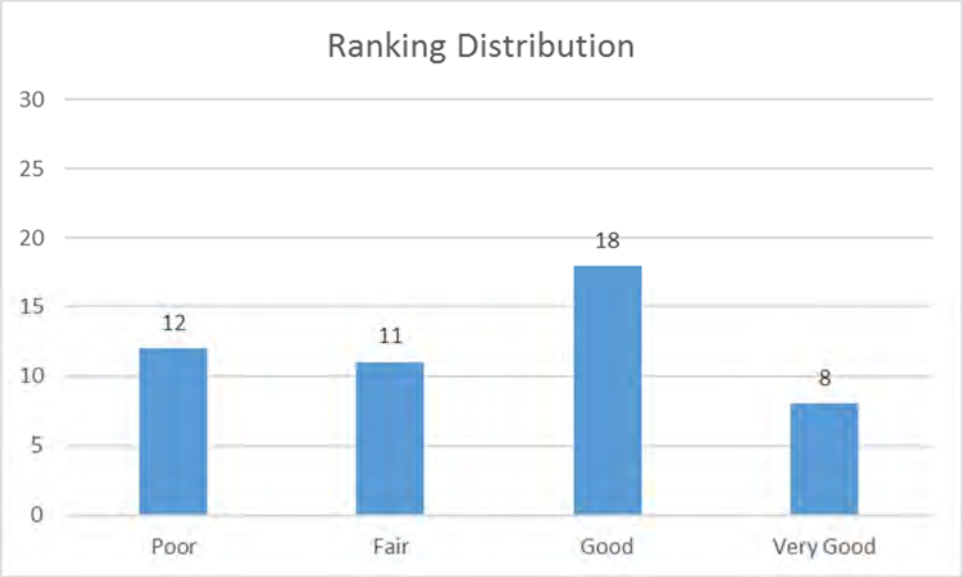


Exhibit 3-6: Ranking Distribution

Table 3-9: Neighborhood Analysis Results

Neighborhood	Subwatershed	Lot Size	Road Length	Road Slope	ROW Width	Road Width	Total Score	Ranking
Cedar Hills	Cedar Fork	7	5	3	7	5	27	Very Good
Ridgefield	Lower Booker Creek	3	7	5	5	7	27	Very Good
Lake Forest	Lower Booker Creek	7	5	3	5	7	27	Very Good
Northwood	Booker Headwaters	5	3	5	7	5	25	Very Good
Booker Creek	Lower Booker Creek	3	5	5	5	7	25	Very Good
Timberlyne	Cedar Fork	5	5	5	5	5	25	Very Good
Lake Forest	Cedar Fork	7	5	1	5	7	25	Very Good
Lake Forest	Eastwood Lake	7	7	1	5	5	25	Very Good
Northwood V	Booker Headwaters	1	7	5	3	7	23	Good
Parkside	Booker Headwaters	1	7	5	3	7	23	Good
Coker Woods West 2	Eastwood Lake	5	5	1	5	7	23	Good
North Forest Hills	Crow Branch	3	3	5	5	7	23	Good
Coker Hills	Eastwood Lake	5	5	1	5	7	23	Good
Steeple Chase	Cedar Fork	5	3	5	3	7	23	Good
Timberlyne	Booker Headwaters	5	3	7	3	5	23	Good
Argonne Hills	Cedar Fork	3	3	5	5	7	23	Good
Forest Creek	Crow Branch	5	1	5	5	7	23	Good
Forest Creek	Eastwood Lake	5	5	1	5	7	23	Good
Eastwood Rd Johnson Farm	Eastwood Lake	5	3	3	7	5	23	Good
Quail Run	Booker Headwaters	7	5	1	5	5	23	Good
Chesley	Lower Booker Creek	5	5	1	3	7	21	Good
Chandler's Green	Cedar Fork	3	3	5	3	7	21	Good
North Forest Hills	Booker Headwaters	3	5	3	5	5	21	Good
Clark Hills	Lower Booker Creek	5	3	1	7	5	21	Good
Countryside	Cedar Fork	5	5	1	3	7	21	Good
Brookview	Cedar Fork	7	3	1	5	5	21	Good
Coker Woods West 1	Eastwood Lake	5	3	3	3	5	19	Fair
North Forest Hills	Cedar Fork	3	3	3	5	5	19	Fair
North Forest Hills	Eastwood Lake	3	3	3	5	5	19	Fair
Coker Hills	Lower Booker Creek	5	3	1	3	7	19	Fair
Partin Hills	Cedar Fork	5	3	1	5	5	19	Fair
Riggsbee Heights Piney Mt	Cedar Fork	5	3	1	5	5	19	Fair
Deerwoods	Lower Booker Creek	3	1	5	3	7	19	Fair
Greene Hills	Cedar Fork	3	3	1	5	7	19	Fair
Glen Heights	Crow Branch	3	3	3	7	1	17	Fair
Oxford Hills	Lower Booker Creek	3	3	3	3	5	17	Fair
Ridgefield North	Lower Booker Creek	1	1	1	7	7	17	Fair
Glen Heights	Booker Headwaters	3	1	3	7	1	15	Poor
Windover	Lower Booker Creek	1	3	3	3	5	15	Poor
Pine Knob	Eastwood Lake	1	3	1	3	7	15	Poor
Cross Creek	Cedar Fork	3	3	1	7	1	15	Poor
Franklin Square	Cedar Fork	3	1	5	5	1	15	Poor
Glenview	Cedar Fork	3	3	1	3	5	15	Poor
Fern Creek	Eastwood Lake	3	1	7	1	3	15	Poor
Coker Woods	Eastwood Lake	1	3	3	1	5	13	Poor
Silver Creek	Lower Booker Creek	3	3	1	1	3	11	Poor
Freeland Place	Booker Headwaters	3	1	3	3	1	11	Poor
Vernon Hills	Eastwood Lake	1	1	1	3	3	9	Poor
Vernon Hills	Lower Booker Creek	1	1	1	5	1	9	Poor

FLOOD MITIGATION ALTERNATIVES

Developing flood mitigation alternatives in an urban environment is a complex process based on limitations imposed by the constraints within the environment such as floodplain encroachments, increased peak flows due to impervious areas, public and private utilities, and private property. Improvements in this portion of the study were identified through an iterative process of infrastructure improvements, increasing floodplain storage, and evaluating detention options. Alternatives were finalized based on discussions with Town staff. The top alternatives that achieve the goals of the project while minimizing impacts to residents and traffic are presented.

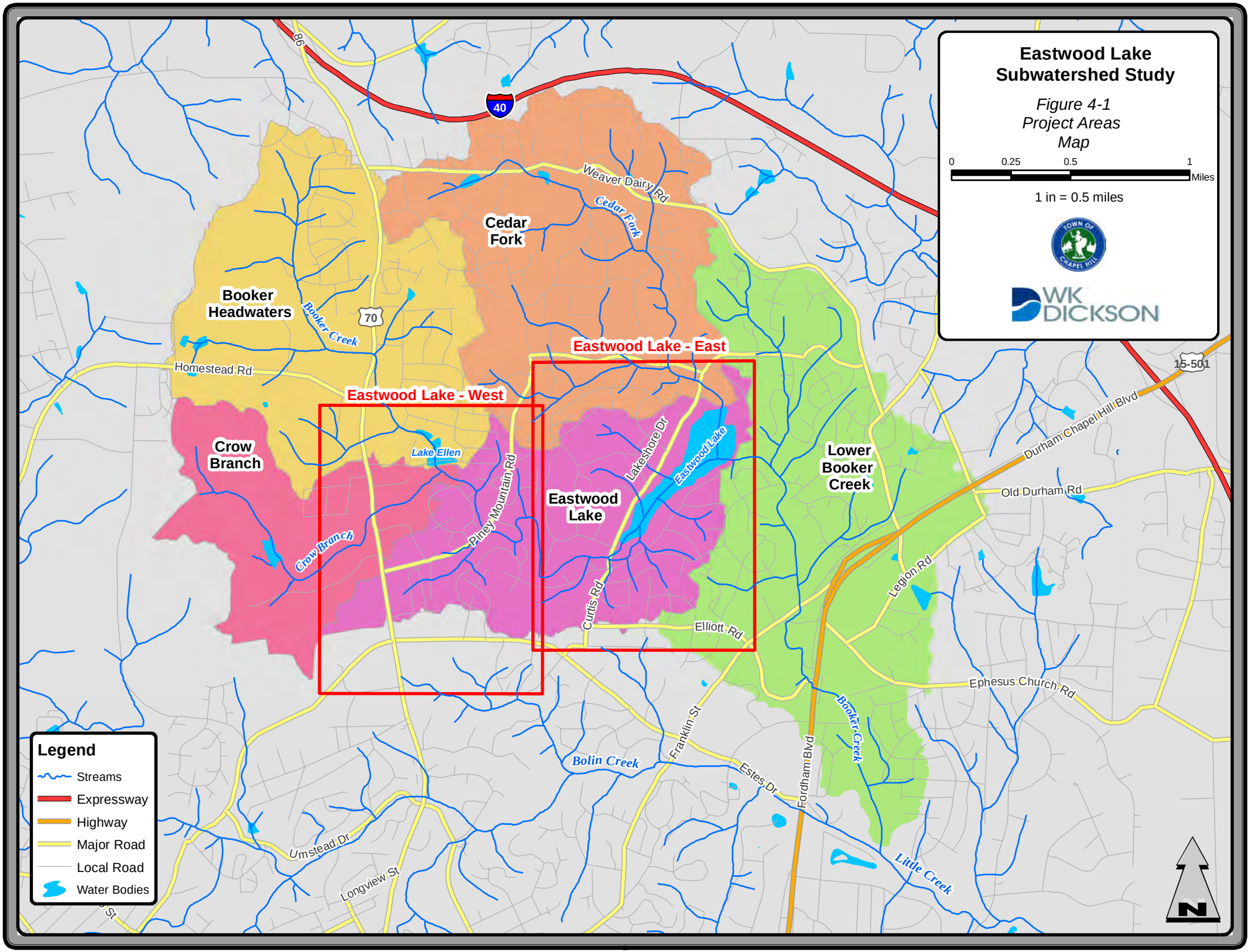
As noted in Section 3, significant development has occurred within the natural floodplain prior to the current federal and local regulations regarding development in a floodplain. The proposed solutions required to reduce the risk of flooding in these areas are a combination of the following:

(1) Infiltration to reduce the volume and rate of runoff;
(2) Flood storage to reduce the rate of runoff by impacting the timing within the overall watershed and reconnect streams to the natural floodplain; and
(3) Infrastructure improvements to increase the capacity of the system to convey runoff from large storm events.

Based on the configuration of the conveyance systems within Eastwood Lake and how those systems interact with each other, the proposed alternatives are best grouped geographically into three (3) distinct areas as shown in Figure 4.1 and described as follows:

(1) The Overall Booker Creek watershed includes proposed storage projects previously identified as part of the Lower Booker Creek Subwatershed Study that can influence peak flows within the Eastwood Lake subwatershed.
(2) Eastwood Lake West consists predominantly of secondary systems located on the upstream portion of Booker Creek in the western portion of the Eastwood Lake subwatershed area.
(3) Eastwood Lake East consists predominantly of secondary systems located on the downstream portion of Booker Creek in the eastern portion of the Eastwood Lake subwatershed area.

All proposed projects are developed based on built-out land use conditions as described in Section 4.4 and Appendix A. All reported water surface elevations and flood depth reductions are based on future land use conditions.


Eastwood Lake
Subwatershed Study
Figure 4-1
Project Areas
Map
0
0.25
0.5
1
Miles
1 in = 0.5 miles
Booker Headwaters
Cedar Fork
Crow Branch
Eastwood Lake
Lower Booker Creek
Eastwood Lake - East
Eastwood Lake - West
Booker Creek
Cedar Fork
Crow Branch
Lake Ellen
Eastwood Lake
Bolin Creek
Little Creek
Weaver Dairy Rd
Homestead Rd
Lakeshore Dr
Piney Mountain Rd
Curtis Rd
Elliott Rd
Legion Rd
Old Durham Rd
Durham Chapel Hill Blvd
Ephesus Church Rd
Franklin St
Estes Dr
Fordham Blvd
Umstead Dr
Longview St
40
70
86
15-501
Legend
Streams
Expressway
Highway
Major Road
Local Road
Water Bodies
N

4.1 OVERALL BOOKER CREEK WATERSHED

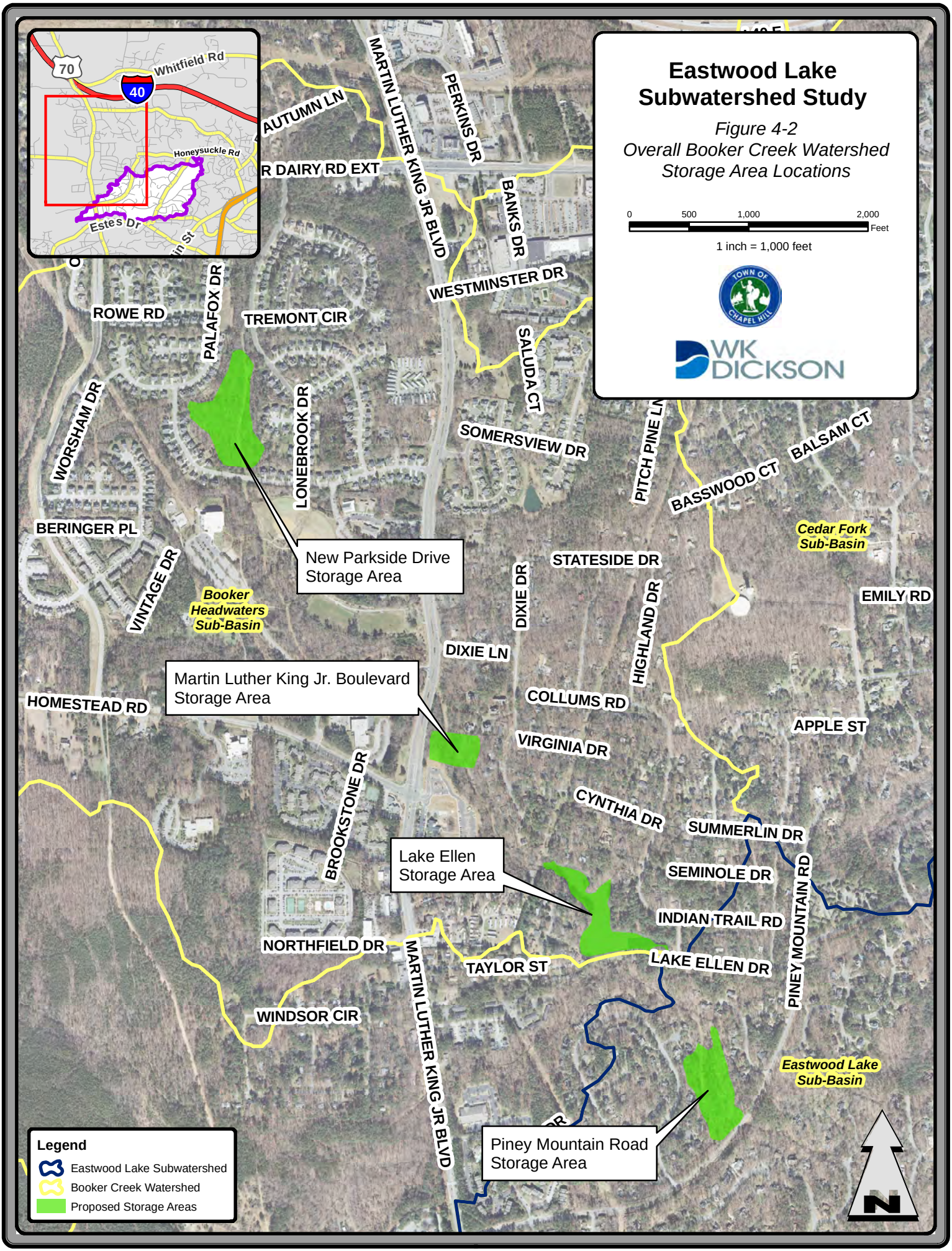
While the focus of this study is to improve conditions within the Eastwood Lake subwatershed, over 80% of the drainage area contributing to the overall watershed is outside of the Eastwood Lake subwatershed. Therefore, potential projects were evaluated within the Booker Creek watershed to determine if strategically increasing flood storage in the upper portions of the watershed could potentially impacts peak flows in the Eastwood Lake subwatershed. Available sites that could make a significant impact on downstream flows were limited based on the extensive existing development within the watershed and topographic constraints.

The largest potential flood storage facility in the Booker Creek watershed is Eastwood Lake. Eastwood Lake is a 50-acre privately owned neighborhood facility generally located near the center of the watershed. The lake is predominantly utilized as a recreational facility and amenity to the Lake Forest community. Residential homes are located around the perimeter of the lake with numerous fixed docks and other structures. The configuration of the existing spillway allows water to quickly overflow out of the lake during a storm event to avoid significant rises in water surface elevation, protecting the surrounding properties. The facility is not designed to detain flows and to provide significant detention would require a reconfiguration of the spillway and normal water surface. To obtain additional storage, some combination of raising the dam or lowering the water surface level would be required. Due to the proximity of residential structures around the perimeter of the lake, it is unlikely the dam could be raised without increasing the risk of flooding to those residents and nearby roads. Therefore, the primary alternative for significantly increasing flood storage in Eastwood Lake would be to lower the water surface elevation. As part of the Lower Booker Creek study, lowering the normal water surface elevation by one (1) foot was evaluated to determine if significant benefits could be achieved. It was assumed that further reductions in water surface elevation would adversely impact the recreational use of the lake. Even lowering the water surface by one (1) foot would require significant reconstruction of docks and recreational facilities. The benefit of lowering the normal water surface by one (1) foot was not found to be significant due to the size of the watershed at that location and the constraints listed above. Any publicly funded project on a private lake would need to demonstrate significant benefits to the community. The proposed projects assume that no significant modification will occur at Eastwood Lake.

The following projects are recommended as potential floodplain storage areas that can positively impact downstream peak flows in Booker Creek. Due to the limited land availability in the watershed, the Town should make use of multi-objective projects if possible. Additionally, the proposed storage areas could be configured to provide water quality treatment as well as flood control benefits. Excavation within the proposed floodplain storage areas should minimize the removal of significant tree stands to the extent possible to comply with Town ordinances and State buffer regulations. The locations of the four (4) proposed floodplain storage areas are shown in Figure 4.2 and summarized in Table 4-1. Detailed information about the proposed storage areas can be found in the Lower Booker Creek Subwatershed Study and the Lake Ellen Evaluation Memorandum.

Table 4-1: Potential Flood Storage Areas

Name	Location	Size (Acres)	25-Year Flow Reductions at Piney Mountain Road	25-Year Flow Reductions at North Lakeshore Drive
New Parkside Drive	North of New Parkside Drive (Booker Headwater Sub-Basin)	7.5	9%	7%
Martin Luther King Jr. Boulevard	East Side of Martin Luther King Jr. Boulevard, Just North of Intersection with Homestead Road (Booker Headwater Sub-Basin)	2.0	0%	0%
Piney Mountain Road	West Side of Piney Mountain Road approx. 0.5 Miles East of Intersection with Martin Luther King Jr. Boulevard (Eastwood Sub-Basin)	5.5	0%	0%
Lake Ellen	North of Piney Mountain Road, Upstream of Crow Branch Confluence with Booker Creek (Booker Headwater Sub-Basin)	5.0	2%	3%


Eastwood Lake Subwatershed Study
Figure 4-2
Overall Booker Creek Watershed Storage Area Locations
0
500
1,000
2,000
Feet
1 inch = 1,000 feet
TOWN OF CHAPEL HILL
WK DICKSON
70
40
Whitfield Rd
Honeysuckle Rd
Estes Dr
AUTUMN LN
R DAIRY RD EXT
MARTIN LUTHER KING JR BLVD
PERKINS DR
BANKS DR
WESTMINSTER DR
SALUDA CT
ROWE RD
PALAFOX DR
TREMONT CIR
WORSHAM DR
LONEBROOK DR
SOMERSVIEW DR
PITCH PINE LN
BALSAM CT
BASSWOOD CT
BERINGER PL
VINTAGE DR
New Parkside Drive Storage Area
Booker Headwaters Sub-Basin
DIXIE DR
STATESIDE DR
HIGHLAND DR
Cedar Fork Sub-Basin
EMILY RD
DIXIE LN
Martin Luther King Jr. Boulevard Storage Area
HOMESTEAD RD
COLLUMS RD
APPLE ST
VIRGINIA DR
BROOKSTONE DR
CYNTHIA DR
SUMMERLIN DR
Lake Ellen Storage Area
SEMINOLE DR
INDIAN TRAIL RD
PINEY MOUNTAIN RD
NORTHFIELD DR
TAYLOR ST
LAKE ELLEN DR
MARTIN LUTHER KING JR BLVD
WINDSOR CIR
Eastwood Lake Sub-Basin
Piney Mountain Road Storage Area
Legend
Eastwood Lake Subwatershed
Booker Creek Watershed
Proposed Storage Areas
N

4.2 EASTWOOD LAKE WEST

The Eastwood Lake West portion of the study consists of the upstream portion of Booker Creek from its confluence with Crow Branch to just downstream of Piney Mountain Road. It is in the western section of the Eastwood Lake subwatershed. Eastwood Lake West generally consists of three (3) different types of projects as follows:

(1) Roadway crossing improvements;
(2) Secondary system infrastructure improvements; and
(3) Stream stabilization (Described in detail in Section 6.1).

Piney Mountain Road – Based on the results obtained from the existing conditions analysis, the existing bridge at this crossing provides a 10-year level of service. For the future conditions analysis, the roadway is overtopped by 0.5 feet during a 10-year storm event. The existing and future conditions do not meet the desired 100-year level of service for roadways located within a FEMA regulated floodway.

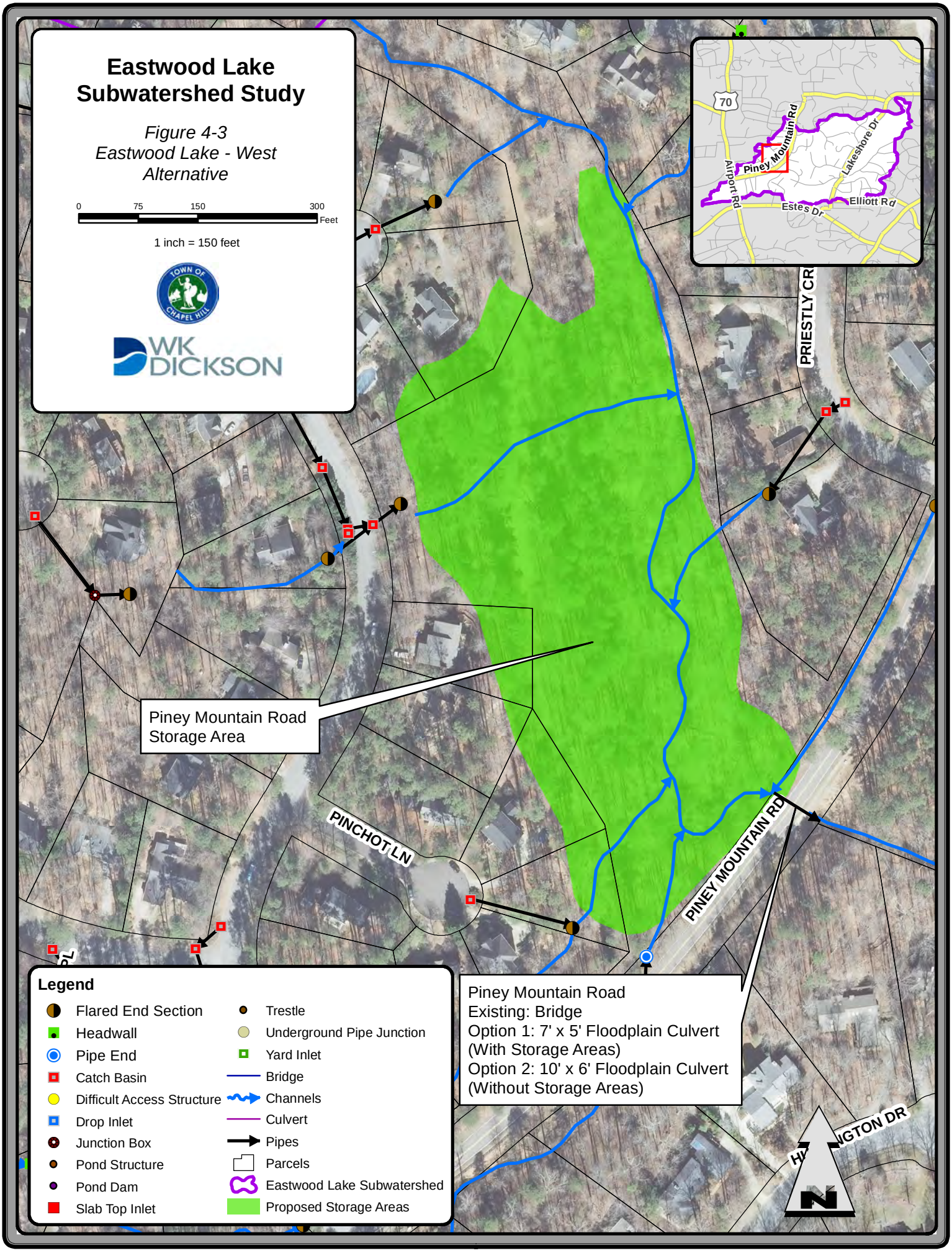
Picture 4-1: Piney Mountain Road Bridge

With the implementation of the three (3) proposed detention projects in Section 4.1, the resulting 10-year water surface elevation will be decreased by 2.1 feet while the resulting 25-year water surface elevation will decrease by 0.3 feet.

This bridge was installed approximately 15 years ago following the failure of the previous metal pipe in the summer of 2000. The bridge is in good condition with no known structural issues; therefore, it is recommended that it be left in place. The improvements proposed at Piney Mountain Road entails installing a 7′ x 5′ reinforced concrete box floodplain culvert (See Figure 4-3). With this improvement along with the proposed detention projects, Piney Mountain Road will be brought up to a 25-year level of service. Additionally, water surface elevations will be reduced by 2.9 feet during the 10-year storm event and 1.7 feet during the 25-year storm event. If the floodplain culvert is installed without the proposed detention projects, the culvert will need to be a 10′ x 6′ reinforced concrete box floodplain culvert to achieve a 25-year level of service. The water surface elevations will be reduced by 2.8 feet during the 10-year storm event and 1.6 feet during the 25-year storm event. Without the implementation of proposed upstream storage areas, the resulting downstream water surface elevations will increase by as much as 0.14 feet in the 25-year storm event with the installation of the floodplain culvert.

During a field visit, there were several potential site restrictions and utility conflicts that were identified including overhead power lines that are located above Piney Mountain Road. The overhead power lines may need to be relocated based on where the contractor accesses the site. Along Piney Mountain Road, there is a water line (16″ ductile iron) that runs perpendicular to Booker Creek in the proposed project area. This line may need to be replaced or relocated based

on its elevation. Impacts to traffic during construction were considered. Piney Mountain Road is a two-lane roadway. It is anticipated that a road closure or a flagged two-way one-lane operation will be required during construction. The total estimated cost for this project is $333,100 for the 7′ x 5′ reinforced concrete box floodplain culvert and $456,800 for the 10′ x 6′ reinforced concrete box floodplain culvert.


Eastwood Lake
Subwatershed Study
Figure 4-3
Eastwood Lake - West
Alternative
0
75
150
300
Feet
1 inch = 150 feet
TOWN OF CHAPEL HILL
WK DICKSON
70
Piney Mountain Rd
Lakeshore Dr
Airport Rd
Elliott Rd
Estes Dr
PRIESTLY CR
Piney Mountain Road
Storage Area
PINCHOT LN
PINEY MOUNTAIN RD
Piney Mountain Road
Existing: Bridge
Option 1: 7' x 5' Floodplain Culvert
(With Storage Areas)
Option 2: 10' x 6' Floodplain Culvert
(Without Storage Areas)
Legend
Flared End Section
Headwall
Pipe End
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Pond Structure
Pond Dam
Slab Top Inlet
Trestle
Underground Pipe Junction
Yard Inlet
Bridge
Channels
Culvert
Pipes
Parcels
Eastwood Lake Subwatershed
Proposed Storage Areas
N

Woodshire Lane/Huntington Drive System

WK Dickson recommends the following improvements for the Woodshire Lane/Huntington Drive System as shown in Figure 4-4:

- Replace 26 LF of twin 24" RCPs with twin 30" RCPs adjacent to 217 Huntington Drive; and
- Replace 84 LF of 24" RCP with a 4' x 5' RCBC across Piney Mountain Road.

In should be noted that in lieu of upsizing the segment of 24" RCP crossing Piney Mountain Road, realigning the stream was considered as an option. Conceptually, the stream was realigned to be brought away from the Piney Mountain right-of-way and to tie-in downstream of the Piney Mountain Road crossing along Booker Creek. This would have reduced the amount of flow at this crossing and the required size of the proposed floodplain culvert at Piney Mountain Road. However, this option was not feasible due to several site constraints including sanitary sewer conflicts, private property impacts, and the steep topography.

The proposed improvements will bring the Woodshire Lane/Huntington Drive System up to the desired level of service. While a portion of the project will be located in the right-of-way, there will be 26 linear feet replaced on private property. Underground sanitary sewer lines and overhead power lines were also identified as potential utility conflicts and site restrictions. The total estimated cost for the recommended alternative is $372,300.

Due to their close proximity, the proposed improvements to the Woodshire Lane/Huntington Drive system should be coupled with the adjacent stream stabilization recommendations shown as Project 1 – Woodshire 2 and Project 2 – Woodshire 3 in Section 6.1 (Page 6-5).

Eastwood Lake Subwatershed Study

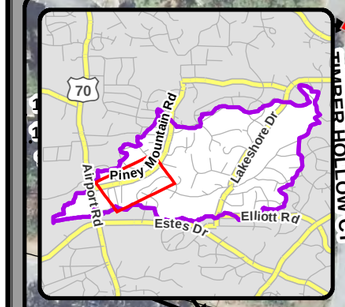
Figure 4-4
Woodshire Lane/
Huntington Drive System
Alternative

0 75 150 300 Feet

1 inch = 150 feet

TOWN OF CHAPEL HILL

WK DICKSON



Replace 84 LF of
24" RCP with 4' x 5' RCBC

Replace 26 LF of Twin 24" RCPs
with Twin 30" RCPs

Legend

- Flared End Section
- Headwall
- Pipe End
- Catch Basin
- Difficult Access Structure
- Drop Inlet
- Junction Box
- Pond Structure
- Pond Dam
- Slab Top Inlet
- Trestle
- Underground Pipe Junction
- Yard Inlet
- Bridge
- Channels
- Culvert
- Pipes
- Parcels
- Eastwood Lake Subwatershed

4.3 EASTWOOD LAKE EAST

The Eastwood Lake East portion of the project consists of the downstream segment of Booker Creek including Eastwood Lake to the area upstream of the North Lakeshore Drive crossing. It is in the eastern portion of the Eastwood Lake subwatershed area. Eastwood Lake East generally consists of two (2) different types of projects as follows:

(1) Secondary system infrastructure improvements; and
(2) Stream stabilization (Described in detail in Section 6.1).

North Lakeshore Drive – As determined by the existing conditions analysis, the existing bridge at this crossing provides a 10-year level of service. The desired level of service for a roadway located within a FEMA regulated floodway is the 100-year design storm. Currently, it is overtopped by 0.51 feet during the 25-year storm event.

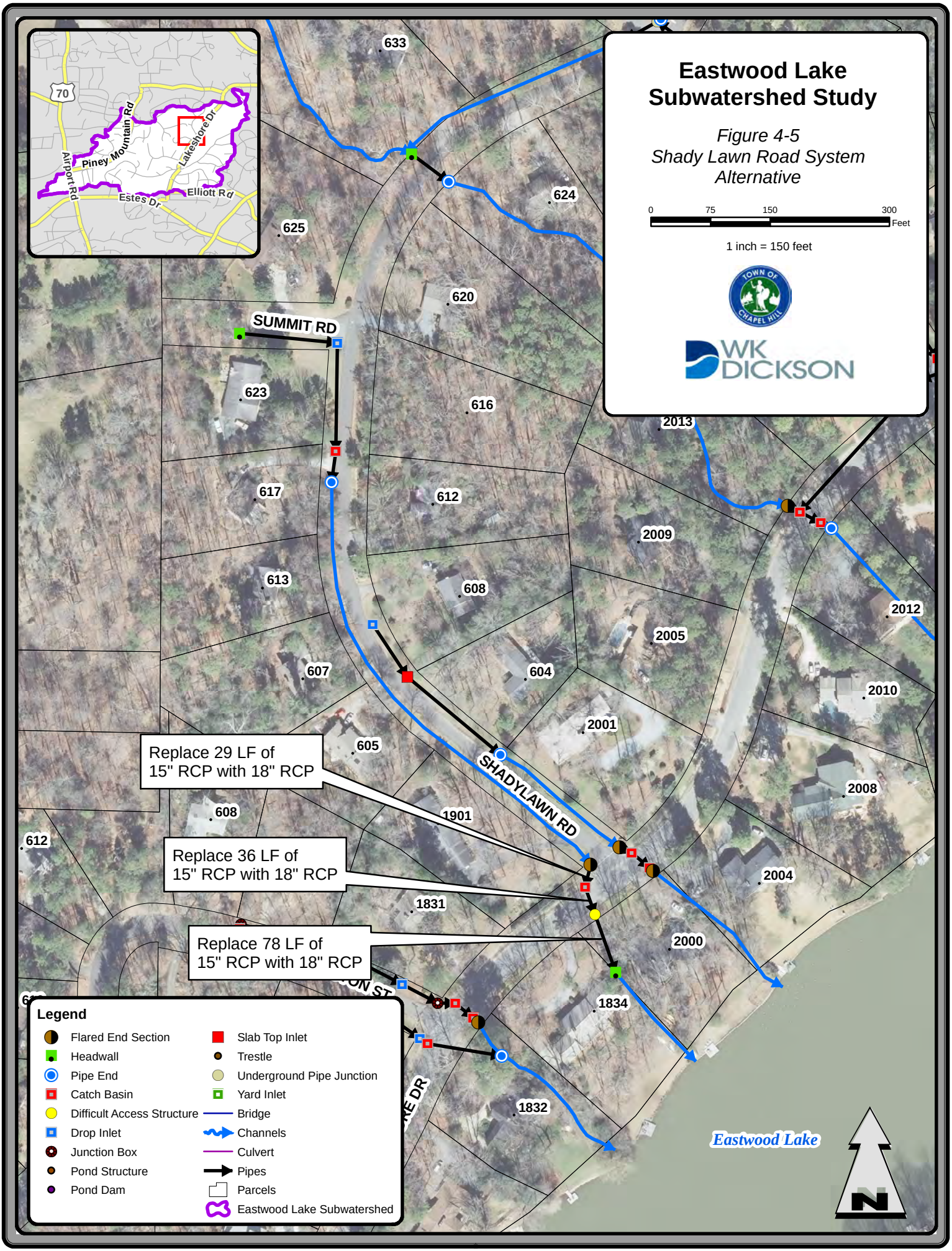
With the storage area improvements proposed upstream, water surface elevations will be reduced by 0.37 feet during the 10-year storm event and 0.11 feet in the 25-year storm event. These reductions will improve the performance of North Lakeshore Drive bridge when considering the future flows. Floodplain culverts are not feasible at this location due to the limited space adjacent to the bridge. The existing bridge is in good condition; therefore, no infrastructure improvements are proposed for this location.

Shady Lawn Road System

WK Dickson recommends the following improvements for the Shady Lawn Road System as shown in Figure 4-5:

- Replace 65 LF of 15" RCP with 18" RCP along North Lakeshore Drive near intersection with Shady Lawn Road;
- Replace 78 LF of 15" RCP with 18" RCP adjacent to 1834 and 2000 North Lakeshore Drive; and
- Install 2 inlets.

The proposed improvements will provide the desired 10-year level of service. While a portion of the project will be located in the right-of-way, there will be 78 linear feet replaced on private property. Sections of the curb and gutter along North Lakeshore Drive will need to be removed and replaced as part of the proposed improvements. Underground water and sanitary sewer lines were identified as potential utility conflicts. Other potential site restrictions include a power pole and overhead power lines. The total estimated cost for the recommended alternative is $153,300.


Eastwood Lake Subwatershed Study
Figure 4-5
Shady Lawn Road System Alternative
0 75 150 300 Feet
1 inch = 150 feet
TOWN OF CHAPEL HILL
WK DICKSON
70
Piney Mountain Rd
Lakeshore Dr
Airport Rd
Estes Dr
Elliott Rd
633
624
625
620
SUMMIT RD
623
616
617
612
613
608
607
604
605
2013
2009
2012
2005
2010
2001
2008
2004
2000
1834
1832
1831
1901
612
Replace 29 LF of 15" RCP with 18" RCP
Replace 36 LF of 15" RCP with 18" RCP
Replace 78 LF of 15" RCP with 18" RCP
SHADYLAWN RD
Eastwood Lake
Legend
Flared End Section
Headwall
Pipe End
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Pond Structure
Pond Dam
Slab Top Inlet
Trestle
Underground Pipe Junction
Yard Inlet
Bridge
Channels
Culvert
Pipes
Parcels
Eastwood Lake Subwatershed
N

Arlington Street #1 Road Closed System

WK Dickson recommends the following improvements for the Arlington Street #1 Closed System as shown in Figure 4-6:

- Remove and replace 22 LF of 24" RCP at intersection of North Lakeshore Drive and Arlington Street (existing pipe has negative slope);
- Replace existing manhole with inlet at intersection of North Lakeshore Drive and Arlington Street;
- Replace 113 LF of 24" RCP with open channel; and
- Install berm on the back side of 1831 North Lakeshore Drive.

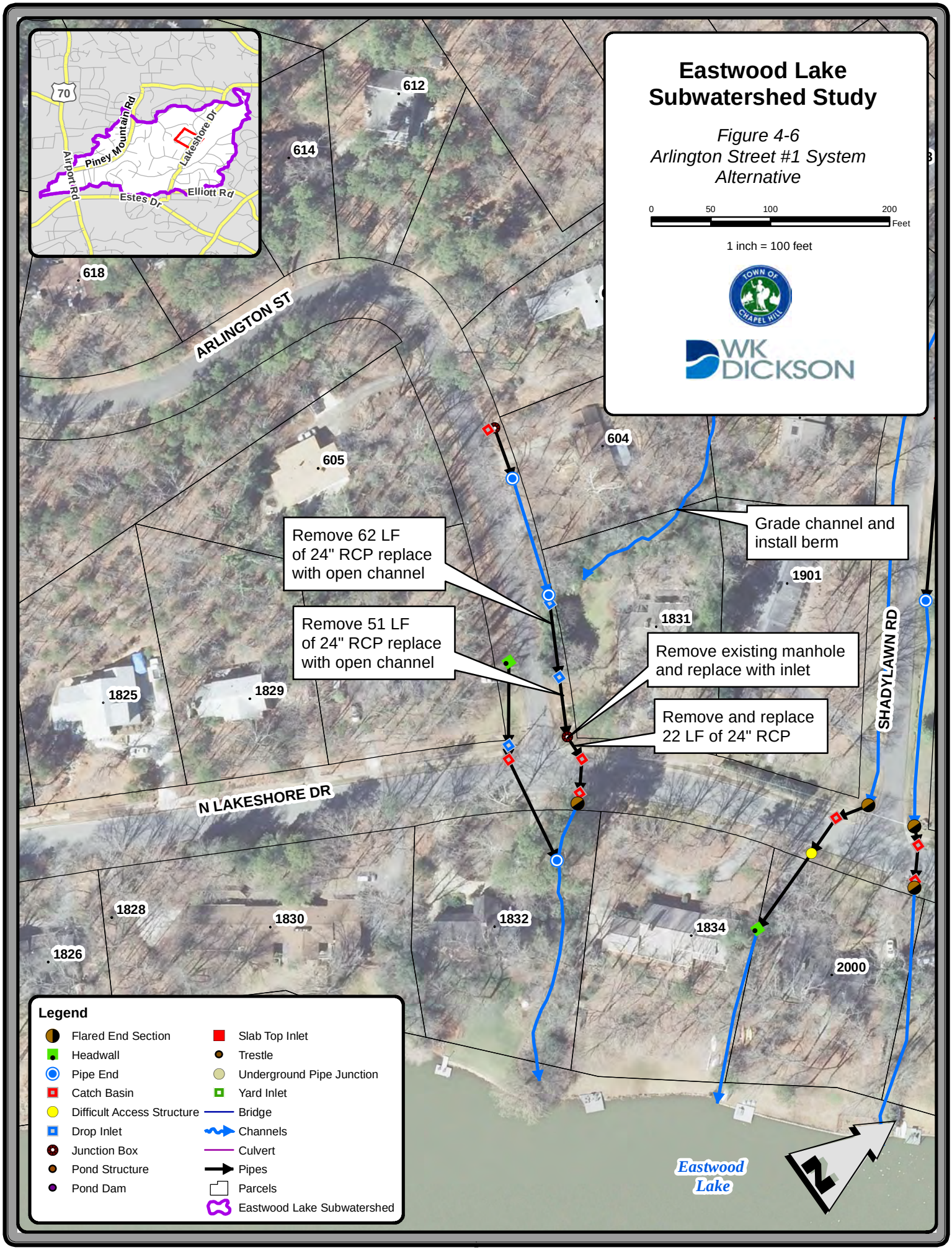
The proposed improvements will continue to provide a 10–year level of service while reducing the spread for the Arlington Street #1 Road Closed System. The project is located in the public right-of-way, so there will be minimal impacts to private properties. The driveways and/or landscaping at the following properties will be impacted: 1831 and 1833 North Lakeshore Drive. Sections of curb and gutter at the intersection of Arlington Street and North Lakeshore Drive will need to be removed and replaced to complete the proposed improvements. Underground sewer lines, overhead power lines, and a power pole were also identified as potential utility conflicts and site restrictions. The total estimated cost for the recommended alternative is $104,400.

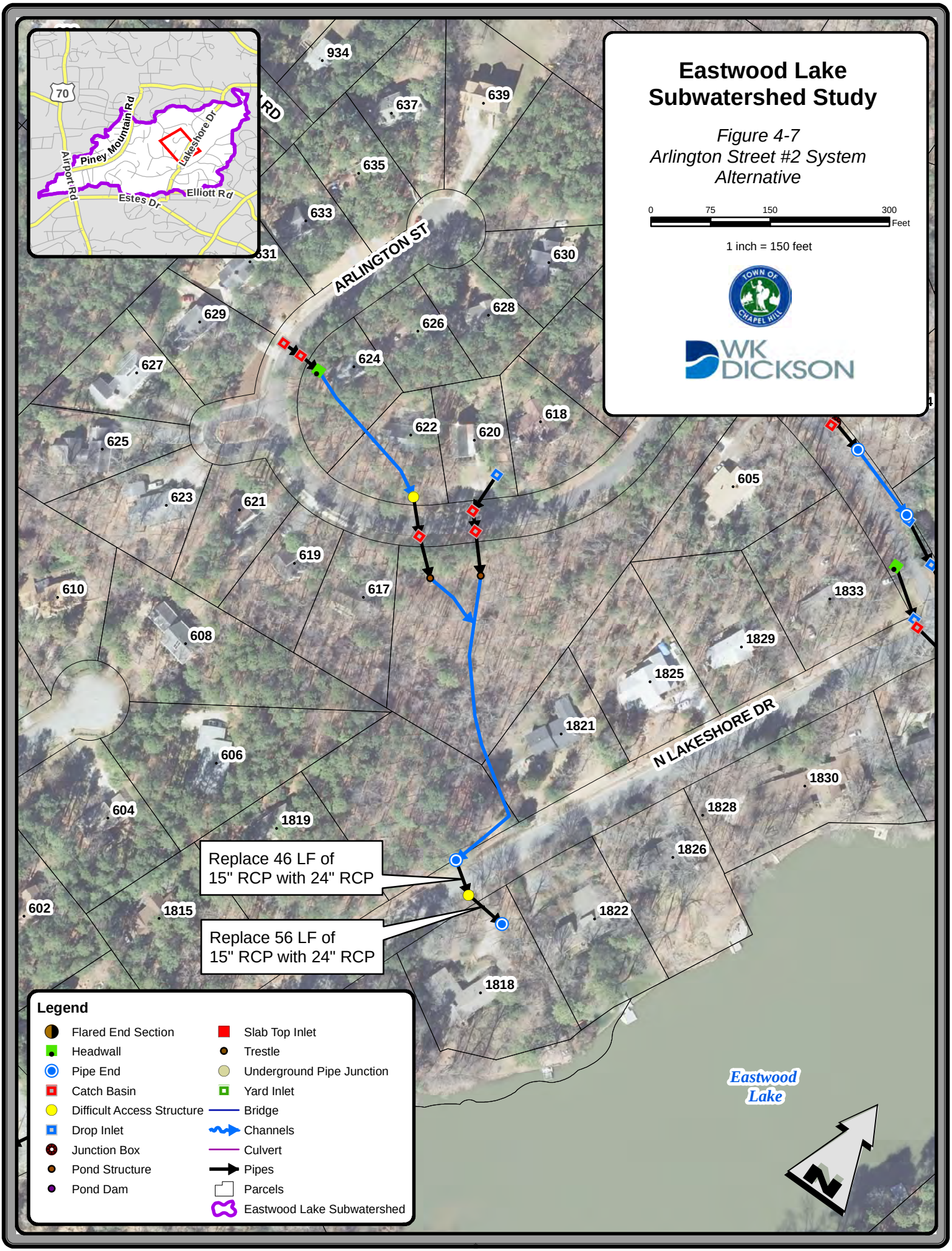
Arlington Street #2 Closed System

WK Dickson recommends the following improvements for the Arlington Street #2 Closed System as shown in Figure 4-7:

- Replace 46 LF of 15" RCP with 24" RCP across North Lakeshore Drive; and
- Replace 56 LF of 15" RCP with 24" RCP adjacent to 1818 North Lakeshore Drive.

The proposed improvements will provide the desired 10-year level of service for the Arlington Street #2 Closed System. Approximately half of the project will be located in the right-of-way, while the remaining half will be located on private property (1818 North Lakeshore Drive). The driveway and landscaping at 1818 North Lakeshore Drive will be impacted. Section of the curb and gutter along North Lakeshore Drive will need to be removed and replaced as part of the proposed improvements. Underground water lines and overhead power lines were also identified as potential utility conflicts and site restrictions. The total estimated cost for the recommended alternative is $133,100. If funds allow, the Town should consider installing the proposed SCM project upstream of the Arlington Street #2 system improvements concurrently.


Eastwood Lake Subwatershed Study
Figure 4-6
Arlington Street #1 System Alternative
0 50 100 200 Feet
1 inch = 100 feet
TOWN OF CHAPEL HILL
WK DICKSON
70
Piney Mountain Rd
Lakeshore Dr
Airport Rd
Estes Dr
Elliott Rd
612
614
618
ARLINGTON ST
605
604
Remove 62 LF of 24" RCP replace with open channel
Grade channel and install berm
1901
Remove 51 LF of 24" RCP replace with open channel
1831
Remove existing manhole and replace with inlet
1825
1829
Remove and replace 22 LF of 24" RCP
SHADYLAWN RD
N LAKESHORE DR
1828
1830
1832
1834
1826
2000
Eastwood Lake
N
Legend
Flared End Section
Headwall
Pipe End
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Pond Structure
Pond Dam
Slab Top Inlet
Trestle
Underground Pipe Junction
Yard Inlet
Bridge
Channels
Culvert
Pipes
Parcels
Eastwood Lake Subwatershed


Eastwood Lake Subwatershed Study
Figure 4-7
Arlington Street #2 System Alternative
0 75 150 300 Feet
1 inch = 150 feet
TOWN OF CHAPEL HILL
WK DICKSON
70
Piney Mountain Rd
Lakeshore Dr
Airport Rd
Estes Dr
Elliott Rd
ARLINGTON ST
N LAKESHORE DR
Eastwood Lake
Replace 46 LF of 15" RCP with 24" RCP
Replace 56 LF of 15" RCP with 24" RCP
934
639
637
635
633
631
630
629
628
626
627
624
625
622
620
618
623
621
605
619
610
617
1833
608
1829
1825
1821
606
1830
604
1828
1819
1826
602
1815
1822
1818
Legend
Flared End Section
Headwall
Pipe End
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Pond Structure
Pond Dam
Slab Top Inlet
Trestle
Underground Pipe Junction
Yard Inlet
Bridge
Channels
Culvert
Pipes
Parcels
Eastwood Lake Subwatershed

South Lakeshore Drive/Ridgecrest Drive Closed System

WK Dickson recommends the following improvements for the South Lakeshore Drive /Ridgecrest Drive Closed System as shown in Figure 4-8:

- Replace and lower 127 LF of 15" RCP with 18" RCP from the South Lakeshore Drive and Ridgecrest Drive intersection across South Lakeshore Drive.

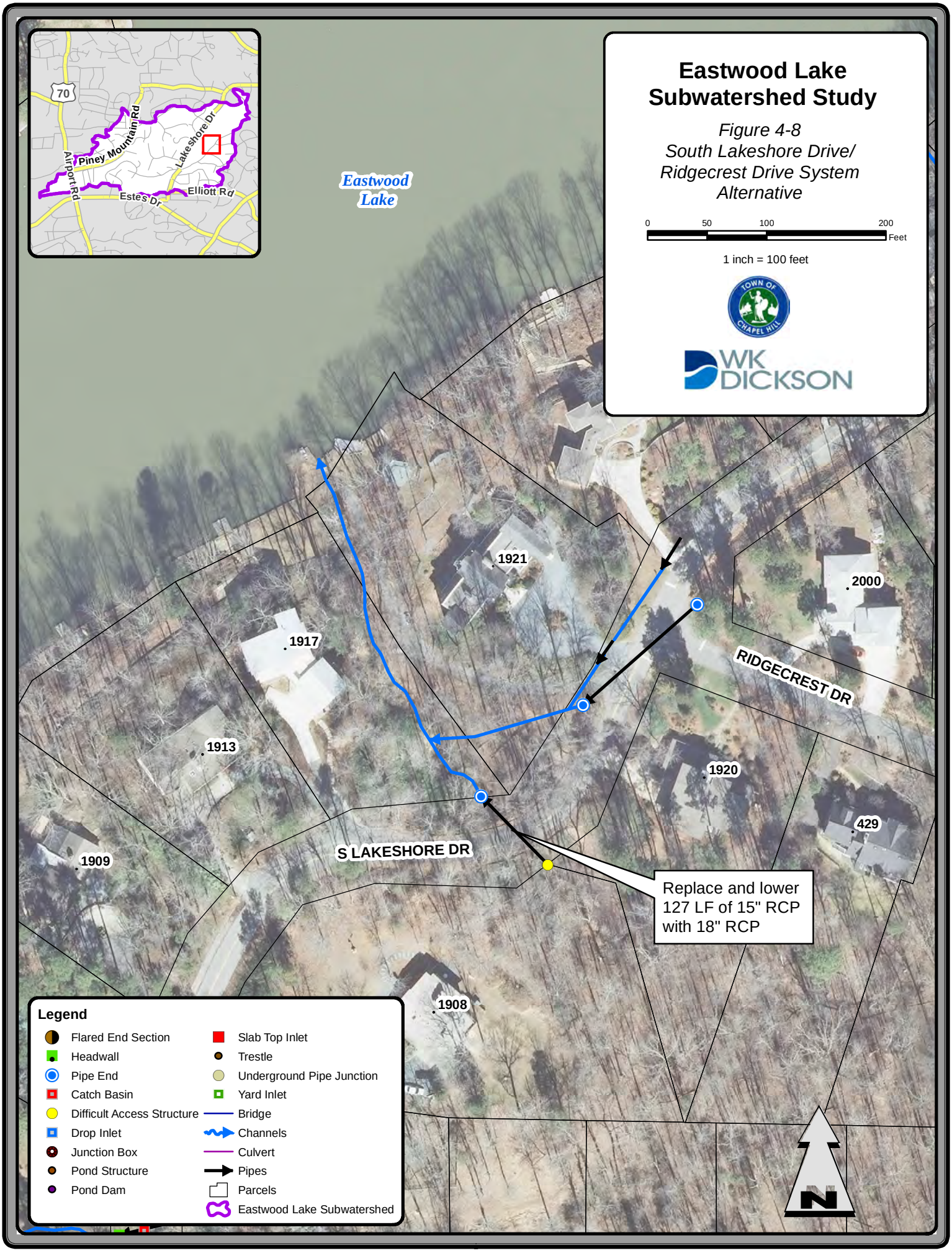
The proposed improvements will provide the desired 10-year level of service for the South Lakeshore Drive /Ridgecrest Drive Closed System. The project is located within the public right-of-way, there will be minimal impacts to private properties. Underground water and sanitary sewer lines were identified as potential utility conflicts. Other potential site restrictions include overhead power lines. The total estimated cost for the recommended alternative is $125,200. Due to the close proximity, the proposed improvements to the South Lakeshore Drive/Ridgecrest Drive system should be coupled with the adjacent stream stabilization recommendations shown as Projects 11 through 14 – Ridgecrest 1 – 4 in Section 6.1 (Pages 6-9 and 6-10).

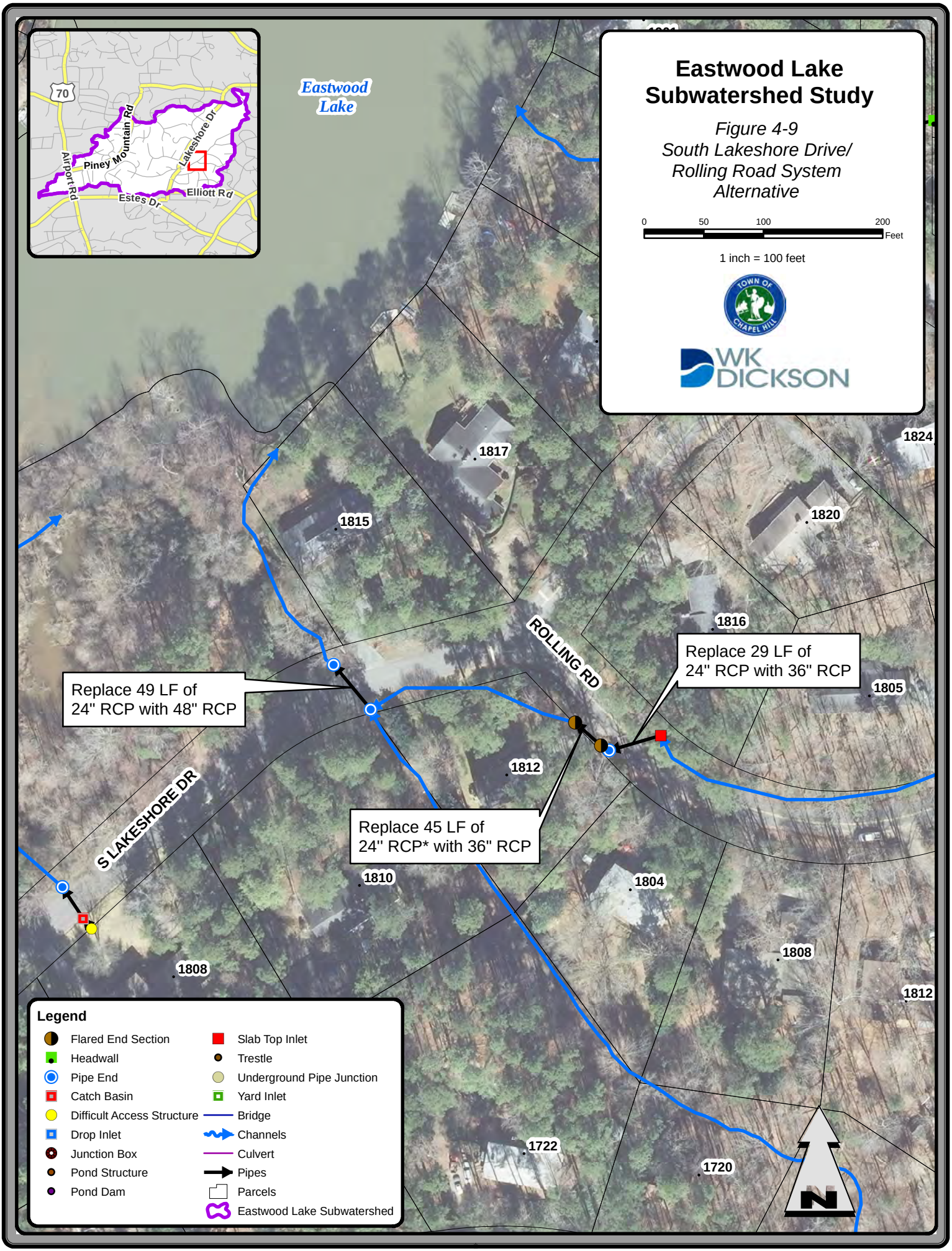
South Lakeshore Drive/Rolling Road Closed System

WK Dickson recommends the following improvements for the South Lakeshore Drive /Rolling Road Closed System as shown in Figure 4-9:

- Replace 45 LF of 24" RCP with 36" RCP across Rolling Road,
- Replace 29 LF of 24" RCP with 36" RCP (driveway culvert at 1812 South Lakeshore Drive); and
- Replace 49 LF of 24" RCP with 48" RCP across South Lakeshore Drive.

The proposed improvements will provide the desired 10-year level of service for the South Lakeshore Drive /Rolling Road Closed System. While a significant portion of the project will be located within the public right-of-way, there will be approximately 30 linear feet that will be located on private property. The driveway and landscaping at 1812 South Lakeshore Drive will be impacted. Underground water and sanitary sewer lines were identified as potential utility conflicts. Other potential site restrictions include overhead power lines. The total estimated cost for the recommended alternative is $216,800. Due to their close proximity, the proposed improvements to the South Lakeshore Drive/Rolling Road system should be coupled with the adjacent stream stabilization recommendations shown as Project 9 – Allard 2 in Section 6.1 (Page 6-9).


Eastwood Lake Subwatershed Study
Figure 4-8
South Lakeshore Drive/
Ridgecrest Drive System
Alternative
0
50
100
200
Feet
1 inch = 100 feet
TOWN OF CHAPEL HILL
WK DICKSON
70
Piney Mountain Rd
Lakeshore Dr
Airport Rd
Estes Dr
Elliott Rd
Eastwood Lake
1921
2000
1917
RIDGECREST DR
1913
1920
429
1909
S LAKESHORE DR
Replace and lower
127 LF of 15" RCP
with 18" RCP
1908
Legend
Flared End Section
Headwall
Pipe End
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Pond Structure
Pond Dam
Slab Top Inlet
Trestle
Underground Pipe Junction
Yard Inlet
Bridge
Channels
Culvert
Pipes
Parcels
Eastwood Lake Subwatershed
N


Eastwood Lake Subwatershed Study
Figure 4-9
South Lakeshore Drive/
Rolling Road System
Alternative
0
50
100
200
Feet
1 inch = 100 feet
TOWN OF CHAPEL HILL
WK DICKSON
Eastwood Lake
70
Piney Mountain Rd
Lakeshore Dr
Airport Rd
Estes Dr
Elliott Rd
ROLLING RD
S LAKESHORE DR
Replace 49 LF of
24" RCP with 48" RCP
Replace 29 LF of
24" RCP with 36" RCP
Replace 45 LF of
24" RCP* with 36" RCP
1824
1817
1815
1820
1816
1805
1812
1810
1804
1808
1722
1720
Legend
Flared End Section
Headwall
Pipe End
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Pond Structure
Pond Dam
Slab Top Inlet
Trestle
Underground Pipe Junction
Yard Inlet
Bridge
Channels
Culvert
Pipes
Parcels
Eastwood Lake Subwatershed
N

A summary of the hydraulic performance for the improvements proposed are include in Table 4-2. Water surface elevations are included for existing conditions, future land use conditions with no improvements, and future land use conditions with all proposed primary system improvements constructed. The level of improvement will be reduced if all projects are not implemented.

Table 4-2: Hydraulic Performance for Eastwood Lake – West and East

Location	Minimum Elevation at Top of Road (feet NAVD)	Desired Level of Service (Year)	Calculated Water Surface Elevations (feet NAVD)				
			2-year flood	10-year flood	25-year flood	50-year flood	100-year flood
			EXISTING	EXISTING	EXISTING	EXISTING	EXISTING
			FUTURE	FUTURE	FUTURE	FUTURE	FUTURE
			FUTURE W/ ALL PROJECTS	FUTURE W/ ALL PROJECTS	FUTURE W/ ALL PROJECTS	FUTURE W/ ALL PROJECTS	FUTURE W/ ALL PROJECTS
BOOKER CREEK							
North Lakeshore Drive	301.63	100	298.73	301.06	**302.31**	**302.52**	**302.61**
			299.02	**301.75**	**302.44**	**302.57**	**302.66**
			298.52	301.51	**302.26**	**302.43**	**302.47**
Piney Mountain Road	385.66	100	378.56	383.64	**386.70**	**387.32**	**387.72**
			379.80	**386.15**	**387.13**	**387.70**	**388.00**
			379.20	383.21	385.42	**386.61**	**387.00**

*Bold text indicates the existing water surface has exceeded the lowest elevation at the road thereby causing flooding.
**Green shade indicates crossing meets desired level of service. Red shade indicates crossing does not meet desired level of service.

Table 4-3 shows the 2-,10-, 25-, 50-, and 100-year WSEL reductions at primary system roadway crossings when comparing the future conditions with and without the implementation of the improvements proposed as part of this Section. The water surface reductions shown in Table 4-3 are the cumulative benefits when all of the proposed storage area projects are implemented.

Table 4-3: WSEL Reductions for Future Conditions

Location	Decrease in Water Surface Elevations (feet NAVD)				
	2-year flood	10-year flood	25-year flood	50-year flood	100-year flood
North Lakeshore Drive	0.50	0.24	0.18	0.14	0.19
Piney Mountain Road	0.60	2.94	1.71	1.09	1.00

4.4 HYDROLOGY

The future land use was accounted for during the development of the proposed improvements. The hydrologic parameters including curve numbers and percent impervious were adjusted for the future conditions and alternatives models.

Peak flows for the primary systems were developed for the 2-, 10-, 25-, 50-, and 100-year storm events considering the future conditions and proposed alternatives (future with all projects). The future conditions peak flows are summarized in Table 4-4. In comparison to the existing conditions flows, the future conditions flows increase between 0 and 11 percent for the 25-year storm. The future flows with all projects were developed from the future conditions taking into account attenuation for the proposed storage areas. The flood storage proposed in the watershed contributes to the alternative flows being less than the future flows. The reductions in flows provided by the proposed detention projects in the alternative are presented in Table 4-5.

Table 4-4: Future Conditions Flows from HEC-HMS for Eastwood Lake Subwatershed

HEC-HMS Node	Road Name / Location	HEC-RAS Station	Storm Event				
			2-year (cfs)	10-year (cfs)	25-year (cfs)	50-year (cfs)	100-year (cfs)
			EXISTING FUTURE FUTURE W/ ALL PROJECTS	EXISTING FUTURE FUTURE W/ ALL PROJECTS	EXISTING FUTURE FUTURE W/ ALL PROJECTS	EXISTING FUTURE FUTURE W/ ALL PROJECTS	EXISTING FUTURE FUTURE W/ ALL PROJECTS
ADD-CB-BH	Confluence of Crow Branch and Booker Creek	21577	505 583 549	1,018 1,128 1,006	1,318 1,478 1,311	1,600 1,750 1,585	1,837 1,976 1,744
Piney Mountain Rd – Booker Ck	Piney Mountain Road	20223	566 634 524	1,022 1,134 1,028	1,373 1,519 1,365	1,661 1,804 1,642	1,899 2,030 1,803
ADD-EL-50	Upstream of Eastwood Lake	16524	603 675 538	1,059 1,165 1,057	1,419 1,559 1,407	1,714 1,853 1,689	1,950 2,075 1,850
N Lakeshore Dr – Booker Ck	North Lakeshore Drive	15024	615 687 542	1,070 1,174 1,065	1,431 1,570 1,416	1,728 1,865 1,699	1,964 2,086 1,863
Eastwood Lake	Downstream of Eastwood Lake	11352	668 697 589	1,641 1,714 1,538	2,217 2,335 2,107	2,614 2,865 2,563	2,850 3,444 2,789

Table 4-5: Flow Reductions for Future vs. Future with All Projects for Eastwood Lake Subwatershed

HEC-HMS Node	Road Name / Location	HEC-RAS Station	Storm Event				
			2-year (cfs)	10-year (cfs)	25-year (cfs)	50-year (cfs)	100-year (cfs)
ADD-CB-BH	Confluence of Crow Branch and Booker Creek	21577	6%	11%	11%	9%	12%
Piney Mountain Rd – Booker Ck	Piney Mountain Road	20223	17%	9%	10%	9%	11%
ADD-EL-50	Upstream of Eastwood Lake	16524	20%	9%	10%	9%	11%
N Lakeshore Dr – Booker Ck	North Lakeshore Drive	15024	21%	9%	10%	9%	11%
Eastwood Lake	Downstream of Eastwood Lake	11352	15%	13%	10%	5%	5%

4.5 HYDRAULICS

The hydraulic analysis for the proposed conditions was similar to the analysis completed for the existing conditions. The model was updated to reflect the proposed culvert improvements and changes in flows.

CONDITION ASSESSMENT

As part of the Eastwood Lake Subwatershed Study, a preliminary condition assessment was completed to identify high priority areas for detailed CCTV and/or maintenance needs. The prioritization is based on the likelihood of asset failure, as well as the consequence of asset failure. By evaluating the likelihood of asset failure in relation to the consequence of asset failure, a combined criticality score is then developed for each asset. This criticality score can enable the Town to more strategically evaluate which assets to focus capital improvement resources on for repair, rehabilitation or further condition assessments. This section summarizes the results of a GIS audit and the scoring criteria and methodology used in developing the condition assessment.

5.1 PROJECT BACKGROUND

WK Dickson collected and analyzed the stormwater infrastructure data which included GIS stormwater data, building and transportation locations, and geographic features. This data was audited to determine the availability of necessary attribute information to conduct the criticality analysis. The results of the GIS data audit were shared with the Town and resolution of critical data gaps was coordinated with Town staff. Upon resolution of the identified data gaps, WK Dickson performed a criticality assessment by running the criticality toolset to generate results. The results of this prioritization are included in this report as the findings of asset criticality within the Eastwood Lake subwatershed. The detailed methodology for customizing the prioritization tool for the Town can be found in Appendix I.

5.2 CRITICALITY ANALYSIS

After the scoring criteria and attribute analysis was completed, the pipe and structure matrices (See Appendix I) were populated and the asset criticality analysis was run. The results presented in Exhibit 5-1, Figure 5-1, and Figure 5-2 indicate color coded scoring ranges based on a statistical Jenks optimization method for distribution among the asset scores. As a result, the highest scoring assets indicate the most critical assets in terms of overall risk due to consequence and likelihood of failure. The critical assets for stormwater pipes and structures are indicated in red on both the maps and the graphs. Since there are a different number of assets for each utility system grouping, the distribution range differs slightly.

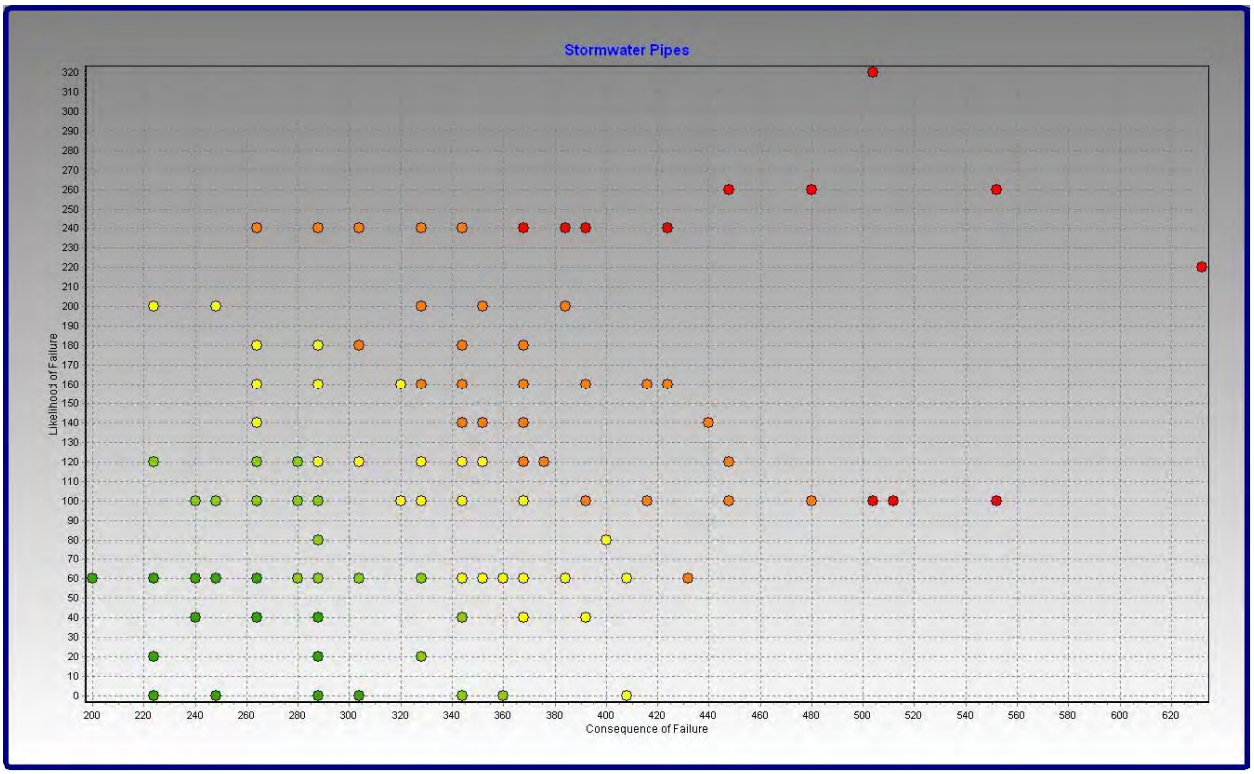
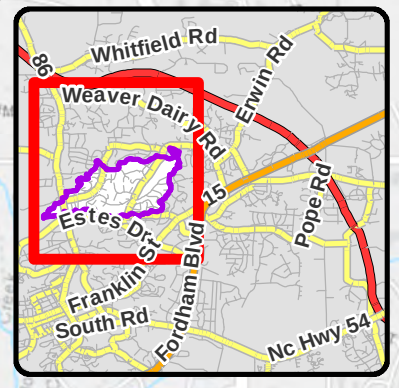


Exhibit 5-1: Stormwater Pipes Scoring Results



Eastwood Lake Subwatershed Study

Figure 5-1
Stormwater Pipes
Scoring Results Map

0 750 1,500 3,000 Feet

1 inch = 1,500 feet

TOWN OF CHAPEL HILL

WK DICKSON

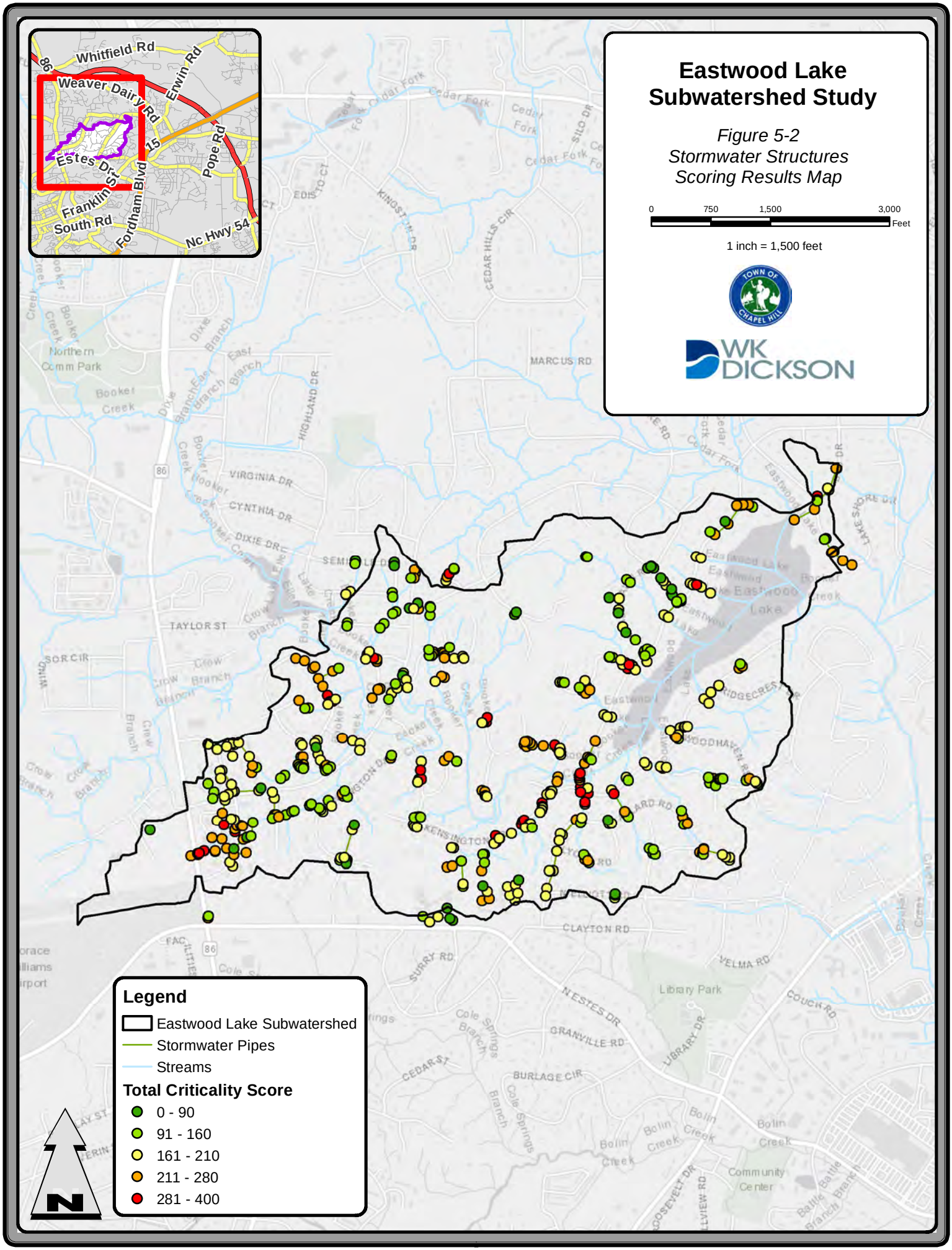
Legend

- Eastwood Lake Subwatershed
- Streams

Total Criticality Score

- 224 - 328
- 329 - 400
- 401 - 480
- 481 - 584
- 585 - 852

N


Eastwood Lake Subwatershed Study
Figure 5-2
Stormwater Structures Scoring Results Map
0
750
1,500
3,000
Feet
1 inch = 1,500 feet
TOWN OF CHAPEL HILL
WK DICKSON
Whitfield Rd
Weaver Dairy Rd
Erwin Rd
Estes Dr
Pope Rd
Franklin St
Fordham Blvd
South Rd
Nc Hwy 54
15
86
Legend
Eastwood Lake Subwatershed
Stormwater Pipes
Streams
Total Criticality Score
0 - 90
91 - 160
161 - 210
211 - 280
281 - 400
N
Northern Comm Park
Booker Creek
MARCUS RD
VIRGINIA DR
CYNTHIA DR
DIXIE DR
TAYLOR ST
CLAYTON RD
SURRY RD
N ESTES DR
GRANVILLE RD
CEDAR ST
BURLAGE CIR
Library Park
Community Center
Eastwood Lake
Cedar Fork
Crow Branch
Cole Springs Branch
Bolin Creek
Battle Branch

5.3 IDENTIFICATION OF CRITICAL INFRASTRUCTURE

Table 5-1 summarizes the number of stormwater pipe assets falling into each scoring range. A single pipe asset is defined as a section of pipe between either two (2) structures or between a structure and an outfall. The table presents the total criticality score as well as the likelihood and consequence scores.

When reviewing the table, it is important to recognize the purpose of establishing natural breaks within the data is to determine a criticality level for evaluating each asset. This criticality level is used to determine the overall scoring of assets that will be targeted during a rehabilitation project. Typically, those assets scoring in criticality level 4 or 5 are classified as the highest priority for rehabilitation efforts. Assets ranked in criticality level 3 are typically considered to need rehabilitation or further condition assessment evaluation.

Table 5-1 shows the criticality levels for stormwater pipes. Of the 385 pipes evaluated, 31% of stormwater pipes scored in Level 4 or 5 indicating the highest need for stormwater rehabilitation efforts. Similarly, 31% of stormwater pipes scored in criticality Level 3. These assets should be evaluated further to determine whether rehabilitation is necessary or whether the 'consequence of failure' criteria are skewing factors for the elevated criticality scores. An example of this scenario would be a stormwater pipe in overall good condition located close to a stormwater structure, a critical facility, and/or under major transportation infrastructure. The pipe's good condition would yield a lower 'likelihood of failure' score but the pipe's location would cause a higher 'consequence of failure' rating, resulting in a higher criticality score.

Table 5-1: Stormwater Pipes Scoring Summary and Distribution

Total Criticality Score Distribution					
	Low	→			**High**
	Level 1	**Level 2**	**Level 3**	**Level 4**	**Level 5**
	0-328	**329-400**	**401-480**	**481-584**	**>584**
Stormwater Pipes	48	98	120	103	16
Likelihood Score Distribution					
	0-60	**61-120**	**121-160**	**161-200**	**>201**
Stormwater Pipes	98	137	79	38	33
Consequence Score Distribution					
	0-264	**265-320**	**321-376**	**377-448**	**>448**
Stormwater Pipes	139	78	127	33	8

Table 5-2 shows the criticality levels for stormwater structures. Within the assets evaluated 39% of the structures score in Level 4 or 5 indicating the highest need for stormwater structure rehabilitation efforts. Similarly, 32% of stormwater structures score in criticality Level 3. These assets should be evaluated further to determine whether rehabilitation is necessary or whether the 'consequence of failure' criteria are the skewing factors for the elevated criticality scores.

Table 5-2: Stormwater Structures Scoring Summary and Distribution

Total Criticality Score Distribution					
	Low		→		**High**
	Level 1	**Level 2**	**Level 3**	**Level 4**	**Level 5**
	0-90	**91-160**	**161-210**	**211-280**	**>280**
Stormwater Structures	36	109	161	140	58
Likelihood Score Distribution					
	0	**1-20**	**21-60**	**61-100**	**>100**
Stormwater Structures	216	10	1	1	276
Consequence Score Distribution					
	0	**1-70**	**71-150**	**151-220**	**>220**
Stormwater Structures	7	121	233	130	13

5.4 TOWN-MAINTAINED ASSET ANALYSIS

Streets in the Eastwood Lake subwatershed are the responsibility of one of three (3) entities: NCDOT, Town, and private owners. In an effort to further refine the prioritization of assets, the Town requested WK Dickson provide a separate analysis of criticality scoring for stormwater structures and pipes that lie within Town-maintained rights-of-way. Limiting the criticality analysis to Town-maintained ROW eliminated Martin Luther King Jr. Boulevard from the project area.

Stormwater assets adjacent to privately-owned roads were also eliminated from the study. Overall, 86.5% of stormwater structures and 86.5% of stormwater pipes fall within Town-maintained areas. Exhibit 5-2 presents the detailed results of this analysis in the same manner as the overall criticality analysis.

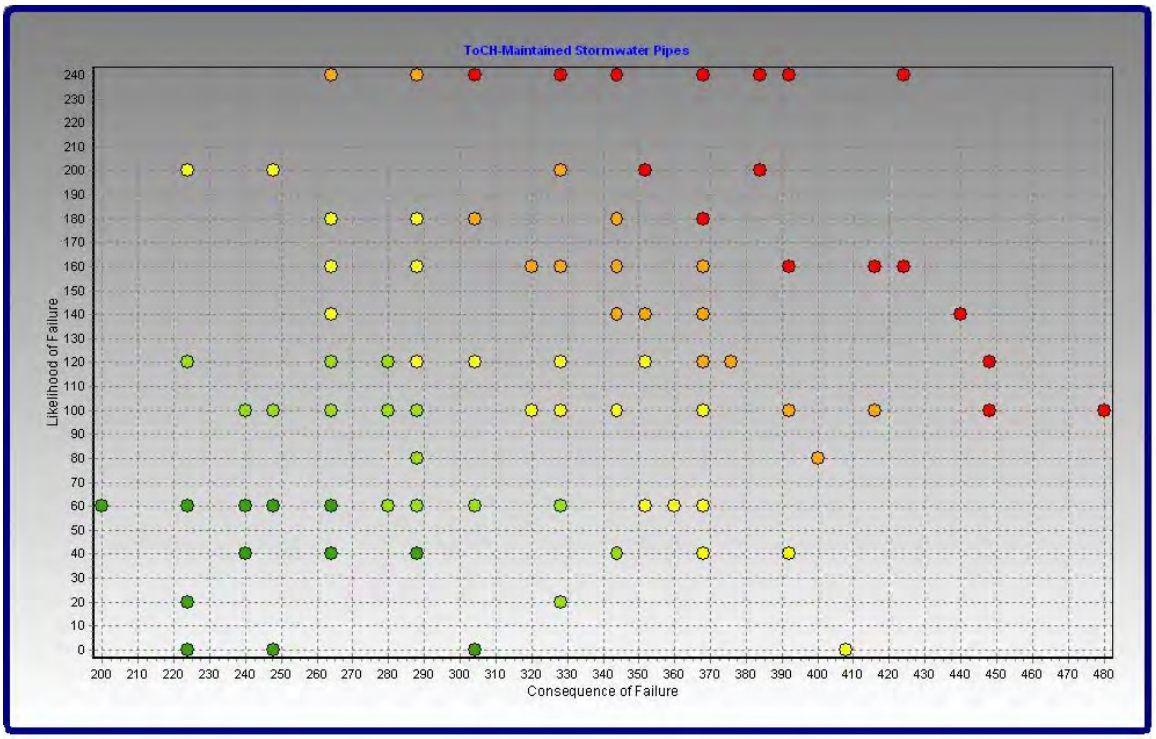
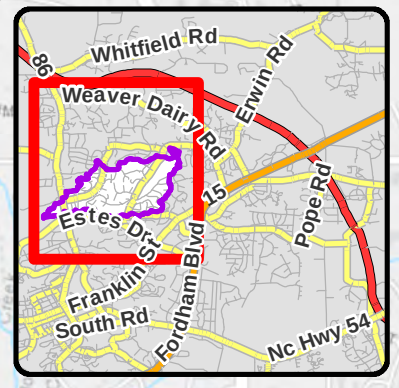


Exhibit 5-2: Town-Maintained Stormwater Pipes Scoring Results



Eastwood Lake Subwatershed Study

Figure 5-3
Town Maintained Stormwater Pipes Scoring Results Map

0 750 1,500 3,000 Feet

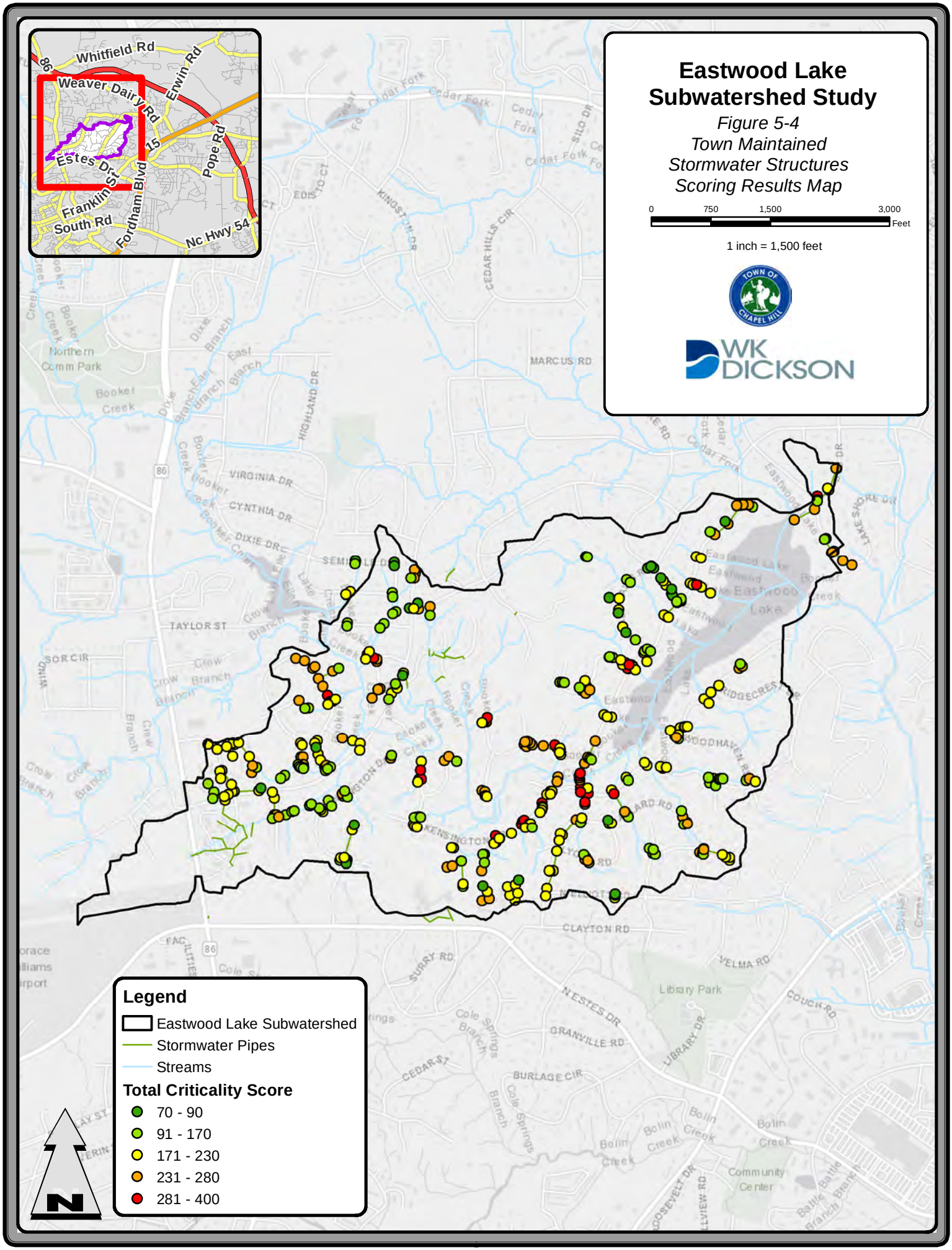
1 inch = 1,500 feet

Legend

- Eastwood Lake Subwatershed
- Streams

Total Criticality Score

- 224 - 328
- 329 - 400
- 401 - 472
- 473 - 528
- 529 - 664


Eastwood Lake Subwatershed Study
Figure 5-4
Town Maintained Stormwater Structures Scoring Results Map
0
750
1,500
3,000
Feet
1 inch = 1,500 feet
TOWN OF CHAPEL HILL
WK DICKSON
Whitfield Rd
Weaver Dairy Rd
Erwin Rd
Estes Dr
15
Pope Rd
Franklin St
Fordham Blvd
South Rd
Nc Hwy 54
86
Legend
Eastwood Lake Subwatershed
Stormwater Pipes
Streams
Total Criticality Score
70 - 90
91 - 170
171 - 230
231 - 280
281 - 400
N
Northern Comm Park
Booker Creek
Dixie Branch
East Branch
MARCUS RD
HIGHLAND DR
VIRGINIA DR
CYNTHIA DR
DIXIE DR
TAYLOR ST
Crow Branch
CLAYTON RD
SURRY RD
NESTES DR
GRANVILLE RD
CEDAR ST
BURLAGE CIR
Cole Springs Branch
Library Park
YELMA RD
COUCH RD
Bolin Creek
Community Center
Eastwood Lake
CEDAR HILLS CIR
KINGSTON DR
EDISTO CT
SILO DR
Cedar Fork

Tables 5-3 and 5-4 indicate the number of Town-maintained assets falling into each scoring range for the stormwater pipes and structures, respectively. The tables present the total criticality score as well as the likelihood and consequence scores.

Table 5-3 shows the criticality levels for Town-maintained stormwater pipe assets falling into each scoring range. Of the 333 pipes evaluated 32% scored in Level 4 or 5 indicating the highest need for stormwater rehabilitation efforts. Similarly, 30% of stormwater pipes scored in criticality Level 3. These assets should be evaluated further to determine whether rehabilitation is necessary or whether the 'consequence of failure' criteria are the skewing factors for the elevated criticality scores.

Table 5-3: Town Stormwater Pipes Scoring Summary and Distribution

Total Criticality Score Distribution					
	Low		→		**High**
	Level 1	**Level 2**	**Level 3**	**Level 4**	**Level 5**
	0-328	**329-400**	**401-472**	**473-528**	**>528**
Stormwater Pipes	41	85	101	65	41
Likelihood Score Distribution					
	0-20	**21-60**	**61-120**	**121-200**	**>200**
Stormwater Pipes	7	66	122	110	28
Consequence Score Distribution					
	0-264	**265-304**	**305-352**	**353-400**	**>400**
Stormwater Pipes	131	60	61	69	12

Table 5-4 shows the criticality levels for Town-maintained stormwater structures. Within the assets evaluated 39% of the structures scored in Level 4 or 5 indicating the highest need for stormwater structure rehabilitation efforts. Similarly, 34% of stormwater structures score in criticality Level 3. These assets should be evaluated further to determine whether rehabilitation is necessary or whether the 'consequence of failure' criteria are the skewing factors for the elevated criticality scores.

Table 5-4: Town Stormwater Structures Scoring Summary and Distribution

Total Criticality Score Distribution					
	Low		→		**High**
	Level 1	**Level 2**	**Level 3**	**Level 4**	**Level 5**
	0-90	**91-170**	**171-230**	**231-280**	**>280**
Stormwater Structures	26	97	147	115	57
Likelihood Score Distribution					
	0	**1-20**	**21-60**	**61-100**	**>100**
Stormwater Structures	190	10	1	1	234
Consequence Score Distribution					
	0	**1-70**	**71-140**	**141-220**	**>220**
Stormwater Structures	4	102	198	123	9

5.5 FUTURE USE OF PRIORITIZATION TOOL

Because the data in the GIS database are dynamic, the results of the prioritization tool are a static representation based upon when the tool is run. As data are updated in the database, the tool can be utilized, and the results of the prioritization process can be updated easily. Typically, a jurisdiction may use a prioritization tool such as this on an annual or semi-annual basis as budgets are developed and capital plans and O&M plans are revised.

It should be noted that the criticality rating system will always generate assets that are rated as high-risk components. The rating system is a relative one, where the risk of a particular asset is rated relative to the other assets that are also evaluated. Therefore, the Town will always have assets that rank in the Level 4 or Level 5 risk category. As these assets are rehabilitated, replaced or repaired their likelihood of failure score will improve and their total risk rating can be reduced. Meanwhile, lower at-risk components will age and deteriorate over time and their risk scores will increase.

A valuable component of this dynamic prioritization tool is the ability to quickly perform different scenario analyses in order to determine the relative benefit of capital and O&M projects. The Town can determine if the at-risk score of a particular component can be dramatically reduced by improvement. In some cases, the consequence of failure score is so high that an improved asset will always remain in the high-risk category. These assets can be monitored on a frequent basis to consistently check their condition and proactively work to prevent a failure.

Conversely, assets with the greatest likelihood of failure scores are often the target of initial condition assessment and rehabilitation programs. Town staff can perform scenario analysis to determine where condition assessment and rehabilitation programs can most reduce the at-risk scores of critical assets.

WATER QUALITY RECOMMENDATIONS

Traditional drainage management has typically been designed to reduce flooding by collecting runoff from impervious surfaces and discharging it directly into a stream causing erosion and deterioration of water quality. Runoff from impervious areas can collect high concentrations of pollutants and nutrients that, if left untreated, can cause negative impacts to water quality in the receiving waters. Negative impacts may include less biodiversity, poor habitat, hazards to macroinvertebrate health, as well as human health hazards. Many communities in North Carolina now require some form of water quality treatment for new development; however, existing developments typically have little or no water quality treatment.

This study considered both stream stabilization and SCM retrofit projects as means of improving water quality. Stream stabilization projects can be constructed to reduce instream sediment loads and to protect private property from further erosion. SCMs can be constructed to treat runoff prior to being discharged to the stormwater conveyance system and the receiving waters of the system. Adding or retrofitting SCMs in existing developments can be difficult due to limited space and other constraints. Stream stabilization and SCM retrofit projects identified in the Eastwood Lake Subwatershed Study are described below.

6.1 STREAM STABILIZATION PROJECTS

Based on the field assessments, fourteen (14) stream reaches were identified as candidates for improvements. The locations of these reaches are shown on Figures 6-1 and 6-2. A list of steam stabilization techniques, arranged in order of less intensive to more intensive in implementation, follows:

1. Streambank stabilization
2. Head-cut stabilization and stream channel grade control
3. Perched culvert rectification
4. Stream channel restoration/relocation
5. Regenerative stormwater conveyances (RSC)

See Appendix K for pictures and a more detailed description of the listed stream stabilization techniques. These techniques were considered separately and in combination to determine an appropriate plan for each respective reach. Table 6-1 summarizes the proposed improvements for each reach.

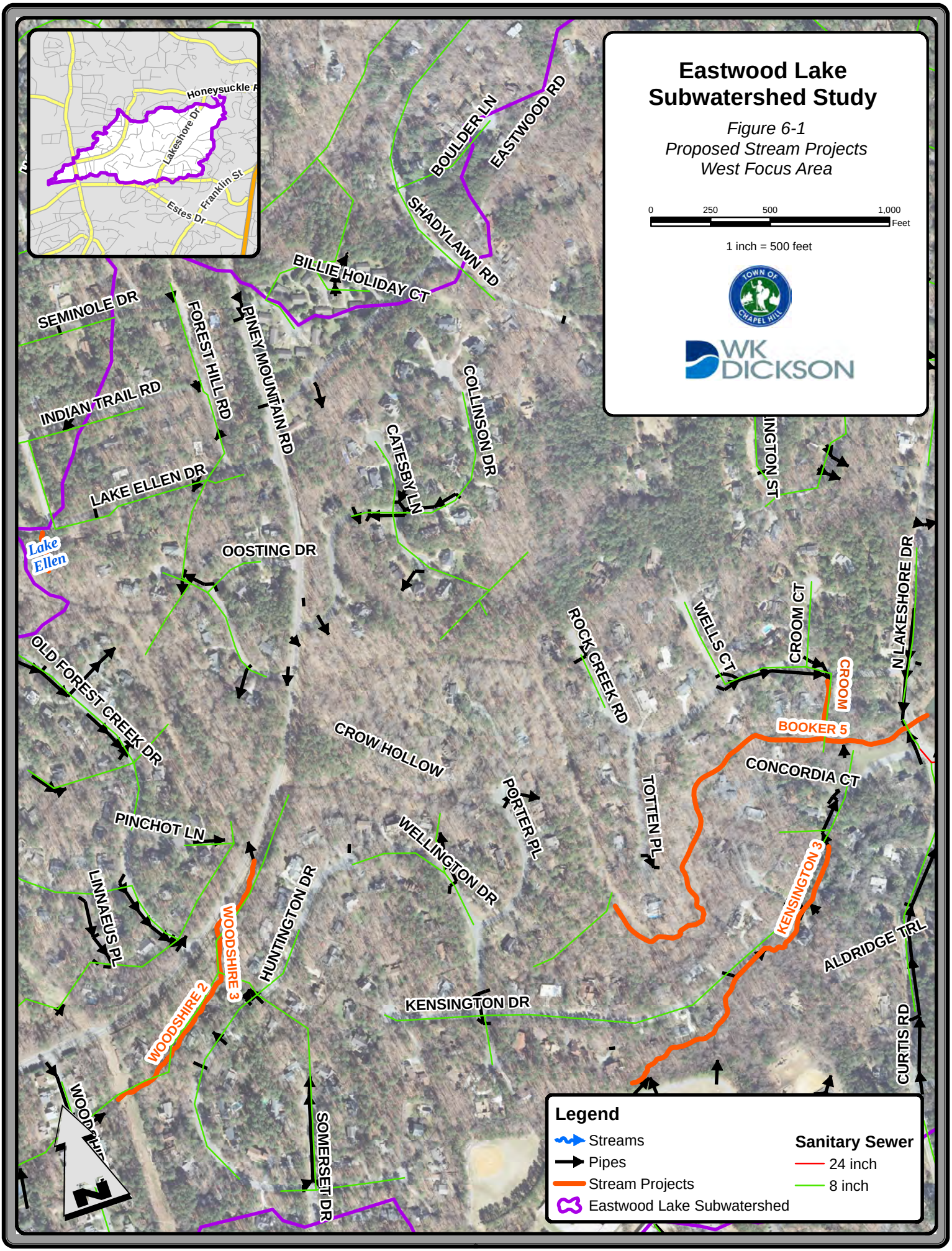
Table 6-1: Summary of Stream Stabilization Projects*

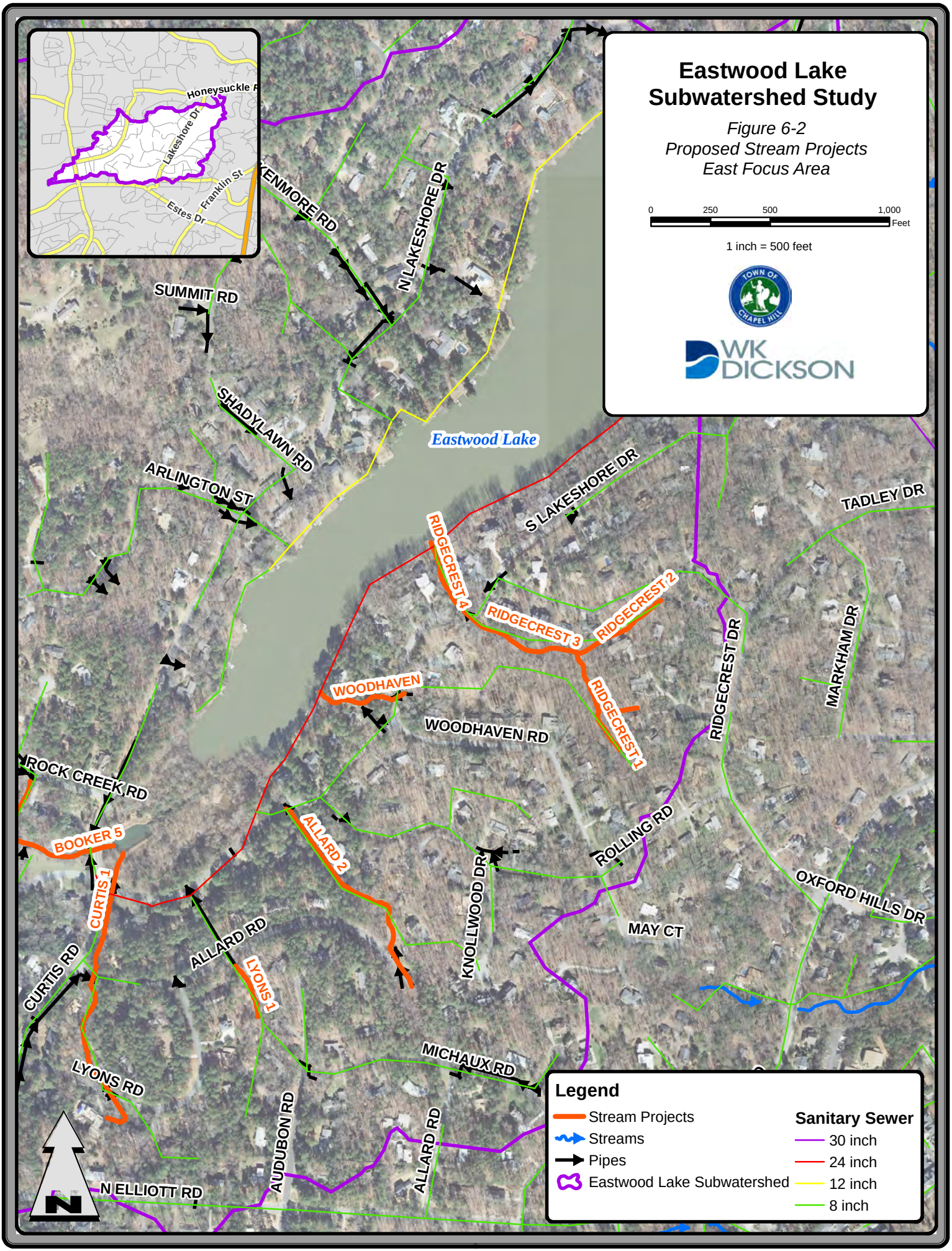
Project	Reach Name	Project Type	Reach and Habitat Score	Reach Length (feet)	Approx. Project Length (LF)
1	Woodshire 2	Stabilize channel, potentially move channel away from houses and existing hardened bank structures beside residences	161	687	200
2	Woodshire 3	Stabilize channel, protect sewer infrastructure	154	564	564
3	Lake Ellen 1	Stabilize banks and channel, RSC	112	168	168
4	Booker 5	Stabilize banks at various locations through reach	201	2,191	1,500
5	Croom	Stabilize outfall and incised channel downstream	169	245	245
6	Kensington 3	Stabilize identified driveway culvert outfalls and channel	206	1,433	200
7	Curtis 1	Stabilize identified driveway culvert outfalls and channel	197	1,292	200
8	Lyons 1	Stabilize channel, protect sewer infrastructure	148	241	241
9	Allard 2	Stabilize channel, protect sewer infrastructure	148	1,229	1,229
10	Woodhaven	Stabilize channel, protect sewer infrastructure	153	395	395
11	Ridgecrest 1	Stabilize channel, protect sewer infrastructure	122	210	210
12	Ridgecrest 2	Stabilize channel, protect sewer infrastructure	90	429	429
13	Ridgecrest 3	Stabilize channel, protect sewer infrastructure	145	872	872
14	Ridgecrest 4	Stabilize channel, protect sewer infrastructure	175	410	410
		TOTALS		10,370	6,863

*Projects are not listed in order of priority in Table 6-1. See Section 9 for prioritization list.

The most common recommendation was streambank stabilization, head-cut stabilization and stream grade control, which in relative comparison, are usually less expensive on a linear foot basis than the techniques that follow it in the list above.

A RSC is listed as a potential improvement at one (1) location. This technique utilizes stream bank and channel stabilization structures, consisting of boulders, cobble and gravel, over a bed of a sand and mulch mixture. RSCs have been shown to stabilize eroding stream channels, reduce pollutant loads, provide a measure of stormwater storage and potentially create aquatic habitat.


Eastwood Lake Subwatershed Study
Figure 6-1
Proposed Stream Projects
West Focus Area
0
250
500
1,000
Feet
1 inch = 500 feet
TOWN OF CHAPEL HILL
WK DICKSON
Honeysuckle R
Lakeshore Dr
Franklin St
Estes Dr
BOULDER LN
EASTWOOD RD
SHADYLAWN RD
BILLIE HOLIDAY CT
SEMINOLE DR
FOREST HILL RD
PINEY MOUNTAIN RD
COLLINSON DR
INDIAN TRAIL RD
CATESBY LN
LAKE ELLEN DR
Lake Ellen
OOSTING DR
INGTON ST
N LAKESHORE DR
ROCK CREEK RD
WELLS CT
CROOM CT
CROOM
BOOKER 5
OLD FOREST CREEK DR
CROW HOLLOW
CONCORDIA CT
PORTER PL
TOTTEN PL
PINCHOT LN
WELLINGTON DR
LINNAEUS PL
WOODSHIRE 3
HUNTINGTON DR
KENSINGTON 3
ALDRIDGE TRL
WOODSHIRE 2
KENSINGTON DR
CURTIS RD
SOMERSET DR
Legend
Streams
Pipes
Stream Projects
Eastwood Lake Subwatershed
Sanitary Sewer
24 inch
8 inch


Eastwood Lake Subwatershed Study
Figure 6-2
Proposed Stream Projects
East Focus Area
0 250 500 1,000 Feet
1 inch = 500 feet
TOWN OF CHAPEL HILL
WK DICKSON
Eastwood Lake
KENMORE RD
N LAKESHORE DR
SUMMIT RD
SHADYLAWN RD
ARLINGTON ST
S LAKESHORE DR
TADLEY DR
RIDGECREST 4
RIDGECREST 3
RIDGECREST 2
RIDGECREST 1
RIDGECREST DR
MARKHAM DR
WOODHAVEN
WOODHAVEN RD
ROCK CREEK RD
BOOKER 5
CURTIS 1
ALLARD 2
ALLARD RD
KNOLLWOOD DR
ROLLING RD
OXFORD HILLS DR
MAY CT
CURTIS RD
LYONS 1
LYONS RD
MICHAUX RD
AUDUBON RD
ALLARD RD
N ELLIOTT RD
Legend
Stream Projects
Streams
Pipes
Eastwood Lake Subwatershed
Sanitary Sewer
30 inch
24 inch
12 inch
8 inch

Stream Stabilization Project 1: Woodshire 2

Woodshire 2 is located south of Piney Mountain Road upstream of the Huntington reach. Most of the project is located on private, residential property in the Cooker Woods West subdivision. The stream channel flows closely beside or behind three (3) residences along Huntington Drive. Several perched culverts are located along this section of the stream. An 8" sewer line parallels the stream which makes relocation challenging. Additionally, a stream located so close to residential housing can be perceived as a landscaping feature to residents further complicating moving the stream.

Picture 6-1: Woodshire 2 – Driveway Culverts

The proposed project would likely include stabilization of the channel near eroding driveway crossings, including resolving the perched culverts. The Town should consider moving the stream to the north immediately downstream of the 217 Huntington Drive driveway crossing, which could allow for incorporating restoration techniques and reduce the potential for structural damage to the nearby residences. Private property owner approval would be required for the project to move forward. If the homeowners are not interested in moving the stream, additional spot bank stabilization would be required. The sewer easement provides good access to most of this reach.

Picture 6-2: Woodshire 3 – Stream Crossing

Stream Stabilization Project 2: Woodshire 3

Woodshire 3 is located southeast of Piney Mountain Road, downstream of the confluence between the Woodshire 2 reach and the Huntington reach. The channel alignment is close to the road embankment of Piney Mountain Road along much of this reach with eroding banks that may ultimately compromise road stability. This project includes bank stabilization and channel grade control to protect Piney Mountain Road and the existing sewer line. A sewer line is located beside the stream, mostly on the right bank, providing a narrow corridor for potential stream stabilization. The sewer easement provides good access to most of this reach.

Stream Stabilization Project 3: Lake Ellen 1

Lake Ellen 1 is a short reach located south of Lake Ellen Drive, downstream of Lake Ellen between two (2) residential properties. The channel is very deeply incised, and the banks are eroding and falling into the channel. Repair options are to: (1) stabilize the channel in place, with grade control and hardened structures along the channel to control bank erosion; or (2) install a regenerative stormwater conveyance or similar device, which creates a sequence of step pools out of an underlying substrate of sand and mulch, with boulder structures used to stabilize the channel bed and banks. The site can be most easily accessed from the sewer right of way on Booker Creek. Repairs on this site are challenging due to access and the deeply incised condition of the existing channel.

Picture 6-3: Lake Ellen 1 – RSC Opportunity

Picture 6-4: Booker 5 – Bank Stabilization

Stream Stabilization Project 4: Booker 5

The Booker 5 reach is located along the main stem of Booker Creek upstream of Eastwood Lake. The surrounding land use is generally wooded residential lots. Approximately 1,500 feet of this 2,191-foot reach needs bank stabilization (on one or both banks) and in some places channel grade control. Repairs include stabilization of both banks for 200 feet on the upstream end, bank stabilization on the right bank farther downstream, bank stabilization on the left bank adjacent to a sewer manhole farther downstream, and bank and streambed stabilization on the lower section as it approaches North Lakeshore Drive. The sewer easement provides good access to this reach.

Stream Stabilization Project 5: Croom

The Croom reach is located south of Rock Creek Road, downstream of the upstream reach that parallels Croom Road. The outfall under Croom Road is perched approximately 5 feet above the channel and extensive erosion is taking place here threatening the future structural integrity of the culvert and the road above. Downstream, the channel needs stabilization where it is incised approximately 2 to 3 feet. The sewer easement provides good access to this reach.

Picture 6-5: Croom – Perched Culvert

Picture 6-6: Kensington 3 – Bank and Channel Stabilization

Stream Stabilization Project 6: Kensington 3

The Kensington 3 reach is located southeast of Kensington Drive flows north towards Booker Reach 5. Repairs in this reach are limited to two short sections, where bank and channel bed stabilization are needed to control erosion, and one perched driveway outfall that is eroding and threatening the structural integrity of the crossing. Accessibility to this reach is fair, although the entire reach is located on private property. There are no sewer utilities present along this reach.

Stream Stabilization Project 7: Curtis 1

This reach flows north to the Eastwood Lake forebay. The stream includes crossings Lyons Road, Allard Road and South Lakeshore Drive. The proposed repair consists of stabilization of the eroding banks and channel bed on a relatively short 200-foot section that flows behind a residence on private property. A grade control structure will likely be required to keep the head-cut from propagating upstream. Access is fair from the street.

Stream Stabilization Project 8: Lyons 1

Lyons 1 is collects runoff from Michaux Road and Audobon Road flowing north through private properties to a 30" RCP pipe system at Allard Road. The steep stream has significant head-cuts and bank erosion resulting in sediment loads entering directly to Eastwood Lake downstream of the forebay. A sanitary sewer line is located along the west bank and may be contributing to the bank erosion. Repairs in this reach include establishing reliable grade control in the channel bed, repairing the head-cuts, protecting the sewer line system, and establishing riparian buffer vegetation. Access is good along the sewer easement.

Picture 6-7: Lyons 1 – Bank Stabilization

Picture 6-8: Allard 2 – Stream Stabilization

Stream Stabilization Project 9: Allard 2

Allard 2 flows northwest to Eastwood Lake through residential properties between Rolling Road and Allard Road. A sanitary sewer is located along the left bank similar to the Lyons 1 reach. The steep terrain and limited vegetated buffer has resulted in multiple head-cuts and significant bank erosion. Potential stabilization activities in this reach include establishing reliable grade control in the channel bed, repairing the head-cuts, and protecting the sewer line system. Access to the channel is good along the sewer.

Stream Stabilization Project 10: Woodhaven

This reach is located north of Woodhaven Road and passes under South Lakeshore Drive between Woodhaven Road and Ridgecrest Drive. The erosion concerns are similar to those listed above for Allard 2 and Lyons 1 with steep terrain resulting in head-cuts and bank erosion. Proposed repairs include grade control structures and flattening of the banks to reduce the shear forces. Spot stabilization will also be required immediately downstream of the South Lakeshore Drive crossing. Access is fair along the sewer easement.

The remaining four (4) projects are all part of the same stream network draining Ridgecrest Drive and Rolling Road. The streams ultimately drain to Eastwood Lake through private properties.

Picture 6-9: Ridgecrest 1 – Existing Sewer Manhole

Stream Stabilization Project 11: Ridgecrest 1

Ridgecrest 1 is located in a sewer right-of-way northwest of Woodhaven Road and west of Ridgecrest Drive, and is the southern fork of the upstream end of the reach. Runoff on the steep terrain has created multiple head-cuts and streambank erosion. The project consists of establishing reliable grade control in the channel bed, stabilizing channel banks, and moving the channel to protect the sewer manhole infrastructure that is currently in the channel. Access to the channel is fair along the sewer easement.

Picture 6-10: Ridgecrest 2 – Bank Stabilization

Stream Stabilization Project 12: Ridgecrest 2

This reach is located north of Ridgecrest 1, the northern fork at the upstream end. Similar to the conditions on Ridgecrest 1, runoff on the steep terrain has created multiple head-cuts and streambank erosion. Repairs consist of establishing reliable grade control in the channel bed, stabilizing channel banks, and protecting sewer infrastructure. Access is fair along the sewer easement.

Stream Stabilization Project 13: Ridgecrest 3

Ridgecrest 3 is located downstream of the confluence of Ridgecrest 1 and 2, upstream of South Lakeshore Drive. This reach is also steep, and repairs consist of establishing reliable grade control in the channel bed, stabilizing channel banks, and protecting sewer infrastructure. Access is fair along the sewer easement.

Stream Stabilization Project 14: Ridgecrest 4

This reach is located downstream of South Lakeshore Drive. Repairs consist of stabilizing the outfall under the street, establishing reliable grade control in the channel farther downstream, and stabilizing stream banks. Access is good from a private driveway, if permission is obtained.

6.2 SCM PROJECT IDENTIFICATION

6.2.1 OUTFALL OPPORTUNITIES

As described in Section 3.4 (See Table 3-8), 114 outfalls were assessed and prioritized for retrofit potential based on applying a desktop screening protocol that focused on ten (10) engineering feasibility factors. Outfalls were further evaluated to consider pairing outfall retrofits with identified stream stabilization and flood mitigation projects for holistic watershed solutions. For example, while an outfall opportunity by itself may not have ranked in the top tier, it might be located upstream of a proposed stream restoration reach which elevates its effectiveness and benefit as a retrofit. Additional opportunities (EL0157/EL0162 and EL0520) were added based on field review of existing stormwater control measure infrastructures and community input. Through these processes, ten (10) outfall retrofit opportunities were identified for water quality improvement in the Eastwood Lake subwatershed (Table 6-2).

Table 6-2: Eastwood Lake Outfall Opportunities

	Area (ac)	Location
EL0431	0.034	Within ROW on west side of Piney Mountain Road, south of intersection with Priestly Creek Drive
EL0389	0.017	Within ROW on west side of Piney Mountain Road at Eastwood Road
EL0541	0.014	Within ROW on west side of Piney Mountain Road at Collinson Drive
EL0109	0.022	Northwest corner of Woodhaven Road and Rolling Road
EL0343[1]	0.016	East of Shadowood Drive, south of tennis courts
EL0344[1]	0.016	East of Shadowood Drive, south of tennis courts
EL0074	0.062	North of Michaux Road at Allard Road
EL0545	0.029	Northeast corner of Piney Mountain Road and Eastwood Road
EL0200	0.023	Within ROW on west side of Kenmore Road at North Lakeshore Drive
EL0523	0.015	Southwest of Linneaus Place dead-end
EL0157/EL0162[2]	0.058	Southeast of Arlington Street, in large, undeveloped lot
EL0520[3]	0.410	North of Piney Mountain Road at Woodshire Lane

[1]EL0343 and EL0344 are outfalls that both flow to the same location, see description of Project 5.

[2]EL0157/EL0162 are field identified stormwater dissipater structures that do not rank highly but have been included as an opportunity in response to community input.

[3]EL0520 is the site of an existing but apparently unmaintained stormwater retention area. It is included in this list as an optional unranked opportunity due to its location within an intermittent stream but may be considered if future investigations identify constraints that preclude other higher-ranking sites. This site was not included in the water quality modeling analysis because it is located within an intermittent stream and is considered an optional opportunity.

A more detailed description of the projects follows. In some instances, the figures illustrating the ten (10) outfall retrofit opportunities also show nearby outfall opportunities that did not rank as high. The outfall being described is labeled in yellow, and included in each figure title, respectively.

Project 1: EL0431

Location: Within ROW on west side of Piney Mountain Road, south of intersection with Priestly Creek Drive (See Figure 6-3).

Description of Observed Problems/Opportunity: This site is a roadside drainage and conveyance channel that is not optimized to provide water quality benefits.

Proposed Retrofit: The proposed opportunity is a linear ROW bioretention facility within the existing ephemeral drainage channel at the downstream end of a 24" culvert. There is additional space available along the roadway to treat 0.1 acres of impervious drainage area in a location with few anticipated tree impacts. This location is situated within the existing drainage network downstream of the opportunities identified at EL00541.

Picture 6-11: EL0431

Potential Constraints: Traffic impacts during construction are expected.

Accessibility: The project has good accessibility from Piney Mountain Road.

Comments: The steepness of the site and the relatively narrow ROW pose design concerns, but do not appear to be insurmountable conceptually. The picture is looking northeast towards Priestly Creek Road, with Piney Mountain Road on the right-hand side of the image.

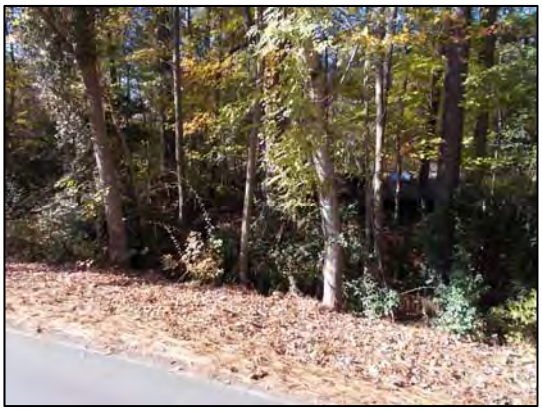
Project 2: EL0389

Location: Within ROW on west side of Piney Mountain Road at Eastwood Road (See Figure 6-4).

Description of Observed Problems/Opportunity: This site is a roadside drainage and conveyance element that is not optimized to provide water quality benefits.

Proposed Retrofit: The proposed opportunity is a linear ROW bioretention facility within the existing ephemeral drainage channel. There is additional space available along the roadway to treat 0.7 acres of impervious drainage area in a location with few anticipated tree impacts. This location is situated within the existing drainage network downstream of opportunities identified at EL0399 and EL0545 and upstream of EL0412 and EL0414.

Potential Constraints: There are potential traffic impacts associated with the construction of this measure.



Picture 6-12: EL0389

Accessibility: The project site is easily accessible from Piney Mountain Road.

Comments: Based on the field review, the topography of this site, and immediate adjacency to private property present greater obstacles to feasibility than the GIS model could detect. Therefore, relative to the other sites that were reviewed in the field, this site's feasibility is low. Picture 6-12 is looking west from the Piney Mountain Road/Eastwood Road intersection.

Project 3: EL0541

Location: Within the ROW on the west side of Piney Mountain Road at Collinson Drive (See Figure 6-5).

Description of Observed Problems/Opportunity: This site is a roadside drainage and conveyance channel that is not optimized to provide water quality benefits.

Proposed Retrofit: The proposed project is a linear ROW bioretention facility within the existing ephemeral drainage channel at the upstream end of a culvert crossing Piney Mountain Road. There is sufficient space available along the roadway to treat a significant portion of the entire 0.2 acres of impervious drainage area in a location with few anticipated tree impacts.

Potential Constraints: The contributing drainage area is small, constraining the opportunity to treat a large volume of runoff in this location.

Accessibility: The project has good accessibility from Piney Mountain Road.

Comments: No outlet found visually at this location, counter to the GIS information, but might be obscured by sediment or buried. However, there is an opportunity to treat roadside stormwater flow with relatively minimal disturbance. This site is just upslope from EL0431 and the outflow from this location would be in series with any potential device located at EL0431.

Picture 6-13: EL0541

Outfall Assessment

Orange County

Chapel Hill, NC

Eastwood Lake Watershed Plan

Outfall EL0431

Figure 6-3

Legend

- Outfall Screening Sites
- Other Outfalls
- Catch Basin
- Access
- Gravity Sewer Mains
- Pressurized Sewer Mains
- Water Lines
- Storm Pipes
- Streams
- Contours
- Public Parcels
- Parcels
- Eastwood Lake Watershed Boundary
- BMP Footprint

0 25 50 Feet

1 in = 50 ft

N

Biohabitats

September 2018

Outfall Assessment

Orange County

Chapel Hill, NC

Eastwood Lake Watershed Plan

Outfall EL0389

Figure 6-4

Legend

- Outfall Screening Sites
- Other Outfalls
- Catch Basin
- Access
- Gravity Sewer Mains
- Pressurized Sewer Mains
- Water Lines
- Storm Pipes
- Streams
- Contours
- Public Parcels
- Parcels
- Eastwood Lake Watershed Boundary
- BMP Footprint

0 25 50 Feet

1 in = 50 ft

N

Biohabitats

September 2018

Outfall Assessment

Orange County

Chapel Hill, NC

Eastwood Lake Watershed Plan

Outfall EL0541

Figure 6-5

Legend

- Outfall Screening Sites
- Other Outfalls
- Catch Basin
- Access
- Gravity Sewer Mains
- Pressurized Sewer Mains
- Water Lines
- Storm Pipes
- Streams
- Contours
- Public Parcels
- Parcels
- Eastwood Lake Watershed Boundary
- BMP Footprint

0 25 50 Feet

1 in = 50 ft

N

Biohabitats

September 2018

Project 4: EL0109

Location: Northwest corner of Woodhaven Road and Rolling Road (See Figure 6-6).

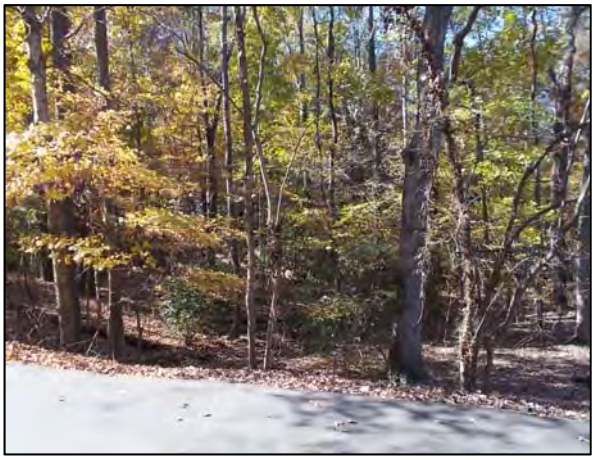
Description of Observed Problems/Opportunity: This site is a roadside drainage and conveyance channel that is not optimized to provide water quality benefits.

Proposed Retrofit: The proposed opportunity is a linear ROW bioretention facility within the existing ephemeral drainage channel at the downstream end of an 18″ culvert crossing Woodhaven Road. There is sufficient space available along the roadway to treat a significant portion of the 0.2 acres of impervious drainage area in a location with few anticipated tree impacts.

Potential Constraints: Constraints to the implementation of this proposed opportunity are expected traffic impacts during construction and potential impacts to the existing water utility running along Woodhaven Road.

Accessibility: The project has good accessibility along Woodhaven and Rolling Roads.

Comments: The site topography may limit the size of the proposed SCM. Access is limited to a steep embankment. Several large trees would have to be removed to construct the SCM. The picture is looking north from Rolling Road onto the site.



Picture 6-14: EL0109

Project 5: EL0343/EL0344

Location: East of Shadowood Drive, south of tennis courts (See Figure 6-7).

Description of Observed Problems/Opportunity: This site is an older in-line stormwater SCM receiving runoff from the Shadowood Apartments complex.

Proposed Retrofit: This site presents an opportunity to retrofit an existing in-line stormwater SCM to provide additional treatment and storage. The existing outfall is located in an area adjacent to recreational and parking facilities where it receives stormwater runoff from 18.2 acres of impervious surfaces. The existing SCM also receives stormwater runoff from 4.3 acres of impervious surfaces associated with outfall EL0344. Treatment of this volume would be improved through the proposed retrofit.

Potential Constraints: There are few constraints associated with this site. It is possible that there may be some minor traffic or parking impacts during construction.

Accessibility: The project is accessible from the parking area off Shadowood Drive.

Comments: To expand the capacity of the existing SCM, many trees that have established on its banks would have to be removed. The retrofit could be designed to be an amenity that provides wetland habitat. The photo is looking northwest across the SCM, from the area near the riser/dam (See Picture 6-15).

Picture 6-15: EL0343

Project 6: EL0074

Location: North of Michaux Road at Allard Road (See Figure 6-8).

Description of Observed Problems/Opportunity: This site is a roadside drainage and conveyance channel that is not optimized to provide water quality benefits.

Proposed Retrofit: There is adequate room here to provide some level of water quality treatment for a large portion of the 1.5 acres of impervious area that drains to the outfall. The retrofit concept is to construct an inline bioretention facility within the ephemeral channel. If inline bioretention is determined unfeasible at this location, there may be sufficient space for offline bioretention with the installation of a flow splitter at the outfall.

Picture 6-16: EL0074

Potential Constraints: This opportunity has potential tree and traffic impacts during construction.

Accessibility: Access is possible along the north side of Michaux Road.

Comments: The site is situated in the front yard of a private lot. Site topography would allow some treatment; however, several trees would have to be removed. Picture 6-16 is looking south from the Allard Road/Michaux Road intersection towards the site.

Outfall Assessment

Orange County

Chapel Hill, NC

Eastwood Lake Watershed Plan

Outfall EL0109

Figure 6-6

Legend

- Outfall Screening Sites
- Other Outfalls
- Catch Basin
- Access
- Gravity Sewer Mains
- Pressurized Sewer Mains
- Water Lines
- Storm Pipes
- Streams
- Contours
- Public Parcels
- Parcels
- Eastwood Lake Watershed Boundary
- BMP Footprint

0 25 50 Feet

1 in = 50 ft

N

Biohabitats

September 2018

Outfall Assessment

Orange County

Chapel Hill, NC

Eastwood Lake Watershed Plan

Outfall EL0343/EL0344

Figure 6-7

EL0335
(48 inches)
Invert 431.38

EL0537
(24 inches)
Invert 434.94

EL0343
(42 inches)
Invert 440.67

EL0344
(36 inches)
Invert 440.46

0.059
acres

EL0341
(15 inches)
Invert 451.2

SHADOWOOD DR

454
434
438
442
446
450
458

Legend

- Outfall Screening Sites
- Other Outfalls
- Catch Basin
- Access
- Gravity Sewer Mains
- Pressurized Sewer Mains
- Water Lines
- Storm Pipes
- Streams
- Contours
- Public Parcels
- Parcels
- Eastwood Lake Watershed Boundary
- BMP Footprint

0 25 50
Feet
1 in = 50 ft

N

Biohabitats

September 2018

Outfall Assessment

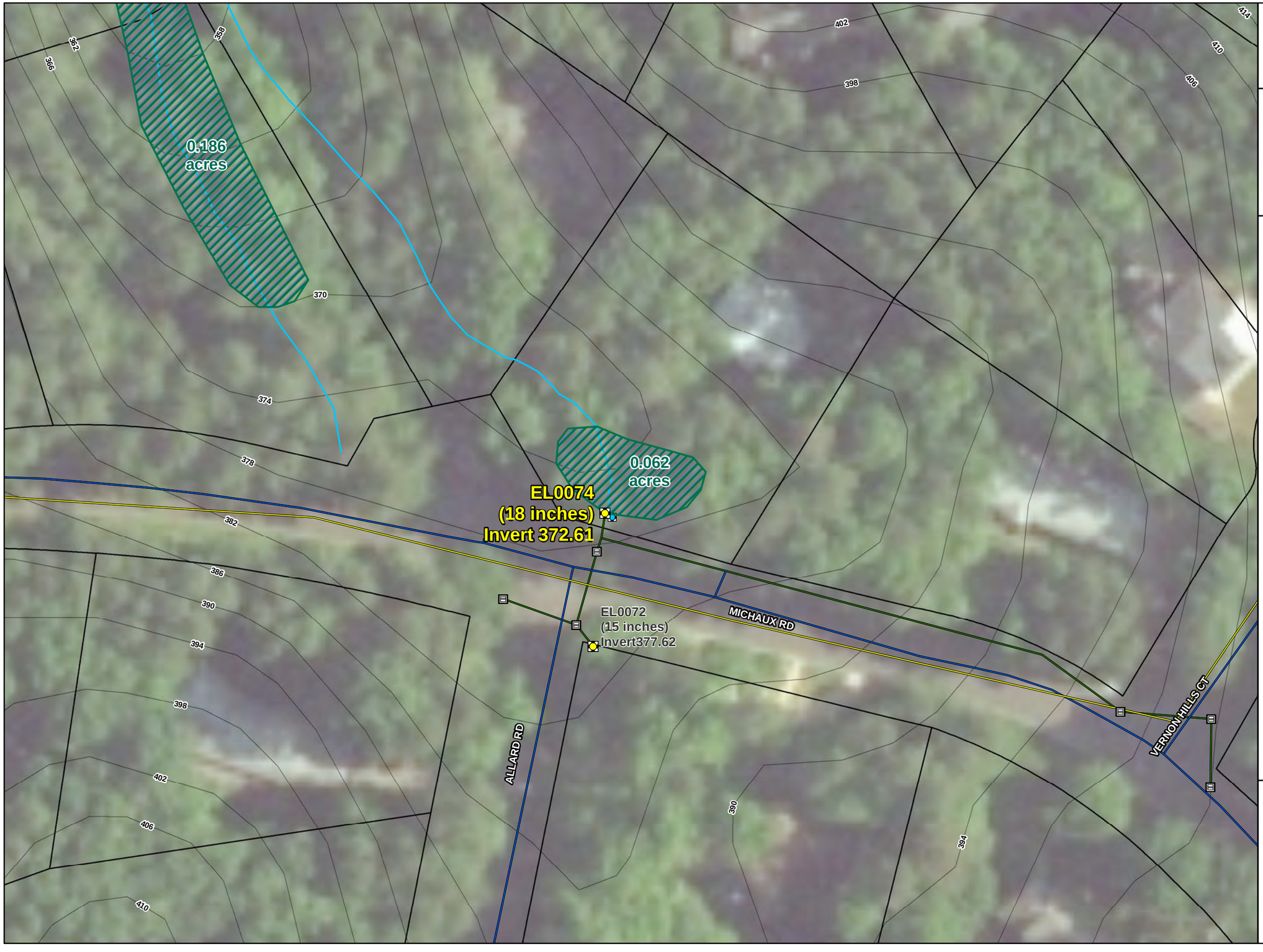
Orange County

Chapel Hill, NC

Eastwood Lake Watershed Plan

Outfall EL0074

Figure 6-8



Legend

- Outfall Screening Sites
- Other Outfalls
- Catch Basin
- Access
- Gravity Sewer Mains
- Pressurized Sewer Mains
- Water Lines
- Storm Pipes
- Streams
- Contours
- Public Parcels
- Parcels
- Eastwood Lake Watershed Boundary
- BMP Footprint

0 25 50 Feet

1 in = 50 ft

N

Biohabitats

September 2018

Project 7: EL0545

Location: Northeast corner of Piney Mountain Road and Eastwood Road (See Figure 6-9).

Description of Observed Problems/Opportunity: This site has untreated surface runoff from a public residential development.

Proposed Retrofit: The proposed opportunity is a bioretention facility upstream of the culvert in a mowed open area to treat the stormwater runoff from a 0.2 acres impervious drainage area from residential buildings and the Louis Armstrong Drive cul-de-sac. Flow enters the SCM through swales directing stormwater through the residential area from the cul-de-sac.

Potential Constraints: There are no obvious constraints to construction of this proposed measure.

Accessibility: The project has good accessibility from Piney Mountain Road.

Comments: There was no outlet found/located at this site, counter to the GIS information. No constraints were documented. It is likely that several large trees would have to be removed to direct flow from Eastwood Road to the site. The picture is looking northeast with Eastwood Road on the right side of the image. This site is upslope of and drains to EL0389.

Picture 6-17: EL0545

Project 8: EL0200

Location: Within ROW on west side of Kenmore Road at North Lakeshore Drive (See Figure 6-10).

Description of Observed Problems/Opportunity: This site is a roadside drainage and conveyance channel that is not optimized to provide water quality benefits.

Proposed Retrofit: The proposed retrofit is to create a linear bioswale facility that provides water quality treatment benefits for stormwater runoff from 0.16 acres of impervious drainage area.

Potential Constraints: Constraints to implementation of this opportunity are possible utility impacts and potential traffic impacts during construction.

Accessibility: The project has good accessibility off Kenmore Road.

Comments: The steepness of the site will be a factor in future feasibility analysis. This site is beside a private residence and implementation would have to be coordinated with the owner.

Picture 6-18: EL0200

Project 9: EL0523

Location: Southwest of Linneaus Place cul-de-sac (See Figure 6-11).

Description of Observed Problems/Opportunity: This site receives runoff from a single family residential area that is discharged without control or treatment to an intermittent stream.

Proposed Retrofit: The proposed retrofit is to create a bioretention cell in a poorly defined ephemeral channel to treat runoff from Linneaus Place and adjacent homes prior to discharging into the intermittent channel downstream.

Potential Constraints: Constraints to the implementation of this project are associated with private ownership of the parcel where the proposed measure is located. It is also possible that there may be some traffic impacts along Linnaeus Place during construction.

Picture 6-19: EL0523

Accessibility: The project is easily accessible from the Linnaeus Pace cul-de-sac.

Comments: The site is on private property and several trees greater than 12 inched diameter breast height would have to be removed to construct. The picture is looking north from a private residence driveway onto the site (See Picture 6-19).

Outfall Assessment

Orange County

Chapel Hill, NC

Eastwood Lake Watershed Plan

Outfall EL0545

Figure 6-9

Legend

- Outfall Screening Sites
- Other Outfalls
- Catch Basin
- Access
- Gravity Sewer Mains
- Pressurized Sewer Mains
- Water Lines
- Storm Pipes
- Streams
- Contours
- Public Parcels
- Parcels
- Eastwood Lake Watershed Boundary
- BMP Footprint

0 25 50 Feet

1 in = 50 ft

N

Biohabitats

September 2018

Outfall Assessment

Orange County

Chapel Hill, NC

Eastwood Lake Watershed Plan

Outfall EL0200

Figure 6-10

EL0196
(15 inches)
Invert 352.62

EL0203
(15 inches)
Invert 333.16

EL0212
(15 inches)
Invert 317.39

EL0217
(15 inches)
Invert 309.27

EL0200
(15 inches)
Invert 326.88

0.023
acres

EL0204
(8 inches)
Invert 317.64

EL0201
(15 inches)
Invert 317.49

EL0208
(36 inches)
Invert 306.68

KENMORE RD

N LAKESHORE DR

362 358 354 350 346 342 338 334 330 326 322 318 314 310 306

Legend

- Outfall Screening Sites
- Other Outfalls
- Catch Basin
- Access
- Gravity Sewer Mains
- Pressurized Sewer Mains
- Water Lines
- Storm Pipes
- Streams
- Contours
- Public Parcels
- Parcels
- Eastwood Lake Watershed Boundary
- BMP Footprint

0 25 50 Feet

1 in = 50 ft

N

Biohabitats

September 2018

Outfall Assessment

Orange County

Chapel Hill, NC

Eastwood Lake Watershed Plan

Outfall EL0523

Figure 6-11

Legend

- Outfall Screening Sites
- Other Outfalls
- Catch Basin
- Access
- Gravity Sewer Mains
- Pressurized Sewer Mains
- Water Lines
- Storm Pipes
- Streams
- Contours
- Public Parcels
- Parcels
- Eastwood Lake Watershed Boundary
- BMP Footprint

0 25 50 Feet

1 in = 50 ft

N

Biohabitats

September 2018

Project 10: EL0157/ EL0162

Location: Large, undeveloped lot southeast of Arlington Street (See Figure 6-12).

Description of Observed Problems/Opportunity: This site has two (2) unmaintained stormwater dissipaters that flow into separate channels that converge just downstream and form a single channel that flows through an undeveloped lot (See Pictures 6-20 and 6-21).

Proposed Retrofit: The proposed retrofit is to create a stormwater wetland that provides storm attenuation and water quality treatment benefits for stormwater runoff from 1.8 acres of impervious drainage area.

Potential Constraints: Constraints to implementation of this opportunity are tree impacts, site access, and relatively steep slopes in the upstream watershed.

Accessibility: The project has fair accessibility off North Lakeshore Drive.

Comments: The existing dissipaters apparently treat water piped down the steep hill from Arlington Street to the northwest. The design will need to accommodate the needed energy dissipation and storage needs.

Picture 6-20: EL0157

Picture 6-21: EL0162

EL0520

This site is located north of Piney Mountain Road at Woodshire Lane (See Figure 6-13). It is an existing but apparently unmaintained stormwater retention area. It has been included as an optional unranked opportunity due to its location within an intermittent stream but may be considered if future investigations identify constraints that preclude other higher-ranking sites. This site was not included in the water quality modeling analysis because it is located within an intermittent stream and is considered an optional opportunity.

Outfall Assessment

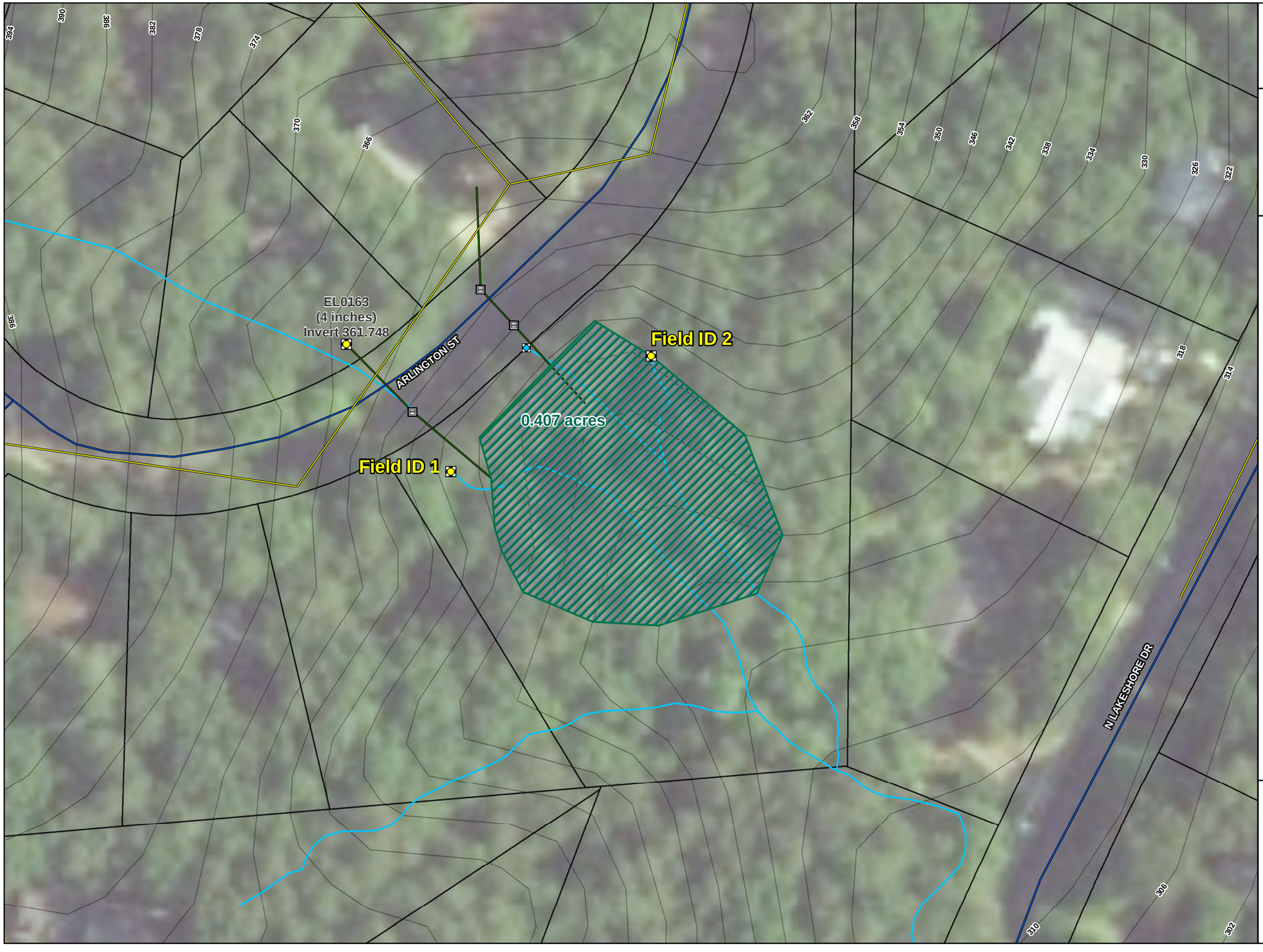
Orange County

Chapel Hill, NC

Eastwood Lake Watershed Plan

Outfall EL0157/EL0162

Figure 6-12



Legend

- Outfall Screening Sites
- Other Outfalls
- Catch Basin
- Access
- Gravity Sewer Mains
- Pressurized Sewer Mains
- Water Lines
- Storm Pipes
- Streams
- Contours
- Public Parcels
- Parcels
- Eastwood Lake Watershed Boundary
- BMP Footprint

0 25 50 Feet

1 in = 50 ft

N

Biohabitats

September 2018

Outfall Assessment

Orange County

Chapel Hill, NC

Eastwood Lake Watershed Plan

Outfall EL0520

Figure 6-13

EL0488
(24 inches)
Invert 452.03

0.028 acres

0.015 acres

EL0523
(N/A inches)
Invert 418.2

EL0524
(N/A inches)
Invert 418.04

EL0526
(N/A inches)
Invert 416.74

EL0527
(N/A inches)
Invert 414.07

EL0437
(18 inches)
Invert 412.63

LINNAEUS PL

EL0521
(8 inches)
Invert 426.04

EL0520
(N/A inches)
Invert 433.16

0.058 acres

0.023 acres

EL0469
(18 inches)
Invert

PINEY MOUNTAIN RD

WOODSHIRE LN

454 450 446 442 438 434 422 418 426 430 414

Legend

- Outfall Screening Sites
- Other Outfalls
- Catch Basin
- Access
- Gravity Sewer Mains
- Pressurized Sewer Mains
- Water Lines
- Storm Pipes
- Streams
- Contours
- Public Parcels
- Parcels
- Eastwood Lake Watershed Boundary
- BMP Footprint

0 25 50 Feet

1 in = 50 ft

N

Biohabitats

September 2018

6.2.2 NEIGHBORHOOD OPPORTUNITIES

As described in Section 3.6, a desktop assessment was conducted on the entire Booker Creek watershed to evaluate neighborhoods for green infrastructure retrofitting potential. Eight (8) neighborhoods were identified through the GIS assessment as the top-ranking (Very Good) neighborhoods for retrofits such as vegetated swales (bioswales), rain gardens, permeable pavement/pavers, and bioretention cells. They are:

1. Northwood (Booker Headwaters subwatershed)
2. Timberlyne (Cedar Fork subwatershed)
3. Cedar Hills (Cedar Fork subwatershed)
4. Lake Forest (Cedar Fork subwatershed)
5. Lake Forest (Eastwood Lake subwatershed)
6. Lake Forest (Lower Booker Creek subwatershed)
7. Booker Creek (Lower Booker Creek subwatershed)
8. Ridgefield (Lower Booker Creek subwatershed)

One (1) of the neighborhoods is located in the Eastwood Lake subwatershed - Lake Forest. Four (4) additional neighborhoods that were in the next lowest ranking (Good) were also analyzed. They were Eastwood Road – Johnson Farm, Forest Creek, Cooker Woods West 2 and Coker Hills. These neighborhoods were selected as the top-ranking neighborhoods. They were further analyzed in GIS to determine specific areas in those neighborhoods where average lot size, road slope, road width, total road length and rights of- way length are conducive for the retrofit types mentioned above (See Figures 6-14 through 6-18).

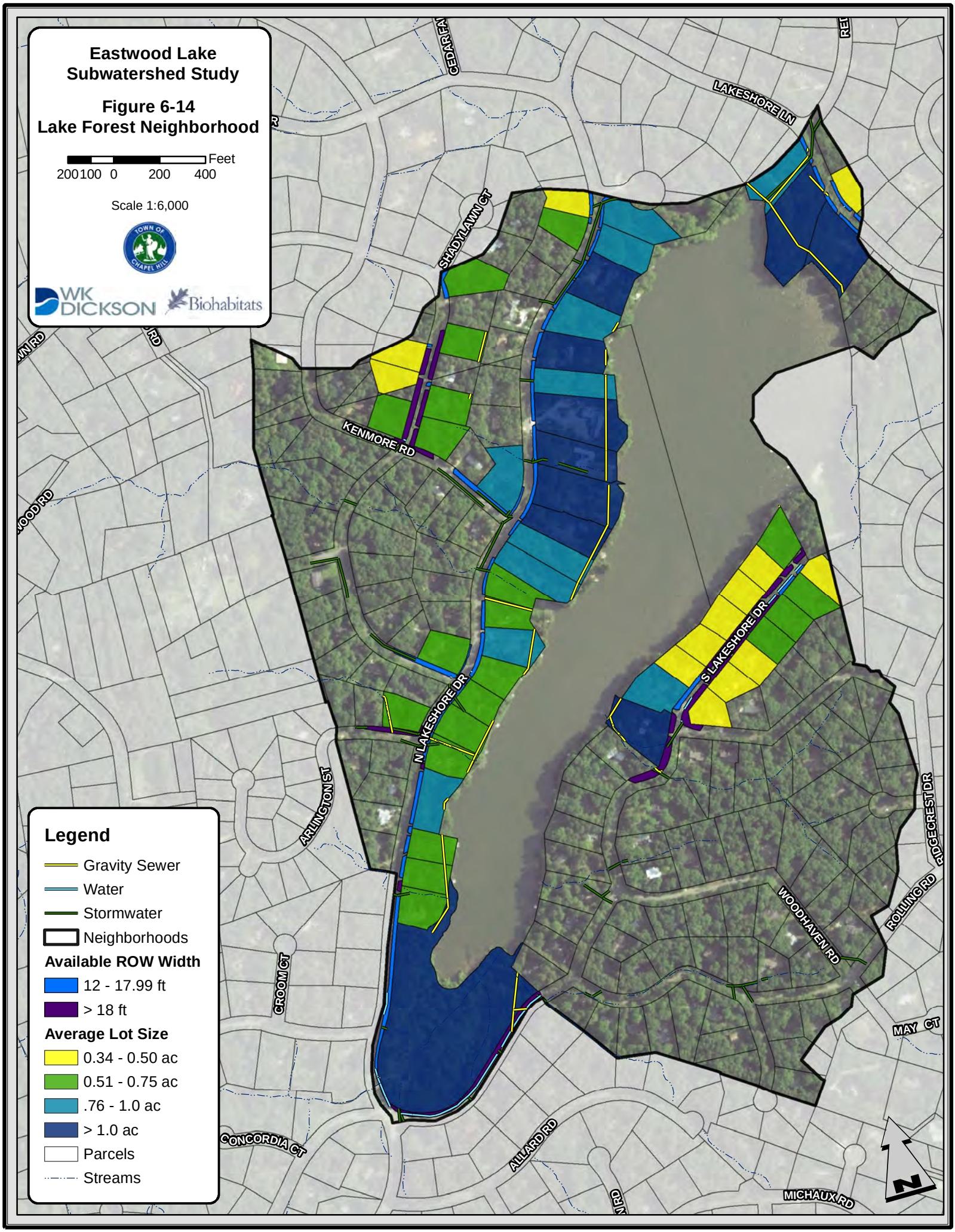
The acreages of each neighborhood are:

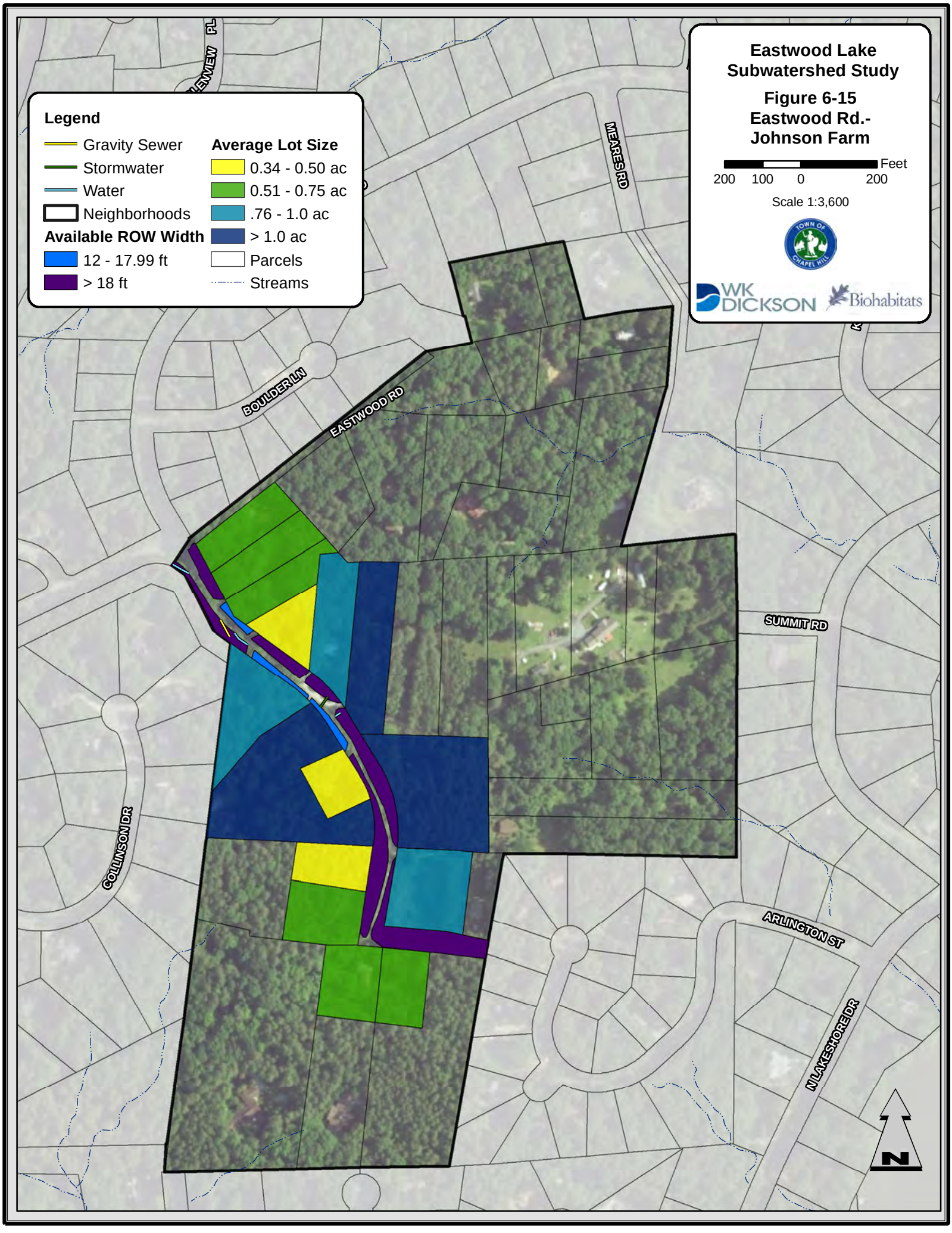
Lake Forest	195.6 ac
Eastwood Road – Johnson Farm	53.3 ac
Forest Creek	85.0 ac
Coker Woods West 2	99.7 ac
Coker Hills	61.1 ac

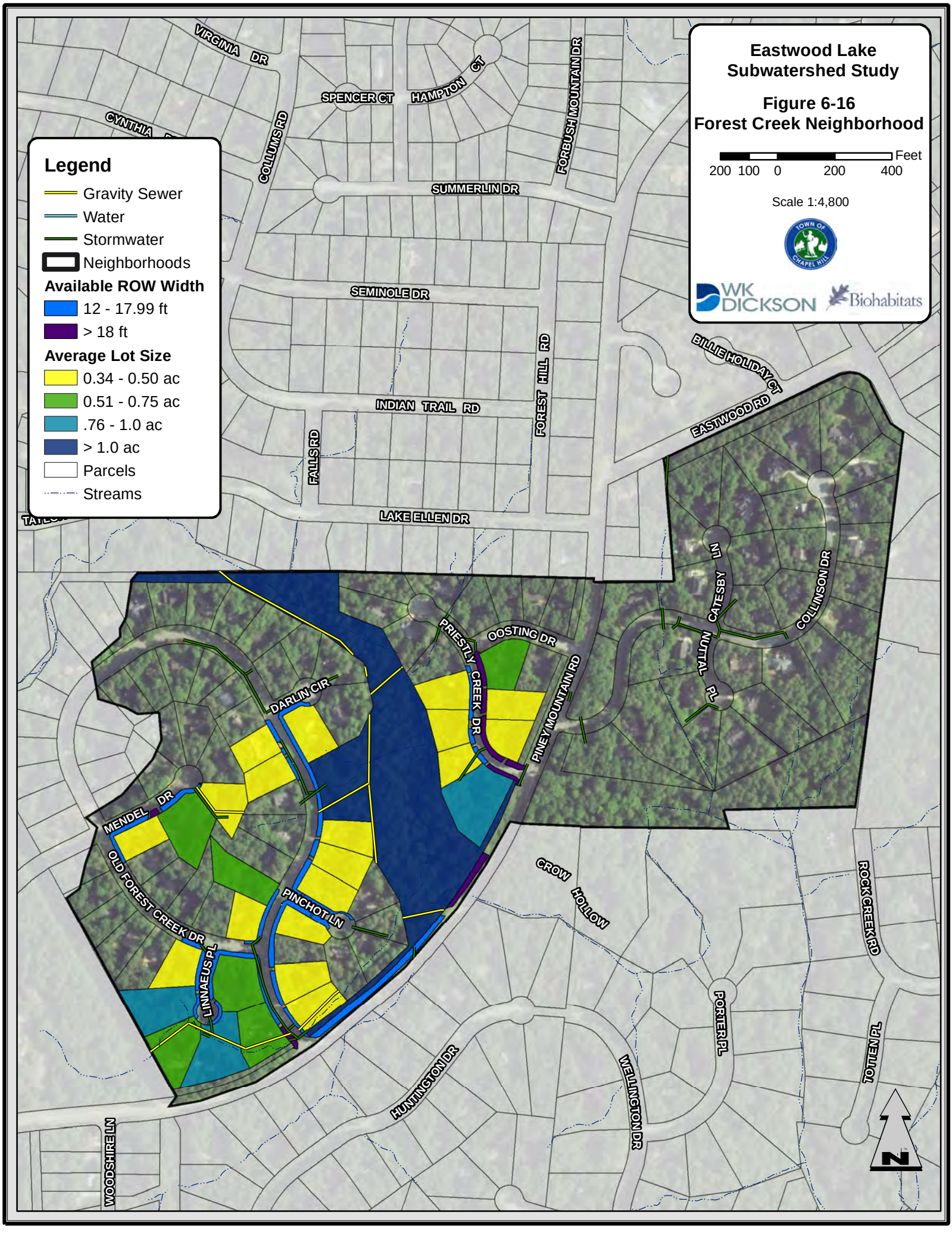
A range of stormwater control measures are available for greening these areas, with the focus being on publicly-owned areas such as the streets themselves and rights-of-way adjacent to the streets. Potential stormwater control measures that can be explored for implementation include: permeable paving for parking lanes, bioswales, rain gardens, impervious cover removal (road narrowing), and tree planting (to promote rainfall interception). Generally, utilities present the biggest constraint for these stormwater control measures.

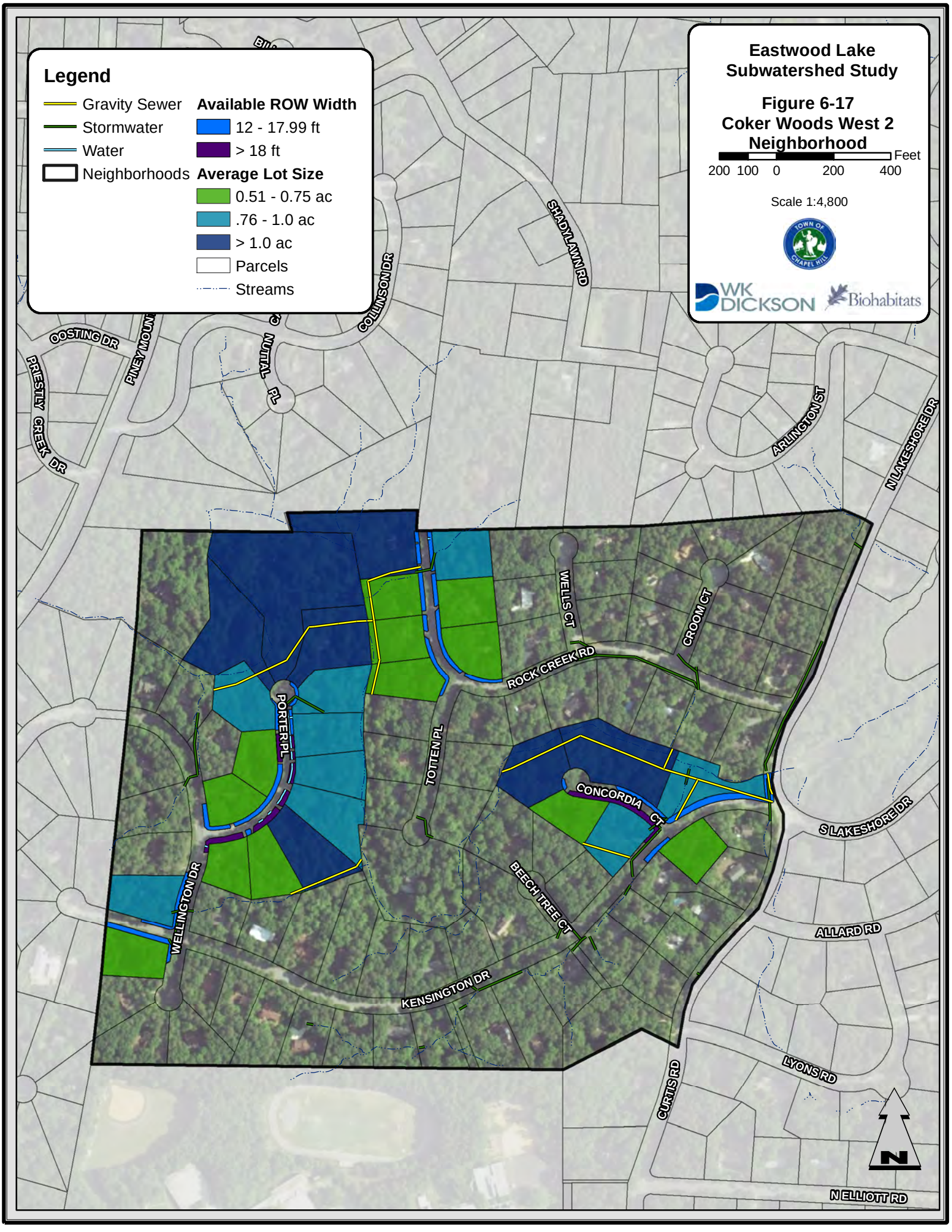
This GIS analysis identified potential areas in each neighborhood where conditions appear to be favorable for water quality retrofits. Future follow-up field work will allow specific stormwater treatment options to be identified. This analysis does not recommend specific water quality

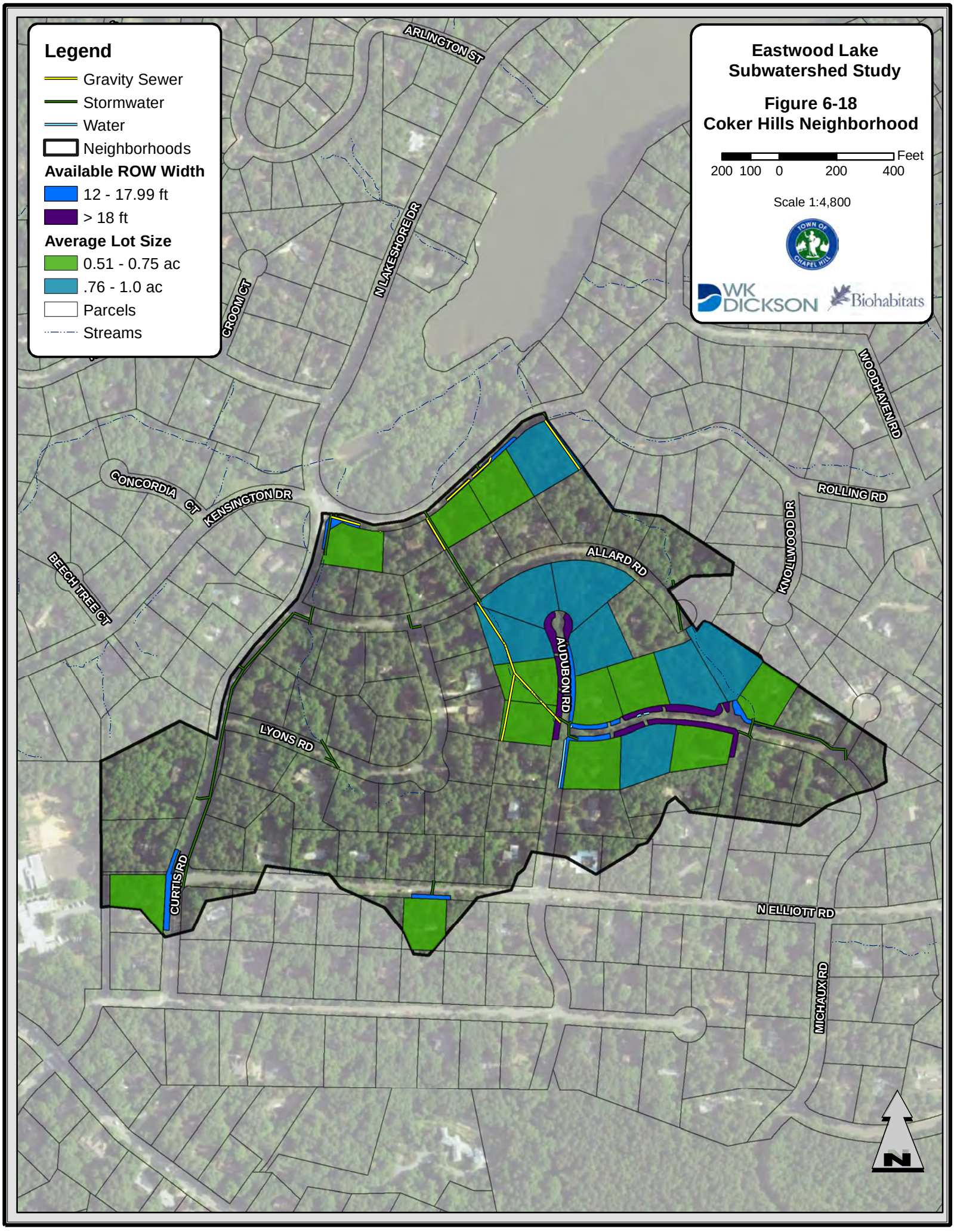
stormwater control measures at any particular location, just that the existing conditions are favorable to implement one or more potential stormwater control measures. Water quality modeling information in Section 6.3 below will help to identify specific areas for further investigation and field work.


Eastwood Lake
Subwatershed Study
Figure 6-14
Lake Forest Neighborhood
Feet
200 100 0 200 400
Scale 1:6,000
WK DICKSON
Biohabitats
Legend
Gravity Sewer
Water
Stormwater
Neighborhoods
Available ROW Width
12 - 17.99 ft
> 18 ft
Average Lot Size
0.34 - 0.50 ac
0.51 - 0.75 ac
.76 - 1.0 ac
> 1.0 ac
Parcels
Streams
LAKESHORE LN
SHADYLAWN CT
KENMORE RD
N LAKESHORE DR
S LAKESHORE DR
ARLINGTON ST
CROOM CT
CONCORDIA CT
ALLARD RD
WOODHAVEN RD
ROLLING RD
RIDGECREST DR
MAY CT
MICHAUX RD
N


Eastwood Lake
Subwatershed Study
Figure 6-15
Eastwood Rd.-
Johnson Farm
Feet
200 100 0 200
Scale 1:3,600
WK DICKSON
Biohabitats
Legend
Gravity Sewer
Stormwater
Water
Neighborhoods
Available ROW Width
12 - 17.99 ft
> 18 ft
Average Lot Size
0.34 - 0.50 ac
0.51 - 0.75 ac
.76 - 1.0 ac
> 1.0 ac
Parcels
Streams
MEARES RD
BOULDER LN
EASTWOOD RD
SUMMIT RD
COLLINSON DR
ARLINGTON ST
N LAKESHORE DR
N


Eastwood Lake
Subwatershed Study
Figure 6-16
Forest Creek Neighborhood
Feet
200 100 0 200 400
Scale 1:4,800
WK DICKSON
Biohabitats
Legend
Gravity Sewer
Water
Stormwater
Neighborhoods
Available ROW Width
12 - 17.99 ft
> 18 ft
Average Lot Size
0.34 - 0.50 ac
0.51 - 0.75 ac
.76 - 1.0 ac
> 1.0 ac
Parcels
Streams
VIRGINIA DR
SPENCER CT
HAMPTON CT
FORBUSH MOUNTAIN DR
CYNTHIA
COLLUMS RD
SUMMERLIN DR
SEMINOLE DR
FOREST HILL RD
BILLIE HOLIDAY CT
EASTWOOD RD
INDIAN TRAIL RD
FALLS RD
LAKE ELLEN DR
CATESBY LN
COLLINSON DR
NUTTAL PL
PRIESTLY CREEK DR
OOSTING DR
PINEY MOUNTAIN RD
DARLIN CIR
MENDEL DR
OLD FOREST CREEK DR
PINCHOT LN
LINNAEUS PL
CROW HOLLOW
ROCK CREEK RD
PORTER PL
HUNTINGTON DR
WELLINGTON DR
WOODSHIRE LN
N


Legend
Gravity Sewer
Stormwater
Water
Neighborhoods
Available ROW Width
12 - 17.99 ft
> 18 ft
Average Lot Size
0.51 - 0.75 ac
.76 - 1.0 ac
> 1.0 ac
Parcels
Streams
Eastwood Lake Subwatershed Study
Figure 6-17
Coker Woods West 2 Neighborhood
Feet
200 100 0 200 400
Scale 1:4,800
WK DICKSON
Biohabitats
SHADYLAWN RD
COLLINSON DR
OOSTING DR
PRIESTLY CREEK DR
NUTTAL PL
ARLINGTON ST
N LAKESHORE DR
WELLS CT
CROOM CT
ROCK CREEK RD
PORTER PL
TOTTEN PL
CONCORDIA CT
S LAKESHORE DR
WELLINGTON DR
BEECH TREE CT
ALLARD RD
KENSINGTON DR
LYONS RD
CURTIS RD
N ELLIOTT RD
N


Legend
Gravity Sewer
Stormwater
Water
Neighborhoods
Available ROW Width
12 - 17.99 ft
> 18 ft
Average Lot Size
0.51 - 0.75 ac
.76 - 1.0 ac
Parcels
Streams
Eastwood Lake Subwatershed Study
Figure 6-18
Coker Hills Neighborhood
200 100 0 200 400 Feet
Scale 1:4,800
WK DICKSON
Biohabitats
ARLINGTON ST
N LAKESHORE DR
CROOM CT
CONCORDIA CT
KENSINGTON DR
BEECH TREE CT
WOODHAVEN RD
ROLLING RD
KNOLLWOOD DR
ALLARD RD
AUDUBON RD
LYONS RD
CURTIS RD
N ELLIOTT RD
MICHAUX RD
N

6.3 WATER QUALITY MODELING

Water quality modeling was performed using the Watershed Treatment Model (2013), which was developed by the Center for Watershed Protection, a Maryland-based non-profit that is a leader in watershed management techniques.

The Watershed Treatment Model (WTM), is a simple spreadsheet-based model that calculates pollutant loads from a wide range of sources and incorporates the full suite of watershed treatment options. In addition, the model allows the watershed manager to adjust these loads based on the level of effort put forth for implementation. Although the simple algorithms in this model are no substitute for more detailed watershed information, and model assumptions may be modified as the watershed plan is implemented, the WTM acts as an empirically-based tool which can be used by watershed managers to evaluate multiple alternatives for watershed treatment.

The WTM can predict annual rates of total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS), and runoff volume. It computes loading based on four (4) major components:

- Sources;
- Practices (existing);
- Practices (future); and
- New development

The WTM determines pollutant loads for one (1) drainage area at a time, using one (1) annual rainfall total. It is strictly a pollutant load model and does not model flow.

Existing Primary Sources Baseline Pollutant Loads

Primary pollutant sources are determined using five (5) major land use/cover categories- Residential, Commercial, Industrial, Forest, and Rural. To determine existing TN, TP and TSS loadings in the watershed, land use/land cover information obtained from the Town of Chapel Hill was entered into the model as summarized in Section 2.

Based on the land use acreages assigned, the existing loadings are as follows:

Table 6-3: Existing Surface Water Loadings Based on Current Land Uses in the Watershed

TN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)
6,250.0	1,442.5	242,471.4

It is important that the Town of Chapel Hill identify existing pollutant sources and calculate the pollutant loads. Chapel Hill is subject to the set of regulations known as the "Jordan Rules," which went into effect in 2009. One of the rules focuses on pollutant loads, specifically nitrogen and phosphorus, from existing development. Based on monitoring performed by the North Carolina Division of Water Resources (Division), the Town may be required to implement a Stage 2 adaptive management program to address nutrient loads from existing development. The Division has established an eight percent reduction for nitrogen and a five percent reduction for

phosphorus. More information about the Jordan Existing Development Rule may be found at http:portal.ncdenr.org/web/jordanlake/read-the-rules.

To comply with the Stage 2 Load Goals using the estimated existing surface water loadings calculated by the WTM (Table 6.3), TN has to be reduced by 500 lbs/yr (8%) and TP has to be reduced by 72.1 lbs/yr (5%).

Identified Outfalls Load Reductions

The priority outfall retrofits identified in Section 6.2 were entered into the WTM to estimate the load reduction achieved by those retrofits. The model required the drainage area and percent impervious cover data, which were calculated for each location. The retrofits were classified by the SCM type as follows in Table 6-4.

Table 6-4: Identified Outfalls Modeled in WTM and Their Associated SCM Types

	ID	Approximate Location	SCM Type
1	EL0431	Within ROW on west side of Piney Mountain Road, south of intersection with Priestly Creek Drive	Bioretention
2	EL0389	Within ROW on west side of Piney Mountain Road at Eastwood Road	Bioretention
3	EL0541	Within ROW on west side of Piney Mountain Road at Collinson Drive	Wetland
4	EL0109	Northwest corner of Woodhaven Road and Rolling Road	Bioretention
5	EL0343/EL0344	East of Shadowood Drive, south of tennis courts	Wetland
6	EL0074	North of Michaux Road at Allard Road	Bioretention
7	EL0545	Northeast corner of Piney Mountain Road and Eastwood Road	Bioretention
8	EL0200	Within ROW of west side of Kenmore Road at North Lakeshore Drive	Bioretention
9	EL0523	Southwest of Linneaus Place dead-end	Bioretention
10	EL0157/EL0162	Southeast of Arlington Street, in large, undeveloped lot	Wetland

As noted in Section 6.2, EL0520 was listed in Table 6-2 as an optional opportunity if a higher-ranking outfall was determined to be infeasible. Therefore, EL0520 was not included in the WTM outfalls loading reductions analysis. The modeling results of the pollutant load reductions for the outfalls listed in Table 6-4 are shown in Table 6-5.

Table 6-5: Surface Water Loadings Based on Modeled Identified Outfalls Loading Reductions

	TN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)
Existing	6,250.0	1,442.5	242,471.4
Modeled (Post- Retrofit)	5,912.5	1,364.4	235,368.5
Pounds Reduced	337.5	78.1	7,102.9
Jordan Stage 2 Reduction Target			
TN – 8% Reduction	500	N/A	N/A
TP – 5% Reduction	N/A	72	N/A
Jordan Stage 2 Target Percent Reduction	68%	107%	N/A

Based on the WTM calculations in Table 6-5, TN is reduced by 337.5 lbs/yr, a 5.4% reduction, which is 68% of the 8% reduction needed to comply with the Jordan Lake Stage 2 load reduction requirement. TP is reduced by 78.1 lbs/yr, a 5.3% reduction, which is 107% of the 5% amount needed to comply with the Jordan Lake Stage 2 requirement. Total suspended solids were also reduced by 7,102.9 lbs/yr, which is a 2.9% reduction.

Neighborhoods Analysis Load Reductions

The five (5) top-ranked neighborhoods in the Eastwood Lake subwatershed – Coker Woods West 2, Coker Hills, Lake Forest, Forest Creek, and Eastwood Road/Johnson Farm were modeled using the WTM. These neighborhoods were analyzed in GIS to determine specific areas where average lot size, road slope, road width, total road length, and rights-of-way width are feasible for the types of retrofits mentioned above.

The acreages of each neighborhood are:

Coker Woods West 2	99.7 ac
Coker Hills	61.1 ac
Lake Forest	195.6 ac
Forest Creek	85.0 ac
Eastwood Road/Johnson Farm	53.3 ac

Based on the GIS analysis, the percent area of each neighborhood where retrofits were feasible was estimated. Those percentages and the resultant acreages used in the analysis are listed below in Table 6-6.

Table 6-6: Acreages Used in the Neighborhoods WTM Analysis

Neighborhood	Acreage	Percent Area for Retrofits	Area Used for Analysis in WTM
Coker Woods West 2	99.7	26%	26.00
Coker Hills	61.1	26%	15.86
Lake Forest	195.6	27%	52.55
Forest Creek	85.0	29%	24.55
Eastwood Road/Johnson Farm	53.3	27%	14.38
Totals	494.7		133.34

To estimate the reduction in pollutant concentrations from the 133.34 acres identified for the proposed retrofits, the land use categories and baseline nutrient event mean concentrations (EMC) in the WTM were revised by creating a new land use category – 'Low Nutrient Input MDR.' The event mean concentrations for TN and TP for this new category were revised to reflect the lower mean runoff concentrations resulting from the proposed retrofits. The Medium Density Residential acreage (MDR 1 – 4 dwelling units per acre) in the baseline WTM was reduced by 133.34 acres.

The revised, lower EMCs were obtained from the National Stormwater Quality Database (NSQD) Version 3 (2003). The NSQD lists statistically-based concentration values for different land use types. A range of EMCs for TN and TP is listed in the NSQD for residential land use - a low concentration, an average concentration, and a high concentration. The low EMC values were selected to replace the baseline EMC values in the WTM. The baseline EMCs in the WTM are 2.1 mg/l for TN and 0.31 mg/l for TP. The EMC values for the new MDR category used in the post-retrofit WTM were 1.5 mg/l for TN and 0.2 mg/l for TP, a 28.5% reduction and 35.5% reduction from the WTM baselines, respectively.

Table 6-7: Surface Water Loadings Based on Modeled Neighborhood Retrofit Reductions

	TN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)
Existing	6,250.0	1,442.5	242,471.4
Modeled (Post- Retrofit)	5,986.4	1,410.4	240,814.5
Pounds Reduced	263.6	32.1	1,656.9
Jordan Stage 2 Reduction Target			
TN – 8% Reduction	500	N/A	N/A
TP – 5% Reduction	N/A	72	N/A
Jordan Stage 2 Target Percent Reduction	53%	44%	N/A

Based on the WTM calculations in Table 6-7, TN is reduced by 263.6 lbs/yr, a 4.2% reduction, which is 53% of the amount needed to comply with the Jordan Lake Stage 2 load reduction requirement. TP is reduced by 32.1 lbs/yr, a 2.2% reduction, which is 44% of the amount needed to comply with the Jordan Lake Stage 2 requirement. Total suspended solids were also reduced by over 1,656.9 lbs/yr, which is a 0.7% reduction.

Stream Restoration/Stabilization Load Reductions

The WTM was not used to estimate load reductions from proposed stream restoration projects. Rather, load reductions for TN, TP and TSS were taken from Table 3 of the *Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects* (2014) and applied to the identified stream projects in Section 6. The load reductions are as follows: TN- 0.075 lb/ft/yr; TP- 0.068 lb/ft/yr; and TSS- 44.88 lb/ft/year. Load reductions were applied to the estimated project lengths listed in Table 6-8.

Table 6-8: Estimated Stream Restoration Loading Reductions

Reach Name	Project Type	Approx. Project Length (lf)	TN Removal (lb/ft/yr)	TP Removal (lb/ft/yr)	TSS Removal (lb/ft/yr)
Woodshire 2	Stabilize banks and channel, channel grade control	200	15	14	8,976
Woodshire 3	Stabilize banks and channel, channel grade control	564	42	38	25,312
Lake Ellen 1	Stabilize banks and channel, channel grade control	168	13	11	7,540
Booker 5	Stabilize banks and channel, channel grade control	1,500	113	102	67,320
Croom	Perched outfall repair, repair head-cuts, grade control, channel stabilization	245	18	17	10,996
Kensington 3	Stabilize banks and channel, channel grade control	200	15	14	8,976
Curtis 1	Stabilize banks and channel, channel grade control	200	15	14	8,976
Lyons 1	Repair head-cuts, grade control, channel stabilization	241	18	16	10,816
Allard 2	Repair head-cuts, grade control, channel stabilization	1,229	92	84	55,158
Woodhaven	Repair head-cuts, grade control, channel stabilization	395	30	27	17,728
Ridgecrest 1	Repair head-cuts, grade control, channel stabilization, sewer pipe in channel	210	16	14	9,425
Ridgecrest 2	Repair head-cuts, grade control, channel stabilization	429	32	29	19,254
Ridgecrest 3	Repair head-cuts, grade control, channel stabilization	872	65	59	39,135
Ridgecrest 4	Repair head-cuts, grade control, channel stabilization	410	31	28	18,401
	TOTALS (lbs/yr)	6,863	515	467	308,011

Using the lb/ft/yr values described above, a surface water loading reduction summary is presented in Table 6-9.

Table 6-9: Surface Water Loadings Based on Estimated Stream Restoration Reductions

	TN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)
Existing	6,250.0	1,442.5	242,471.4
Modeled (Post- Retrofit)	5,735.0	975	
Pounds Reduced	515	467	308,011.4
Jordan Stage 2 Reduction Target			
TN – 8% Reduction	500	N/A	N/A
TP – 5% Reduction	N/A	72	N/A
Jordan Stage 2 Target Percent Reduction	103%	647%	N/A

Based on the load reductions in the *Expert Panel Recommendations* paper and the results from Tables 6-8 and 6-9, TN is reduced by 515 lbs/yr, an 8.2% reduction which is more than the amount needed to comply with the Jordan Lake Stage 2 load reduction requirement. TP is reduced by 467 lbs/yr, a 32.4% reduction, which is more than six times the amount needed to comply with the Jordan Lake Stage 2 requirement.

Table 6-10 summarizes estimated load reduction results with respect to achieving the Jordan Lake Stage 2 load reduction requirements, based on the identified outfalls, neighborhoods and stream restoration modeling/estimates presented in this section.

Table 6-10: Summary of Load Reduction Estimates

	TN	% of Jordan Lake Stage 2 TN Requirement	TP	% of Jordan Lake Stage 2 TP Requirement
Jordan Lake Stage 2 Loading Reduction Requirement	8%		5%	
Identified Outfall Reduction	2.9%	36%	3.5%	70%
Neighborhood Retrofit Reduction	4.2%	52%	2.2%	44%
Stream Restoration Reduction (adjusted per explanation above)	8.2%	103%	32.4%	647%
TOTALS	15.3%	191%	38.1%	761%

Table 6-10 presents a summary of load reductions including the outfall retrofits, neighborhood retrofits, and stream restoration opportunities identified in the Eastwood Lake subwatershed. The total length of stream restoration identified is over 20% of the total length of intermittent and perennial stream in the subwatershed. The modeling estimates that stream restoration, at that scale, is the most effective practice in reducing TN and TP loads. The neighborhood retrofits are more effective in reducing TN than the outfall reductions. However, according to the modeling, the outfall retrofits are more effective at reducing TP loads in the subwatershed than the

neighborhood retrofits. The results indicate that an assortment of choices are available with respect to effective nutrient load reductions in the Eastwood Lake subwatershed.

ANTICIPATED PERMITTING

The proposed improvements described in Sections 4 and 6 may require local, State, and/or Federal permits or approvals prior to the onset of construction. Based on the types of projects identified in the Eastwood Lake subwatershed, permits or approvals may be required for any of the following reasons:

- Stream, riparian buffer, and/or wetland impacts;
- FEMA floodway and floodplain impacts;
- Land disturbance; and
- Potable water and sewer line adjustments.

The permitting matrix in Table 7-1 shows the different types of permits that are anticipated for each of the proposed projects. The proposed SCMs may require erosion control permits if the land disturbance area is greater than 1.0 acre, but permits or agreements from NCDEQ, USACE, FEMA, and NCDOT are not anticipated for these projects. Riparian buffer requirements may apply to projects located within fifty (50) feet of a streambank. Coordination with NCDEQ is recommended to determine if buffer impacts are exempt or allowable with mitigation.

The types of 404/401 permits are described below and may vary based on the length of stream impacts and/or acreage of wetland impacts. Wetlands will need to be delineated to determine the acreage of impacts. Permit requirements for a given project may change based on the final design and any changes to the existing regulations. The appropriate permitting agencies should be contacted during the design process to determine if permits will be required for the proposed project.

7.1 NORTH CAROLINA DIVISION OF WATER RESOURCES 401 WATER QUALITY CERTIFICATION AND US ARMY CORPS 404 PERMIT

Proposed improvements must adhere to the requirements set forth in Section 401 and 404 of the Clean Water Act. Required permitting can range from activities that are pre-authorized to those requiring pre-construction notification (PCN) for a Nationwide Permit (NWP) to those requiring an Individual Permit (IP). Individual permits may be required for projects with stream impacts greater than 300 feet and wetland impacts greater than 0.5 acres. It is anticipated that NWP #3 (Maintenance) and NWP #13 (Bank Stabilization) may be required to support the projects that include work within channels that are claimed jurisdictional by the US Army Corps of Engineers (USACE). More detailed explanations of the types of 404 permits are provided below.

NWP#3 – Maintenance

This permit authorizes the repair, replacement, or rehabilitation of any previously permitted or currently serviceable structure. A PCN is not required for minor deviations in the structure's configuration or filled area that occur as a result of changes in materials, construction techniques, or safety standards necessary to make repair or replacement, provided environmental impacts

are minimal. A PCN to the USACE is required if a significant amount of sediment is excavated/filled within the channel. The North Carolina Division of Water Resources (DWR) does not typically require a PCN for NWP #3 but usually receives one as a courtesy.

Other provisions imposed by the State of North Carolina require that culvert inverts must be buried a minimum of 1-foot below the streambed for culverts greater than or equal to 48 inches in diameter to allow low flow passage of water and aquatic life. Culverts less than 48 inches in diameter should be buried to a depth of 20% or greater of the culvert's diameter.

NWP #13 – Bank Stabilization

This permit authorizes the reshaping of channel banks or bank stabilization activities that are necessary for erosion prevention. The placement of material is prohibited in any special aquatic site in a manner that may impede surface water flow into or out of a wetland area, or in a manner that will be eroded during normal or high flows. The activity must be part of a single and complete project and cannot exceed 1 cubic yard per running foot placed below the high-water mark line. If stabilization activities exceed 500 linear feet, then a PCN is required for both the USACE and DWR. DWR must also be notified should fill be placed within the streambed.

NWP #27 – Stream and Wetland Restoration Activities

This permit authorizes stream enhancement, stream restoration, and channel relocation for restoration purposes that provide gains in aquatic functions. Stream channelization and the conversion of streams to other aquatic uses such as impoundments or waterfowl habitat are not authorized. A PCN to the USACE is required for any restoration activities occurring on private or public lands. DWR requires a PCN if impacts are proposed for greater than 500 feet of stream bank or if in-stream structures are used.

Impacts proposed to the streams may need evaluation under the State Environmental Policy Act (SEPA). An Environmental Assessment (EA) is required under SEPA if greater than 500 linear feet of perennial stream is disturbed and stream restoration or enhancement is not performed. Channel disturbances are defined as activities that remove or degrade stream uses such as channelization, culvert placement, riprap, and other hard structures.

A list of some other conditions that should be followed under regulations provided by the USACE and DWR are as follows:

- Soil erosion and sediment controls must be used and maintained in effective operating conditions during construction, and all exposed soil and fills should be stabilized at the earliest possible date.
- No activity is authorized under any NWP that is likely to jeopardize the existence of a threatened or endangered species, or which will destroy or adversely modify the habitat of such species.
- No activity is authorized that may affect historic properties listed or eligible for listing in the National Register of Historic Places.

- More than one NWP used for a single and complete project is prohibited.
- Impacts to waters of the US should be avoided and minimized to the greatest extent practicable.
- Mitigation in all its forms will be required to the extent necessary to ensure that the adverse effects to the aquatic environment are minimal.
- Hardening techniques should be avoided and minimized to the greatest practicable extent.

7.2 INDIVIDUAL PERMITS

Individual permits are required when stream or wetland impacts do not meet the conditions of a nationwide permit. Permit applications may be reviewed by multiple agencies including but not limited to USACE, DWR, EPA, State Historic Preservation Office (SHPO), North Carolina Wildlife Resources Commission (NCWRC), and United States Fish and Wildlife Service (USFWS). The application is also made available for public review. There is no defined timeline for review of the application for an IP; therefore, the permitting process for an IP is typically significantly longer that the review time for a NWP. Typically, 404 and 401 Individual Permits are applied for jointly and their review is concurrent.

7.3 FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

Streams with a drainage area greater than one (1) square mile are typically modelled and mapped by FEMA for flood insurance purposes. The 100-year floodway and floodplain have been mapped for the entire reach of Booker Creek within the Eastwood Lake subwatershed study area. Any proposed projects that will include grading within a FEMA defined floodway will require a Conditional Letter of Map Revision (CLOMR) submitted to FEMA for pre-approval purposes and a Letter of Map Revision (LOMR) upon completion of construction. Table 7-1 identifies projects where FEMA permitting is expected.

7.4 EROSION AND SEDIMENTATION CONTROL

North Carolina Department of Environmental Quality (NCDEQ) is another agency that requires notification before proposed activities are constructed. NCDEQ requires that an erosion and sedimentation control plan be submitted to the Division of Energy, Mineral, and Land Resources (DEMLR) for approval before the start of construction for any disturbance greater than one (1) acre. Erosion and Sedimentation permits are anticipated for most of the proposed projects as shown in Table 7-1.

Table 7-1: Permitting Matrix for Proposed Projects

	FEMA	NCDEQ /NPDES	404/401 (NWP)	404/401 (IP)	NCDOT
OVERALL BOOKER CREEK WATERSHED					
New Parkside Drive Storage Area		X	X		
Martin Luther King, Jr. Boulevard Storage Area	X	X	X		
Piney Mountain Road Storage Area	X	X	X		
EASTWOOD LAKE - WEST					
Piney Mountain Road	X	X	X		
Woodshire Lane/Huntington Road		X			
EASTWOOD LAKE - EAST					
Shady Lawn Road System		X			
Arlington Street #1 Closed System		X			
Arlington Street #2 Closed System		X			
South Lakeshore Drive/Ridgecrest Drive Closed System		X			
South Lakeshore Drive/Rolling Road Closed System		X			

COST ESTIMATES

The cost estimates provided as part of the Eastwood Lake Subwatershed Study were prepared to assist Town staff in making planning level decisions and prioritizing improvements. These cost estimates are not final design cost estimates. The preliminary project cost estimates in Table 8-1 were developed using recent bid tabulations from other communities and NCDOT projects within North Carolina. They include easement acquisitions, surveying, engineering, legal, and administrative costs. A detailed breakdown of the costs for the projects listed below in Table 8-1 is included in Appendix G. Projects are not listed based on priority. See Section 9 for a prioritization list. The cost estimates are approximate and are subject to change due to local costs, materials, delivery, construction, and other factors.

The stormwater drainage systems evaluated in this report are composed of a series of culverts, closed drainage systems, open channels, floodplain grading, and SCMs. For these drainage systems to function as designed, they must be properly maintained.

Table 8-1: Preliminary Project Cost Estimates

PROJECTS	PRELIMINARY PROJECT COST
Overall Booker Creek Watershed	
New Parkside Drive Storage Area[1]	$2,786,000
Martin Luther King, Jr. Boulevard Storage Area[1]	$3,789,000
Piney Mountain Road Storage Area[1]	$1,906,000
Eastwood Lake - West	
Piney Mountain Road	$456,800
Woodshire Lane/Huntington Road	$372,300
Eastwood Lake - East	
Shady Lawn Road System	$153,300
Arlington Street #1 System	$104,400
Arlington Street #2 System	$133,100
South Lakeshore Drive/Ridgecrest Drive System	$125,200
South Lakeshore Drive/Rolling Road System	$216,800

[1] Costs taken from Lower Booker Creek Subwatershed Study

Stream Stabilization Cost Estimates

To estimate the cost of stream restoration, a low and high cost per linear foot of construction were derived from local bid tab sources and best professional judgment. The strategy for determining the cost range per linear foot, and the low, medium, and high price points begins by noting the NCDEQ Division of Mitigation Services' fees for stream mitigation in highly developed or urban watersheds, which is currently $394 per foot (April 2018).

Many factors influence stream restoration costs in developed or urbanized areas. Those that tend to increase costs include the presence of utilities near the channel; presence of infrastructure such as stormwater outfalls, roads and buildings; constrained work areas that make

excavation/building material movement logistics difficult; higher land costs; and short restored reach lengths which can reduce the economy of scale for construction. A convergence of multiple factors such as these can add hundreds of dollars to the per-foot construction cost.

For the purposes of this cost estimate, $400/linear foot is taken as a conservative low construction cost estimate, $550/linear foot is taken as a medium construction cost estimate, and $700/linear foot is assumed as a high construction cost estimate. Design, easement acquisition, surveying, legal, and administrative costs can add up to 30% to the implementation process increasing the total project costs as follows:

Low cost estimate: $520/linear foot

Medium cost estimate: $715/linear foot

High cost estimate: $910/linear foot

Using these estimates of design plus construction costs for stream stabilization or restoration, the costs of the identified stream restoration projects are estimated in Table 8-2.

In addition, a cost estimate range per linear foot for regenerative stormwater conveyances in urban settings, based on professional experience, is $600 to $900 per linear foot. The midpoint of this range is $750/LF. Estimated RSC project costs using this medium cost estimate are included on reaches where an RSC is identified as a potential alternative to stream restoration in Table 8-2.

Table 8-2: Summary of Stream Project Cost Estimates

Reach Name	Approx. Project Length (lf)	Restoration Costs Based on Low, Medium and High Cost/LF Estimates			RSC Costs Based on Medium Cost/LF Estimate
		Low $520/lf	Med $715/lf	High $910/lf	Med $750/lf
Woodshire 2	200	$104,000	$143,000	$182,000	
Woodshire 3	564	$293,280	$403,260	$513,240	
Lake Ellen 1	168	$87,360	$120,120	$152,880	$126,000
Booker 5	1,500	$780,000	$1,072,500	$1,365,000	
Croom	245	$127,400	$175,175	$222,950	
Kensington 3	200	$104,000	$143,000	$182,000	
Curtis 1	200	$104,000	$143,000	$182,000	
Lyons 1	241	$125,320	$172,315	$219,310	
Allard 2	1,229	$639,080	$878,735	$1,118,390	
Woodhaven	395	$205,400	$282,425	$359,450	
Ridgecrest 1	210	$109,200	$150,150	$191,100	
Ridgecrest 2	429	$223,080	$306,735	$390,390	
Ridgecrest 3	872	$453,440	$623,480	$793,520	
Ridgecrest 4	410	$213,200	$293,150	$373,100	
TOTALS	6,863	$3,568,760	$4,907,045	$6,245,330	$126,000

Based on Table 8-2, the cost of constructing the identified stream restoration projects ranges from approximately $3.6 million dollars to $6.2 million dollars. The costs associated with RSC implementation is estimated at $126,000.

Outfall Retrofit Cost Estimates

To estimate the cost of outfall retrofit opportunities a range of cost sources was considered depending on the proposed SCM type. For constructed wetlands and bioretention, King and Hagen (2011) was used as the primary source. In this report, costs are determined based on acres of impervious cover treated as the unit cost factor. Costs include design, permitting, and construction. Bioretention costs were separated into two (2) categories, low and high. The low-cost category was for installations in a suburban setting (less constraints and lower unit cost), and the higher cost range was for urban retrofits (more constraints and higher unit costs). The lower bioretention cost factor ($50,000) was used for all the identified measures that are located within parcel sites, where the more expensive cost factor ($186,750) was applied to opportunities within the public ROW, which are likely to require additional provisions such as hardscape retrofits, utility coordination, and traffic maintenance.

For existing SCM retrofit opportunities, a unit cost was employed based on recent design and construction experience in the mid-Atlantic and North Carolina.

Three (3) identified opportunities returned a cost less than $25,000 based on the described unit cost/area calculations. These opportunities were assigned a value of $25,000, which is assumed to be the minimum for provision of design, permitting, and construction.

Table 8-3: Summary of Outfall Retrofit Project Cost Estimates

Outfall ID	SCM Area (acres)	Drainage Area (acres)	Impervious Area (acres)	SCM Type	Total Cost	Unit Cost $/IA
EL0431	0.03	0.35	0.14	ROW Bioretention	$25,585	$186,750
EL0389	0.02	1.03	0.71	Bioretention	$35,700	$50,000
EL0541	0.01	1.14	0.32	ROW Bioretention	$59,760	$186,750
EL0109	0.01	0.10	0.04	ROW Bioretention	$25,000*	$186,750
EL0343 EL0344	0.06	38.62	18.24	Retrofit	$300,960	$16,500
EL0074	0.06	5.93	1.53	Bioretention	$76,300	$50,000
EL0545	0.03	0.60	0.16	ROW Bioretention	$29,880	$186,750
EL0200	0.02	0.43	0.16	ROW Bioretention	$29,880	$186,750
EL0523	0.02	0.68	0.13	Wetland	$25,000*	$66,000
EL0157 EL0162	0.41	7.92	1.80	Wetland	$118,800	$66,000
EL0520	0.31	12.63	0.69	Retrofit	$25,000*	$16,500
				TOTAL	$751,865	

* Cost less than $25,000 based on the unit cost/area calculations; assigned a value of $25,000.

PRIORITIZATION AND RECOMMENDATIONS

After completing all the assessments and modeling described throughout the report, WK Dickson developed conceptual solutions for a wide variety of capital projects to fulfill the Eastwood Lake Subwatershed Study's goals of addressing stormwater quantity; addressing stormwater quality; and protecting and restoring natural stream corridors.

The recommended solutions begin with projects that reduce flooding, which was identified as a priority for residents who provided input via the project survey, website, and public information meetings. These flood reduction projects were categorized as either flood storage/primary system projects or secondary system projects. Success criteria used to measure the proposed flood reduction projects included:

- Improved level of service for roadways and structures;
- Economic feasibility;
- Minimizing stream and wetland impacts;
- Confirmation of physical feasibility using available GIS and survey data; and
- Minimizing easement acquisition.

The two (2) lists of flood reduction projects were then prioritized separately. The prioritization factors used were:

- Public health and safety;
- Severity of street flooding;
- Cost effectiveness;
- Effects of improvements;
- Project dependency
- Water quality – SCM;
- Open channel – erosion control;
- Implementation constraints;
- Grant funding; and
- Constructability.

In some instances, project prioritization will be impacted by the required sequencing of projects to provide the highest possible flood reduction benefits and to reduce or negate any downstream impacts from the proposed projects. Table 9-1 shows the proposed prioritization of the Flood Storage/Primary System Projects. The Town should re-visit the prioritization lists annually to determine if the priorities should change.

Table 9-1: Flood Reduction Prioritization – Flood Storage/Primary System Projects

Priority	Project
1	Piney Mountain Road Culvert

As shown Table 9-1, the Piney Mountain Road Culvert is the only proposed flood reduction project in the Eastwood Lake subwatershed. The four (4) flood storage projects were prioritized in the Lower Booker Creek Subwatershed Study and Lake Ellen Evaluation Memorandum. This study does two (2) things – it prioritizes the projects identified in the Eastwood Lake subwatershed and then a merged priority list for the two studied subwatersheds will be created.

Table 9-2 below lists the Secondary Systems prioritization.

Table 9-2: Flood Reduction Project Prioritization – Secondary System Projects

Priority	Project
1	South Lakeshore Drive/Ridgecrest Drive System
2	South Lakeshore Drive/Rolling Road System
3	Arlington Street #1 System
4	Woodshire Lane/Huntington Road
5	Shady Lawn Road System
6	Arlington Street #2 System

Stream stabilization projects, neighborhood retrofits, and outfall retrofits are not separately prioritized. Some of these project types will be reflected as prioritization factors represented by "water quality – SCM" and "open channel – erosion control" as shown on Page 9-1.

Neighborhood retrofits and stream stabilization projects on private property will be heavily dependent on community acceptance and willingness to participate.

Outfall retrofit priorities will likely change with project opportunities such as grant funding or availability of property.

REFERENCES

1. Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling.1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

2. Berg, J., et al. (2014), Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects, Chesapeake Bay Program. [Available at http://chesapeakestormwater.net/bay-stormwater/baywide-stormwater-policy/urban-stormwater-workgroup/urban-stream-restoration/.]

3. Booth D.B. and Jackson C.R. (1997) Urbanization of aquatic systems: Degradation thresholds, stormwater detection, and the limits of mitigation. Journal of the American Water Resources Association 33(5):1077-1090.

4. Brant, T. R. 1999. Community Perceptions of Water Quality and Management Measures in the Naamans Creek Watershed. *Masters Thesis for the Degree of Master of Marine Policy. 146 pp.*

5. Caraco, Deb. 2013. Watershed Treatment Model (WTM) 2013 Documentation. Center for Watershed Protection, Inc. Funding Provided By: US EPA Office of Wetlands Oceans and Watersheds, Altria Foundation, Cooperative Institute for Coastal and Estuarine Environmental Technology.

6. King, D and P. Hagan. Cost of Stormwater Management Practices in Maryland Counties. 2011. Prepared for the Maryland Department of the Environment.

7. Kitchell, A. and T. Schueler. 2004. Unified Stream Assessment: A User's Manual. Version 1.0. Urban Subwatershed Restoration Manual Series: Manual 10. Center for Watershed Protection. Ellicott City, MD.

8. Pitt, R. 2008. National Stormwater Quality Database Version 3. University of Alabama, Tuscaloosa, AL.

9. Stepenuck KF, Crunkilton RL, Wang L (2002) Impacts of urban landuse on macroinvertebrate communities in southeastern Wisconsin streams. Journal of the American Water Resources Association 38(4):1041-1051.

10. Division of Water Quality Planning Branch. 2003. Assessment Report: Biological Impairment in the Little Creek Watershed Cape Fear River Basin Orange County, N.C. North Carolina Department of Environment and Natural Resources

11. Urban Hydrology for Small Watersheds, United States Department of Agriculture, Natural Resources Conservation Service, Conservation Engineering Division, Technical Release 55, June 1986.

12. Hydraflow Storm Sewers Extension User's Guide Version 8, 2011

13. Town of Chapel Hill Design Manual, 2005.

14. Estimating Change in Impervious Area (IA) and Directly Connected Impervious Areas (DCIA) for Massachusetts Small MS4 Permit, April 2014

    www3.epa.gov/region1/npdes/stormwater/ma/MADCIA.pdf

15. Municipal Storm Water Management, by Debo and Reese, 1995

16. Stormwater Best Management Practices; North Carolina Department of Environment and Natural Resources, Division of Water Quality, July 2007

17. Environmental Protection Agency
    http://www.epa.gov/caddis/ssr_urb_is4.html

18. National Weather Service
    http://hdsc.nws.noaa.gov/hdsc/pfds/orb/nc_pfds.html

WK DICKSON
community infrastructure consultants

Town of Chapel Hill
Eastwood Lake Subwatershed Study

Volume II: Appendices

June 2020

TOWN OF CHAPEL HILL

Eastwood Lake Subwatershed Study Volume II: Appendices

WKD # 20170067.00.RA

June 2020

Prepared for

Town of Chapel Hill
405 Martin Luther King, Jr. Boulevard
Chapel Hill, NC 27514

Prepared by
W. K. Dickson & Co., Inc.
Raleigh, NC
919/782/0495
NC License No. F-0374

LIST OF APPENDICES

Appendix A	Hydrologic Analysis
Appendix B	Hydraulic Analysis
Appendix C	Watershed Map, Land Use Map, and Soils Map
Appendix D	Citizen Input
Appendix E	SCS Hydrologic Input Data
Appendix F	Time of Concentration Calculations
Appendix G	Preliminary Opinion of Probable Construction Costs
Appendix H	Hydraulic and Hydrologic Input and Output
Appendix I	Condition Assessment Methodology
Appendix J	Digital Copy of Hydraulic and Hydrologic Models
Appendix K	Stream Assessment
Appendix L	Prioritization Matrix

Appendix A:

Hydrologic Analysis

APPENDIX A
HYDROLOGIC ANALYSIS

Three (3) different models were used to develop design flows for the primary and secondary systems. For each system analyzed, the hydrologic model(s) was selected based on the complexity of the stormwater conveyance system.

The USACE HEC-HMS model was selected to model the primary systems defined as Booker Creek. HEC-HMS simulates the surface runoff response to precipitation for an interconnected system of surfaces, channels, and ponds. Input data for the HEC-HMS model was developed using topographic, land use, and soils maps in GIS to delineate and calculate the basin areas and SCS hydrologic parameters. The HEC-HMS model offers a variety of methods for simulating the rainfall-runoff response, hydrograph development, channel and pond routing. The selection of methods for the analyses is based on the study objectives, data availability, and watershed characteristics. The precipitation data for the 24-hour duration, NRCS Type II storm was used to represent the synthetic rainfall event. The NRCS curve number approach was selected to calculate runoff volumes from the precipitation data, and the sub-basin unit hydrographs for these flood volumes were developed using the NRCS lag times. Where appropriate, reservoir routing was selected to model attenuation behind culvert embankments.

For the secondary systems that may: (a) have significant backwater effects from rising water surface elevations within the primary systems, (b) have attenuation within drainage ditches or behind roadways, and (c) show a sensitivity to the timing response of runoff to rainfall, SWMM developed by the EPA was selected as the hydrologic and hydraulic model. The NRCS curve number approach was selected to calculate runoff volumes from the precipitation data, and the sub-basin unit hydrographs for these flood volumes were developed using the watershed width parameter. SWMM simulates the surface runoff response to precipitation for an interconnected system of surfaces, channels, and ponds. Input data for the SWMM model was developed using topographic data, land use data, and soils maps in GIS to delineate and calculate the basin areas and NRCS hydrologic parameters. The SWMM model offers a variety of methods for simulating the rainfall-runoff response, hydrograph development, and channel routing. One advantage to using SWMM to model both hydrology and hydraulics is that channel routing is modeled in the EXTRAN (hydraulics) block automatically based on the geometry and nature of the conveyance system. This eliminates the need to iterate between a hydrologic model and a hydraulic model to produce reasonable flows.

Some project areas with smaller drainage areas and less complex conveyance systems required a less rigorous approach. Hydraflow Storm Sewers, an extension of AutoCAD Civil 3D, was used to generate peak flows using the Rational Method. Table A-1 lists the different systems and the modeling methodology applied to each system.

Table A-1: Project Area Model Selection

Project Area	Model Selection
Booker Creek	HEC-HMS
Shady Lawn Road System	SWMM
Arlington Street #1 System	SWMM
Arlington Street #2 System	SWMM
Rock Creek Road Closed System	Hydraflow Storm Sewers
South Lakeshore Drive/Ridgecrest Drive System	SWMM
South Lakeshore Drive/Woodhaven Road System	SWMM
South Lakeshore Drive/Rolling Road System	SWMM
South Lakeshore Drive System	SWMM
Allard Road System	SWMM
Curtis Road System	SWMM
Woodshire Lane/Huntington Drive System	SWMM

Watershed Delineation and Connectivity

Watersheds were delineated for the entire Booker Creek utilizing digital LiDAR data available from the State of North Carolina and the stormwater inventory. The preliminary watersheds were created using automated procedures in a GIS platform and then adjusted as necessary based on the conveyance system and known ridge lines. Each flood control project watershed for the primary systems was subdivided into subwatersheds selected at hydrologically and hydraulically significant points, such as major roadway crossings, stream convergences, known problem areas, etc. Sixty-six (66) sub-basins were delineated for the entire Booker Creek watershed including the Booker Headwaters, Crow Branch, Cedar Fork, and Eastwood Lake, and Lower Booker Creek subwatersheds. The sub-basins ranged in size from 14 to 118 acres. Additional sub-basins were delineated as necessary for the secondary systems to accurately model the hydraulics of the system. Each sub-basin for the secondary systems was selected as the area that drained to each inlet modeled on the secondary system. The watershed maps included in Appendix C illustrate the subwatershed and hydrologic connectivity for the primary system located in the Eastwood Lake subwatershed.

NRCS Curve Numbers

The NRCS curve number approach was used in computing the runoff response. Runoff curve numbers (RCNs) were generated by using the NRCS document entitled Urban Hydrology for Small Watersheds, dated June 1986 and commonly referred to as TR-55. This method relates the drainage characteristics of the hydrologic soil group, land use category, and antecedent moisture conditions (AMC) to a runoff curve number. The runoff curve number and an estimate of the initial surface moisture storage capacity are used to calculate a total runoff depth for a storm in a basin.

The AMC refers to the total rainfall in a 5-day period preceding a storm and relates to the soil moisture condition at the beginning of the storm event. The AMC value can be used as a calibration tool in the hydrologic computations where AMC-1 represents "dry" conditions

and AMC-3 represents "wet" conditions. The average antecedent moisture conditions (AMC-2) are generally considered most representative for the humid southeastern portion of the country and were used for the hydrologic calculations in this study.

TR-55 provides CN values for typical land use categories. However, those values can vary based on the specific development within a community. To more accurately calculate land cover, the impervious percentage was determined for each subwatershed utilizing the impervious GIS coverage provided by the Town. The data was field checked to ensure it represented actual field conditions. Within the HEC-HMS model, both the CN value and the percent impervious can be included as input parameters. The HEC-HMS model assumes that all runoff from the designated impervious coverages enters the system and that no infiltration occurs. However, in some instances runoff will drain from impervious surfaces to pervious surfaces allowing some infiltration. One example would be water that drains off of a building across a lawn or other pervious area prior to entering the conveyance system. Therefore, to best represent the actual hydrologic conditions of the watershed, the directly connected impervious area (DCIA) should be calculated to match the definition of impervious area in HEC-HMS. The estimation of DCIA based on actual impervious area is calculated using the Sutherland Equations developed for the Massachusetts Small MS4 Permit, 2014. The equations varied based on land use. Appendix E shows the impervious area based on GIS and the adjusted DCIA. The portion of the impervious area that is not defined as DCIA is included in the weighted curve numbers along with all pervious areas within the watershed. Table A-2 shows the CN values used for impervious and pervious surfaces.

Table A-2: Curve Numbers Based on Land Cover and Soil Groups

Land Use Category	Soil Group			
	A	B	C	D
Impervious Surface	98	98	98	98
Open Space, Good	39	61	74	80
Woods, Good	30	55	70	77

A composite runoff curve numbers (RCN) was calculated for each of the sub-basins from the grass cover (open space), woods, and impervious area not assumed to be DCIA. A summary of the hydrologic input data for the primary systems, including the runoff curve numbers, lag time, and DCIA is shown in Table A-8. The detailed calculations are included in Appendix E (runoff curve numbers and DCIA) and Appendix F (times of concentration).

Soils

The NRCS curve number method uses basin characteristics, such as soil types and land use, to compute the runoff response. The infiltration rate of a soil influences the volume of surface runoff that results from given storm events. Soils with high infiltration rates produce lower runoff than soils with lower infiltration rates. The Soil Conservation Service has prepared soil maps for Orange County that identify four (4) primary soil groups. This data is

available digitally and was obtained for the Town of Chapel Hill. The groups (A, B, C, and D) correspond to decreasing rates of infiltration. A general description of the four (4) soil groups taken from the USDA, SCS, NEH-4 (1972) is presented in Table A-3.

Table A-3: Hydrologic Soils Groups

Soil Group	Description
A	Group A soils have high infiltration rates even when thoroughly wetted and consist chiefly of deep, well to excessively drained sand or gravels. These soils have a high rate of water transmission (greater than 0.3 inches per hour).
B	Group B soils have moderate infiltration rates even when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse texture. These soils have a moderate rate of water transmission (0.15 to 0.3 inches per hour).
C	Group C soils have slow infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission (0.5 to 0.15 inches per hour).
D	Group D soils have a very slow infiltration rate when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay pan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission (0 to 0.05 inches per hour).
B/D C/D	The first letter applies to the drained condition and the second to the undrained condition. For the purpose of hydrologic soil group, adequately drained means that the seasonal high water table is kept at least 60 centimeters (24 inches) below the surface.

Soils within the watershed are predominantly NRCS hydrologic soil groups B soils, although five (5) different hydrologic soil groups are represented in some quantity throughout the Booker Creek watershed (See Table A-4 and Appendix C).

Table A-4: Area Distribution of Hydrologic Soil Groups – Entire Booker Creek

Soil Group	Total Area (acre)	Percent of Total Area
B	2,048	50.9%
C	527	13.1%
D	1,046	26.0%
B/D	113	2.8%
C/D	224	5.6%

The distribution of soils within the Eastwood Lake subwatershed are shown in Table A-5. Soils within the subwatershed are predominantly NRCS hydrologic soil groups B soils, although five (5) different hydrologic soil groups are represented in some quantity.

Table A-5: Area Distribution of Hydrologic Soil Groups – Eastwood Lake

Soil Group	Total Area (acre)	Percent of Total Area
B	378	53.8%
C	100	14.3%
D	140	19.9%
B/D	9	1.3%
C/D	31	4.4%

The remaining 6.6% of the Eastwood Lake subwatershed is composed of water.

Land Use

Land use is the watershed cover condition as it relates to the actual type of development and zoning within the watershed. Land use influences the runoff characteristics of a watershed, and combined with other basin characteristics, is used to determine the SCS curve number for the basin.

The existing land use was determined based on Town of Chapel Hill GIS data including impervious coverage, land use, and zoning. Eight (8) land use categories were delineated within the Booker Creek Watershed based on the information provided (See Appendix C). Aerial photography and field observation was used to check the coverages which were revised as applicable.

In its entirety, the Booker Creek Watershed covers an area of approximately 4,000 acres (6.3 square miles). The Eastwood Lake subwatershed is approximately 700 acres of this total area. Land use in the Eastwood Lake subwatershed is mostly residential with a small percentage of office, and institutional as shown on the Existing Conditions Land Use Map included in Appendix C. As shown on the Existing Conditions Land Use Map, the subwatershed is predominately built out. Similarly, the overall Booker Creek watershed is mostly built out with areas of the upper watershed located in the Booker Headwaters and Crow Branch subwatersheds that have not been developed to their zoned uses. Impervious percentages for each subwatershed are based on actual impervious coverages within the watershed as noted above.

The future land use condition was adjusted based on Town zoning, feedback from Town planning staff, upcoming development projects (http://www.townofchapelhill.org/town-hall/departments-services/planning-and-sustainability/development), analysis of Town focus areas, and adjustments related to redevelopment. The changes made to the develop the future land use conditions are as follows:

- Incorporate the Carolina North plan including the requirement to provide detention for up to the 50-year storm event.
- Assign specific land use and impervious values for the Ephesus-Fordham area and Northern Area Task Force focus areas.
- Assign impervious values for undeveloped areas zoned for future development or anticipated rezoning based on known development projects. Impervious values are assigned based on typical impervious percentages for land uses within the watershed or based on Town ordinances.
- Zoning does not account for single lot redevelopment. Estimating the extent of single lot redevelopment is difficult as it can widely vary within a community, however it can be assumed that single lot redevelopment typically occurs for older houses. Additionally, the impact of single lot redevelopment is most significant for larger lots where the percentage of impervious area can be significantly increased. The future land use conditions assumes that low density residential lots with homes built prior to 1990 would have an aggregate 25% increase in impervious area due to single lot redevelopment. Protected neighborhoods either through neighborhood conservations such as Coker Hills or those areas within the Jordan Lake water supply area assumed no increase in impervious area as a result of single lot redevelopment.

Percentages of each existing and future land use groups and the correlating acreage are listed in the table below.

Table A-6: Eastwood Lake Subwatershed Land Use

	Existing		Future	
Land Use Category	**Area (acres)**	**Percent of Basin Area**	**Area (acres)**	**Percent of Basin Area**
Office/Institutional/Mixed Used	46	6.5%	28	4.0%
High Density Residential	34	4.8%	34	4.8%
Medium Density Residential	14	2.0%	14	2.0%
Low Density Residential	598	84.8%	598	84.8%
Parks/Open Space	6	0.9%	-	-
Right-of-Way	7	1.0%	7	1.0%
University (Carolina North)	-	-	24	3.4%

Table A-7: Entire Booker Creek Watershed Land Use

Land Use Category	Existing		Future	
	Area (acres)	Percent of Basin Area	Area (acres)	Percent of Basin Area
Commercial	20	0.5%	125	3.1%
Office/Institutional/Mixed Used	256	6.4%	278	6.9%
High Density Residential	167	4.2%	272	6.8%
Medium Density Residential	470	11.7%	505	12.6%
Low Density Residential	2,175	54.1%	2,183	54.3%
Parks/Open Space	510	12.7%	228	5.7%
Right-of-Way	133	3.3%	173	4.3%
Development Opportunity Area*	292	7.3%	-	-
University	-	-	259	6.4%

Table A-8: Summary of Hydrologic Input Data for Booker Creek Watershed

Drainage Basin ID	Drainage Area (acre)	Existing RCN	Future RCN	Lag Time (minutes)
BOOKER HEADWATERS				
BH-10	89.01	63	64	47.86
BH-20	49.08	66	67	32.20
BH-30	105.65	70	72	55.57
BH-40	67.59	71	72	16.69
BH-50	75.19	69	71	25.89
BH-60	82.84	69	71	51.96
BH-70	40.25	71	71	18.49
BH-80	65.63	71	72	35.10
BH-90	60.53	68	70	57.65
BH-100	70.93	71	71	35.29
BH-110	75.11	63	68	20.14
BH-120	17.58	67	69	17.44
BH-130	64.34	76	77	37.04
CEDAR FORK				
CF-10	50.49	65	67	16.69
CF-20	49.21	73	76	59.15
CF-30	28.70	66	68	41.40
CF-40	59.43	66	70	46.88
CF-50	18.65	62	63	20.44
CF-60	78.95	66	68	55.38
CF-70	76.95	67	68	67.79
CF-80	113.17	67	68	29.70
CF-90	118.24	65	66	43.55

Drainage Basin ID	Drainage Area (acre)	Existing RCN	Future RCN	Lag Time (minutes)
CF-100	54.63	66	66	13.52
CF-110	28.23	65	66	23.14
CF-120	61.50	64	65	20.76
CF-130	96.90	69	70	43.08
CF-140	27.19	64	65	28.00
CF-150	32.54	65	66	16.06
CROW BRANCH				
CB-10	92.60	64	73	61.29
CB-20	72.01	58	67	47.50
CB-30	17.27	58	73	46.52
CB-40	32.87	68	79	21.95
CB-50	46.08	77	84	43.69
CB-60	20.46	71	82	28.50
CB-70	95.93	71	78	62.90
CB-80	53.16	67	68	29.14
EASTWOOD LAKE				
EL-10	88.88	76	76	16.29
EL-20	88.02	72	72	13.80
EL-30	76.64	65	66	17.36
EL-40	47.93	74	75	17.12
EL-50	74.07	68	69	16.41
EL-60	90.90	65	65	24.21
EL-70	60.22	72	73	23.90
EL-80	58.71	71	71	16.83
EL-90	64.09	73	74	18.01
EL-100	55.77	85	85	25.25
LOWER BOOKER CREEK				
LBC-10	62.29	70	70	29.25
LBC-20	54.09	73	73	26.64
LBC-30	102.27	80	81	66.19
LBC-40	100.15	81	81	17.20
LBC-50	14.22	65	68	15.41
LBC-60	90.92	72	73	19.59
LBC-70	69.09	69	70	17.26
LBC-80	41.07	81	82	39.52
LBC-90	73.64	83	83	57.37
LBC-100	18.60	82	82	53.40
LBC-110	21.31	81	83	54.32
LBC-120	31.87	81	82	56.95
LBC-130	23.08	82	82	37.94
LBC-140	56.73	81	81	32.15
LBC-150	69.01	71	72	31.82

Drainage Basin ID	Drainage Area (acre)	Existing RCN	Future RCN	Lag Time (minutes)
LBC-160	49.68	76	76	30.16
LBC-170	17.56	84	85	18.10
LBC-180	91.01	80	82	21.44
LBC-190	32.44	80	80	33.80
LBC-200	107.57	78	78	51.01

Table A-9: Summary of Impervious Data for Booker Creek Watershed

Drainage Basin ID	Existing Total Impervious Area (sq. ft.)	Existing Percent Impervious (%)	Existing DCIA (%)	Future Total Impervious Area (sq. ft.)	Future Percent Impervious (%)	Future DCIA (%)
BOOKER HEADWATERS						
BH-10	862,717	22.3	7.8	994,248	25.6	9.9
BH-20	563,703	26.4	13.5	607,466	28.4	15.1
BH-30	908,027	19.7	8.8	1,379,727	30.0	16.4
BH-40	718,391	24.4	12.1	846,371	28.7	15.4
BH-50	229,167	7.0	0.5	535,301	16.3	6.6
BH-60	885,718	24.5	9.2	1,188,854	32.9	15.2
BH-70	517,931	29.5	16.1	517,931	29.5	16.1
BH-80	771,030	27.0	14.0	943,356	33.0	19.0
BH-90	336,725	12.8	3.0	691,901	26.2	10.3
BH-100	768,428	24.9	9.4	851,720	27.6	11.2
BH-110	899,829	27.5	14.4	1,898,079	58.0	44.2
BH-120	186,628	24.4	9.1	270,647	35.3	17.1
BH-130	534,003	19.1	6.0	705,194	25.2	9.6
CEDAR FORK						
CF-10	1,174,127	53.4	47.3	1,223,465	55.6	49.7
CF-20	628,431	29.3	15.9	1,096,693	51.2	36.6
CF-30	167,855	13.4	1.8	299,850	24.0	8.9
CF-40	483,642	18.7	5.8	885,949	34.2	16.2
CF-50	121,403	14.9	5.8	155,426	19.1	8.4
CF-60	666,805	19.4	6.2	945,252	27.5	11.2
CF-70	918,352	27.4	14.3	1,120,172	33.4	19.3
CF-80	899,024	18.2	5.6	1,174,813	23.8	8.8
CF-90	701,665	13.6	3.4	928,699	18.0	5.5
CF-100	331,698	13.9	3.5	405,544	17.0	5.0
CF-110	234,516	19.1	6.0	277,042	22.5	8.0
CF-120	478,626	17.9	5.4	609,840	22.8	8.1
CF-130	541,798	12.8	1.6	706,543	16.7	2.8
CF-140	227,570	19.2	6.1	312,073	26.4	10.4
CF-150	214,040	15.1	4.0	312,360	22.0	7.7
CROW BRANCH						
CB-10	53,592	1.3	0.02*	1,246,957	36.8	24.9

Drainage Basin ID	Existing Total Impervious Area (sq. ft.)	Existing Percent Impervious (%)	Existing DCIA (%)	Future Total Impervious Area (sq. ft.)	Future Percent Impervious (%)	Future DCIA (%)
CB-20	22,098	0.7	0.00*	1,220,630	38.9	24.3
CB-30	23,027	3.1	0.00*	1,501,121	69.2	53.5
CB-40	21,825	1.5	0.02*	956,534	70.0	57.2
CB-50	95,344	4.7	0.2	1,132,168	70.0	58.6
CB-60	20,796	2.3	0.05*	624,171	70.0	54.8
CB-70	746,939	17.9	5.4	1,865,392	46.1	26.3
CB-80	561,427	24.2	9.0	692,168	29.9	12.9
EASTWOOD LAKE						
EL-10	1,265,918	32.7	19.3	1,385,644	36.9	21.4
EL-20	880,272	23.0	8.1	1,185,494	30.7	9.8
EL-30	514,738	15.4	4.2	747,211	22.4	7.9
EL-40	497,585	23.8	8.8	562,925	27.0	10.8
EL-50	571,758	17.7	5.3	827,753	25.7	9.9
EL-60	831,450	21.0	7.1	923,376	23.3	8.5
EL-70	364,084	13.9	3.5	524,541	20.0	6.5
EL-80	369,906	14.5	3.8	520,194	20.3	6.7
EL-90	377,759	13.5	3.4	574,731	20.6	6.8
EL-100	319,755	13.2	3.2	481,129	19.8	6.4
LOWER BOOKER CREEK						
LBC-10	475,048	17.5	7.3	541,076	19.9	8.9
LBC-20	578,487	24.6	9.2	653,644	27.7	11.4
LBC-30	1,109,571	24.9	9.5	1,365,101	30.6	13.5
LBC-40	1,253,554	28.7	15.4	1,483,558	34.0	19.8
LBC-50	54,099	8.7	0.8	156,537	25.3	9.7
LBC-60	975,294	24.6	9.3	1,114,970	28.2	11.6
LBC-70	657,730	21.9	7.6	810,756	26.9	10.8
LBC-80	476,176	26.6	13.7	734,587	41.1	26.3
LBC-90	1,226,850	38.2	23.7	1,396,916	43.5	28.7
LBC-100	351,773	43.4	36.9	415,397	51.3	45.1
LBC-110	274,647	29.6	16.1	457,149	49.2	34.6
LBC-120	427,918	30.8	17.1	518,155	37.3	22.8
LBC-130	328,781	32.7	18.7	423,612	42.1	27.3
LBC-140	1,446,699	58.5	52.9	1,456,076	58.9	53.3
LBC-150	1,231,430	41.0	26.2	1,334,909	44.4	29.6
LBC-160	1,126,082	52.0	45.9	1,343,020	62.1	56.7
LBC-170	134,030	17.5	7.3	495,199	64.7	48.0
LBC-180	1,623,788	41.0	34.4	2,319,251	58.5	44.7
LBC-190	248,546	17.6	5.2	286,154	20.2	6.7
LBC-200	793,065	16.9	4.9	796,137	17.0	4.9

*Minimum DCIA value input into the HEC-HMS model was 0.1%.

Rainfall

Rainfall distributions for Chapel Hill are derived using the NRCS Type II standard distribution. Total rainfall volumes for the modeled frequency storms were based on data obtained from Appendix 2-A of the Town of Chapel Hill's Design Manual. Table A-10 shows the total rainfall volumes used for this study.

Table A-10: Design Storm Rainfall Depths

Design Storm	Rainfall Depth (in)
2-year, 24-hour	3.60
10-year, 24-hour	5.38
25-year, 24-hour	6.41
50-year, 24-hour	7.21
100-year, 24-hour	8.00

While the depth-duration-frequency curves are calculated based on real rainfall data, the rainfall data used for the SWMM and HEC-HMS models represent the Type II synthetic rainfall distribution. Actual runoff is based on several factors including rainfall intensity, duration and the antecedent moisture conditions of the watershed.

Hydrograph Translation

The lag time, as defined by the NRCS for use in the NRCS dimensionless unit hydrograph method, is the time, or lag, between the center of mass of rainfall excess and the peak of the unit hydrograph. The lag time is based on the subwatershed time of concentration, or travel time, and is a function of the subwatershed size, shape, slope, cover, and other basin characteristics. For the NRCS method, the subwatershed lag time is calculated to be 0.6 times the time of concentration for each subwatershed.

The times of concentration for the subwatersheds were calculated from the methodology described in TR-55. A summary of the calculations is shown in Appendix F. The longest flow path is divided into three types of flow; overland flow, shallow concentrated flow, and channel flow. A spreadsheet was developed to tabulate the incremental travel times for each type of flow for each sub-basin. The incremental travel times were totaled and multiplied by 0.6 to compute the lag time for each sub-basin. The equation detailing the travel time for sheet flow is as follows:

$$T_t = \frac{.007\,(nL)^{0.8}}{(P_2)^{0.5}\, s^{0.4}}$$

T_t = Travel Time in hours
n = Manning Roughness Coefficient (Paved=0.011, Unpaved=0.24)
L = flow length in feet
P_2 = 2-year, 24 hour rainfall = 3.76 inches
S = slope of hydraulic grade line (land slope in ft/ft)

For shallow concentrated flow, the velocity (V) is calculated for either paved or unpaved sections by using the following equations:

$$\text{Unpaved } V = 16.1345\ (S)^{1/2}$$
$$\text{Paved } V = 20.3282\ (S)^{1/2}$$

The travel time for shallow flow is then calculated by dividing the flow length (L in feet) by velocity as follows:

T_t = Travel Time = L / (3600*V)

The open channel travel times are determined by a modified version of the Manning equation, which is as follows:

$$V = \frac{1.49\ R^{2/3}\ S^{0.5}}{n}$$

V = Average full-flow velocity (ft/s)
R = Hydraulic radius (ft)
S = Slope of hydraulic grade line (ft/ft)
n = Manning roughness coefficient

Instead of a time of concentration parameter, the SWMM model uses a watershed width parameter to create the unit hydrograph used in the model that will translate the rainfall into runoff. The watershed width is a parameter unique to SWMM that typically represents the watershed area divided by the longest flow path. The width parameter is typically calibrated to flow gauge data, if available. The Eastwood Lake subwatershed lacks flow gauge data, so the peak flows from SWMM were compared to flows developed using the Rational Method. Based on the flow comparison, the watershed widths for each basin were increased in some instances to produce reasonable flows. Increasing the watershed width parameters is not an uncommon practice for calibrating models for areas with gradual slopes and moderate conveyance systems.

Channel Elements

Flood peaks attenuate, or reduce, as they travel downstream due to the storage characteristic of the stream reach. The Muskingum-Cunge routing method in HEC-HMS was selected to define the storage characteristic of selected stream reaches in the Eastwood Lake subwatershed. It can be described as a hydrologic routing method based on physical parameters of the channel and floodplain. Input data for this method consists of representative channel/floodplain sections, reach length, Manning's roughness coefficient,

and channel bed slope. This method provides advantages over other hydrologic techniques based on the relative size and slope of the channels and floodplains in the watershed.

Structure and Pond Routing

Reservoir storage routing was used for routing hydrographs through the storage areas upstream from undersized structures (culverts). HEC-HMS is able to model the effects of an undersized culvert through inputs defining the relationship between water volume or area and elevation and the relationship between outflow and water surface elevations. The relationship between outflow and water surface elevations is developed using an iterative process between HEC-HMS and HEC-RAS. A rating curve generated using HEC-RAS defines the outflow of the water leaving this system.

Structures having fill heights greater than or equal to 50% of the height of the structure were assumed to provide significant peak flow attenuation and, therefore, were routed in the HEC-HMS model. In addition, any structure which exhibited significant upstream floodplain storage or significant backwater from the HEC-RAS model output would be analyzed for providing peak flow attenuation.

For each structure, the cutoff point in the backwater pool was determined where the structure routing ends and upstream channel routing begins. This determination was necessary so that available storage areas calculated for channel and structure routing did not overlap. The following procedure was used for this determination:

- The approximate limit of the 100-year frequency flood backwater pool was delineated in the topographic map.
- The distance from the upstream face of the structure to the upstream limit of the pool was measured.
- From the upstream end of the backwater pool, a distance equal to 20% of the total pool length was measured in the downstream direction and the point marked on the topographic map.
- Through this point a line was drawn perpendicular to the contour lines.
- This line was then designated as the cutoff point to be used as the upstream limit of the channel routing.

For each structure, the elevation-storage relation for the Modified Puls method was derived by calculating the surface area of the topographic contours from the upstream face of the structure to the routing cutoff point associated with the structure. A pair of "SA" (storage area) – "SE" (elevation) records, the elevation-storage relation for each structure was input from the delineated information. To avoid interpolating storage areas for each stage-discharge point, a separate stage-discharge relation was entered into the HEC-HMS model

on a pair of "SQ" (discharge) – "SE" (elevation) records based on the HEC-RAS model output.

However, the method described in the previous paragraph does not account for the reduction in tailwater on the structure due to the attenuation effects of the upstream storage, which in turn can affect the stage-discharge relation of the structure. Therefore, an iterative process for storage structures was followed with an objective to obtain a set of peak discharge values, runoff volumes, and water surface elevations that are "balanced" between the two models. The process was initiated by inputting a set of discharges into the HEC-RAS model to develop a set of discharge-storage relations for each reach. This initial set of relations was input into the HEC-HMS model. These values were supplemented by the depth-storage relation for each structure.

The HEC-HMS model was run with these values to derive new discharges at downstream locations. These new values were input into the HEC-RAS model and it was recomputed. The new discharges and water surface elevations listed in the HEC-HMS summary output were compared with the discharges listed in the previous HEC-RAS run. When the values stabilized, the model was considered "balanced." If not, then additional iterations were performed. Typically, three iterations are adequate to derive a balanced model.

Summary of Hydrologic Model Results

The HEC-HMS model was used to compute peak runoff for the 2-, 10-, 25-, 50- and 100- year design storms for the existing conditions.

The results of the hydrologic model are summarized in Table A-11. The HEC-HMS input and output are included in Appendix H. Additionally, a CD is included in Appendix J and contains the digital files for the HEC-HMS model.

Table A-11: Existing Conditions Flows from HEC-HMS for Eastwood Lake Subwatershed

HEC-HMS Node	Road Name / Location	HEC-RAS Station	Storm Event				
			2-year (cfs)	10-year (cfs)	25-year (cfs)	50-year (cfs)	100-year (cfs)
ADD-CB-BH	Confluence of Crow Branch and Booker Creek	21577	505	1,018	1,318	1,600	1,837
Piney Mountain Rd – Booker Ck	Piney Mountain Road	20223	566	1,022	1,373	1,661	1,899
ADD-EL-50	Upstream of Eastwood Lake	16524	603	1,059	1,419	1,714	1,950
N Lakeshore Dr – Booker Ck	North Lakeshore Drive	15024	615	1,070	1,431	1,728	1,964
Eastwood Lake	Downstream of Eastwood Lake	11352	668	1,641	2,217	2,614	2,850

Comparison of Peak Flows

For comparison purposes, flood peaks were estimated using the U.S. Geological Survey (USGS) publications entitled "The National Flood-Frequency Program – Methods for Estimating Flood Magnitude and Frequency in Rural and Urban Areas in North Carolina – USGS Fact Sheet 007-00" (2001) and "Methods for Estimating the Magnitude and Frequency of Floods for Urban and Small, Rural Streams in Georgia, South Carolinas, and North Carolina" (2014) at key locations within the watershed. Table A-12 compares the peak flows determined from the USGS regional regression equations for the Piedmont region and hydrologic region 1 versus the peak flows from HEC-HMS. Additionally, the peak flows from HEC-HMS were also compared to available FEMA flows.

Table A-12: Comparison of Existing Conditions Peak Flows

Methodology	Location	2-Year (cfs)	10-Year (cfs)	25-Year (cfs)	50-Year (cfs)	100-Year (cfs)
HEC-HMS	Confluence of Crow Branch and Booker Creek	505	1,018	1,318	1,600	1,837
	Piney Mountain Road	566	1,022	1,373	1,661	1,899
	Upstream of Eastwood Lake	603	1,059	1,419	1,714	1,950
	North Lakeshore Drive	615	1,070	1,431	1,728	1,964
	Downstream of Eastwood Lake	668	1,641	2,217	2,614	2,850
USGS – Regional Regression Equations: Urban Piedmont (2001)	Confluence of Crow Branch and Booker Creek	396	840	1,215	1,398	1,576
	Piney Mountain Road	454	943	1,350	1,548	1,738
	Upstream of Eastwood Lake	486	1,002	1,429	1,638	1,838
	North Lakeshore Drive	501	1,027	1,462	1,674	1,877
	Downstream of Eastwood Lake	754	1,477	2,050	2,336	2,606
FEMA Flows	Confluence of Crow Branch and Booker Creek	-	833	-	1,420	1,610
	Piney Mountain Road	-	833	-	1,420	1,610
	Upstream of Eastwood Lake	-	964	-	1,620	1,840
	North Lakeshore Drive	-	964	-	1,620	1,840
	Downstream of Eastwood Lake	-	1,210	-	2,010	3,020

Methodology	Location	2-Year (cfs)	10-Year (cfs)	25-Year (cfs)	50-Year (cfs)	100-Year (cfs)
USGS – Regional Regression Equations: Hydrologic Region 1 (2011)	Confluence of Crow Branch and Booker Creek	456	877	1,104	1,278	1,459
	Piney Mountain Road	517	984	1,236	1,427	1,627
	Upstream of Eastwood Lake	552	1,058	1.332	1,540	1,759
	North Lakeshore Drive	567	1,085	1,365	1,579	1,803
	Downstream of Eastwood Lake	840	1,645	2,094	2,440	2,807

Appendix B:

Hydraulic Analysis

APPENDIX B
HYDRAULIC ANALYSIS

The purpose of the hydraulic modeling analysis is to determine an existing level of flooding for the stormwater drainage network and to develop proposed solutions to mitigate flooding, on both the primary systems and the secondary systems. Three (3) different modeling methodologies were used depending on the complexity and location of the conveyance system. For the primary system comprised of Booker Creek, HEC-RAS was used for hydraulic modeling. For smaller less complex secondary systems, Hydraflow Storm Sewers was used to calculate the hydraulic grade lines using an energy grade based approach, while more complex secondary systems were modeled using SWMM. Table B-1 lists the project areas that were modeled using each approach.

Table B-1: Project Area Model Selection

Project Area	Model Selection
Booker Creek	HEC-HMS
Shady Lawn Road System	SWMM
Arlington Street #1 System	SWMM
Arlington Street #2 System	SWMM
Rock Creek Road Closed System	Hydraflow Storm Sewers
South Lakeshore Drive/Ridgecrest Drive System	SWMM
South Lakeshore Drive/Woodhaven Road System	SWMM
South Lakeshore Drive/Rolling Road System	SWMM
South Lakeshore Drive System	SWMM
Allard Road System	SWMM
Curtis Road System	SWMM
Woodshire Lane/Huntington Drive System	SWMM

HEC-RAS Model

The HEC-RAS model calculates water surface profiles for steady, gradually varied flow, both sub-critical and supercritical, for user-specified discharges. The standard step backwater analysis for sub-critical flow was modeled for the Booker Creek Primary System. The model calculates the effect of obstructions, such as culverts, and building structures in the channel and floodplain on the water surface profile. The hydraulic computations are based on the solution of a one-dimensional energy equation with energy loss due to friction evaluated by Manning's equation.

Input data for the HEC-RAS computer model includes the following:

- Cross-section geometry of the channel and floodplain.
- Roughness coefficients to describe the characteristics of the channel and floodplain.
- Size, shape, and characteristics of culverts and roadways along the stream reach.
- Energy loss coefficients for flow in the channel and at roadway crossings.

Primary System Study Limits

As discussed with the Town of Chapel Hill stormwater staff, study limits for the hydraulic evaluation of the primary system include Booker Creek from Eastwood Lake at the downstream end to its confluence with Crows Branch at the upstream end.

Stormwater Inventory

For the Eastwood Lake Subwatershed Study, stormwater utility infrastructure throughout the watershed was collected by WK Dickson personnel to compile a GIS stormwater inventory database for the Town. This was accomplished by using GPS as the primary means of data capture. WK Dickson employed survey grade GPS to locate the x, y, and z coordinates of each visible stormwater system structure and conventional surveying techniques to obtain other attributes including but not limited to size, material, slope, and length. Additionally, attributes were also collected for select streams and open channel. Data was obtained for those streams and open channels required to complete connectivity for modeling purposed. The data was collected using horizontal datum NAD 1983 and vertical datum NAVD 1988

Attributes collected as part of the inventory were used to populate the various models. Field visits and digital photographs for each structure and channel were used to estimate the roughness coefficients and energy loss coefficients. The topographic data used for the Eastwood Lake Subwatershed Study was the State of North Carolina's LiDAR data.

Cross Sections

Cross sections utilized in the HEC-RAS model were based on the existing FEMA cross sections (where available). These surveyed cross sections were augmented with additional cross sections surveyed by WK Dickson. The surveyed cross section points were than merged with the digital elevation model based on the LiDAR data. Cross sections were located perpendicular to the flow and at intervals along the stream to characterize the flow capacity of the channel and floodplain for the primary system. Along stream reaches where the shape, size, and geometry of the cross-section are varying, cross sections were cut at closer intervals than for reaches having little change in channel characteristic. Additional sections were cut as required by the HEC-RAS program to sufficiently model structures such as culverts.

Surveyed cross sections are identified by station number, which for the HEC-RAS model, refers to the approximate linear distance upstream from a reference point on the main channel or tributary reach. The cross sections depict the locations of cut sections from field topographic surveys. Similarly, the cross section at each road crossing represents the top-of-road cross section. The cross sections just upstream and just downstream of highest point of roadway (commonly referred to as the weir) represent the locations of the upstream and

downstream faces, respectively, of the bridge or culvert in an area not impacted by roadway fill.

Roughness Coefficients

Manning's roughness coefficients, or 'n' values, represent the resistance to flow and influence the flow capacity of channels and floodplains. The HEC-RAS model uses these coefficients to compute friction loss longitudinally in the channel and floodplain. The roughness value is a function of the type and density of the vegetation, channel bottom and stream bank material, degree of channel meandering, and depth of flow.

Roughness coefficients were determined for all stream reaches for which hydraulic analyses were performed. The "horizontal variation in n-values" option was enabled to allow for correct modeling of the widely varied surfaces on a given cross-section. The right or left bank of the stream is referenced facing downstream. Roughness coefficients used in this study are listed in Table B-2.

Table B-2: Roughness Coefficients

Location	Range of 'n' values
Main Channel	0.04 - 0.055
Left Overbank	0.14 - 0.2
Right Overbank	0.14 - 0.2

All roughness coefficients were estimated through field observation and by referencing standard engineering manuals.

Culvert and Roadway Data

Culverts generally have different characteristics than the channel and floodplains away from roadway crossings. Often culverts constrict flood flows in the channel and floodplain, which may create backwater effects upstream of the structure. The constriction can produce increased velocities and result in localized scour.

For culvert analysis, the HEC-RAS model utilizes the concepts of "inlet" control and "outlet" control to simplify complicated culvert hydraulics. Inlet control flow occurs when the flow carrying capacity of the culvert entrance is less than the flow capacity of the culvert barrel. Outlet control flow occurs when the culvert carrying capacity is limited by downstream conditions or by the flow capacity of the culvert barrel.

During inlet control computations, the culvert inlet acts as either a weir or an orifice, and the resulting headwater is computed. The equations used by HEC-RAS are the same as those developed by the Federal Highway Administration during extensive laboratory testing, which describe the inlet control headwater under various conditions.

For outlet control flow conditions, the required headwater is computed considering various conditions. For culverts flowing full, a form of the Bernoulli Equation, which considers friction losses, entrance losses and exit losses is utilized. Friction losses are based on Manning's equation. Entrance losses are computed as a coefficient times the velocity head in the culvert at the upstream end. Exit losses are computed as a coefficient times the change in velocity head from just inside the culvert (at the downstream end) to outside the culvert.

When the culvert is not flowing full, the direct step backwater procedure is used to calculate the profile through the culvert up to the culvert inlet. An entrance loss is then computed and added to the energy inside the culvert to obtain the upstream headwater. Culvert input data for the HEC-RAS model include:

- Shape and dimensions of the structure openings;
- Culvert length;
- Entrance loss coefficient, exit loss coefficient and coefficient of discharge for weir flow during roadway overtopping;
- Upstream and downstream invert elevations;
- Federal Highway Administration chart number for the culvert type;
- Top-of-road elevations to describe the weir during roadway overtopping and the weir crest length; and
- Four cross sections are required; one cross section sufficiently downstream of the culvert that flow is not affected by the culvert, one at the downstream end of the culvert, one at the upstream end of the culvert, and one located far enough upstream that the culvert has no effect on flow.

Energy Loss Coefficients

Contraction and expansion of flow produces energy losses caused by the transition. The magnitude of these losses is related to the velocity and the estimated loss coefficient. Where the transitions are gradual, the losses are small. At abrupt changes in cross-sectional area, the losses are higher. Energy losses resulting from expansion are greater than losses associated with contraction. Energy loss coefficients used for the Eastwood Lake subwatershed hydraulic models are presented in Table B-3.

Table B-3: Energy Loss Coefficients

Type of Transition	Expansion	Contraction
None	0	0
Gradual	0.3	0.1
Culvert sections	0.5	0.3

Starting Water Surface Elevation

The starting water surface elevations for HEC-RAS model was set based on values calculated in the Little Creek FEMA HEC-RAS models.

Model Run Descriptions and Assumptions

The HEC-RAS model was used to compute flood elevations at each cross-section for the Booker Creek Primary System for the 2-, 10-, 25-, 50- and 100-year floods. A hard copy of the HEC-RAS input and output is included in Appendix H, while a digital copy of the input and output is located on the CD in Appendix J.

The hydraulic analysis for this study is based only on the condition of unobstructed flow. Therefore, flood elevations shown on the profiles are considered valid only if hydraulic structures remain unobstructed and do not fail. Flood elevations may be raised by debris blockage of the culvert, channel, or floodplain.

Model Validation

Efforts were made to verify the models for various storm events. Feedback obtained from the questionnaires was reviewed for relevant information that could be used to verify the model. The comments and responses received were not specific enough to verify the model. Likewise, the information received during the public meetings was not useful for the purposes of verifying the models. The Town Staff was able to provide some feedback that was useful during the model validation process.

During the validation process, the flows and water surface elevations initially calculated were determined to be significantly higher than the FEMA flow and base flood elevations. Furthermore, the results from the initial existing conditions model were not aligned with some of the feedback received from the Town. The flows were calibrated to get results to more closely match FEMA flows, USGS Regional Regression flows, and Town feedback.

Open Channel Systems and Roadway Flooding

Two (2) roadway crossings were analyzed for flooding potential in the Eastwood Lake Subwatershed Study. All roadway crossings that were analyzed in this study are listed in Tables B-4 and B-5 along with the minimum top-of-road elevations and the 2-, 10-, 25-, 50- and 100-year flood elevations at the crossing for existing and future conditions with projects.

Table B-4: Hydraulic Performance of Roadway Crossings – Existing Conditions

Location	Minimum Elevation at Top of Road (feet NAVD)	Desired Level of Service (Year)	Calculated Water Surface Elevations (feet NAVD)				
			2-year flood	10-year flood	25-year flood	50-year flood	100-year flood
North Lakeshore Drive	301.63	100	298.73	301.06	**302.31**	**302.52**	**302.61**
Piney Mountain Road	385.66	100	378.56	383.64	**386.70**	**387.32**	**387.72**

*Bold text indicates the existing water surface has exceeded the crest or low point in the road thereby causing flooding.
** Green shade indicates crossing meets desired level of service. Red shade indicates crossing does not meet desired level of service.

Table B-5: Hydraulic Performance of Roadway Crossings – Future Conditions with Projects

Location	Minimum Elevation at Top of Road (feet NAVD)	Desired Level of Service (Year)	Calculated Water Surface Elevations (feet NAVD)				
			2-year flood	10-year flood	25-year flood	50-year flood	100-year flood
North Lakeshore Drive (Existing Bridge)	301.63	100	298.52	301.51	**302.26**	**302.43**	**302.47**
Piney Mountain Road (Existing Bridge with Proposed Floodplain Culverts)	385.66	100	379.20	383.21	385.42	**386.61**	**387.00**

*Bold text indicates the existing water surface has exceeded the crest or low point in the road thereby causing flooding.
** Green shade indicates crossing meets desired level of service. Red shade indicates crossing does not meet desired level of service.

In addition to the roadway crossings, the open channel systems were also analyzed as part of this study. Tables summarizing the existing, future, and alternative flows and water surface elevations for the 2-, 10-, 25-, 50- and 100-year storm events have been included at the end of this appendix.

Hydraflow Storm Sewers

The purpose of the hydrologic analysis for the secondary systems, or closed systems, was to estimate the peak runoff that would flow to the catch basins and into the closed system. The rational method was used for the closed system hydrologic analysis. The rational method can be expressed as follows:

$$Q = CiA$$

Q = maximum rate of runoff (cfs)
C = runoff coefficient representing a ration of runoff to rainfall
i = average rainfall intensity for a duration equal to the time of concentration (in/hr)
A = drainage area contributing to the design location (acres)

SWMM

SWMM is a dynamic rainfall-runoff model capable of modeling the hydrologic response of a watershed and hydraulic routing throughout a stormwater conveyance system. The model calculates the effect of backwater, flat or negative slopes, energy losses, and minor headlosses associated with bends, entrances and exits.

Input data for the EPA SWMM (hydraulics) computer model include the following:

- Conveyance pipes including structure inverts, pipe sizes and lengths;
- Open channel cross section geometries;
- Roughness coefficients for pipes and channels;
- Energy loss coefficients for flow in the pipes and channels;
- Storage rating curves; and
- Overland flow characteristics.

SWMM provides an accurate evaluation of the existing and proposed conditions because it combines hydrology and hydraulics while accounting for the routing effects of the channel and overbank storage areas. Because hydrology and hydraulics are combined, changes to peak flows or water surface elevations resulting from proposed modifications to the existing channels or culverts are calculated in the model in one (1) step. Additionally, changes to flows from proposed pipes and channel improvements are seen both upstream and downstream, reducing the potential for a stormwater system having increased flooding downstream.

Energy Loss Coefficients

Contraction and expansion of flow produces energy losses caused by the transition. The magnitude of these losses is related to the velocity and the estimated loss coefficient. Where the transitions are gradual, the losses are small. At abrupt changes in cross-sectional area, the losses are higher. Energy losses resulting from expansion are greater than losses associated with contraction. Energy loss coefficients used for the hydraulic SWMM models are presented in Table B-6.

Table B-6: Energy Loss Coefficients for SWMM Models

Type of Transition	Expansion	Contraction
None	0	0
Manhole/Inlet	0.7	0.5
Open Channel	1	0.5–Headwall/ 0.9 - Projecting

Additional energy losses for structures having bends were divided between the two (2) joining pipes. The bend losses used for this project are based on NCDOT values and are shown below in Table B-7.

Table B-7: Bend Loss Coefficients

Angle (°)	Loss Coefficient	Angle (°)	Loss Coefficient
90	0.70	40	0.38
80	0.66	30	0.28
70	0.61	25	0.22
60	0.55	20	0.16
50	0.47	15	0.10

Table B-8: Eastwood Lake Subwatershed Study: Infrastructure Capacity

Location	Existing Size/Material	Existing Capacity (cfs)	Proposed Size/Material	Proposed Capacity (cfs)
North Lakeshore Drive	Bridge	1,140	No Change	No Change
Piney Mountain Road	Bridge	1,114	Existing Bridge with Proposed Floodplain Culvert (7′ x 5′ RCBC)	1,529

Table B-9: Eastwood Lake
Subwatershed Study - Flow and WSEL Comparison (2-Year)

Station	2-Year Existing Flow (cfs)	2-Year Future Flow (cfs)	2-Year Alternative Flow (cfs)	2-Year Existing WSEL (feet)	2-Year Future WSEL (feet)	2-Year Alternative WSEL (feet)	Difference in 2-Year WSEL: Future vs. Alternative (feet)
BOOKER CREEK							
22230.4	Bridge						
22205.4	335.00	460.00	56.00	424.80	425.28	422.91	-2.37
22061.4	335.00	460.00	56.00	403.48	403.96	401.87	-2.09
21877	335.00	460.00	56.00	392.59	393.01	391.58	-1.43
21577.4	505.00	583.00	549.00	388.70	389.02	388.89	-0.13
21329	505.00	583.00	549.00	384.85	385.19	385.03	-0.16
21024.2	505.00	583.00	549.00	382.51	383.35	381.63	-1.72
20803	505.00	583.00	549.00	382.10	383.05	380.06	-2.99
20582.7	505.00	583.00	549.00	382.08	383.04	379.94	-3.10
20391.6	505.00	638.00	578.00	381.74	382.65	378.31	-4.34
20349.6	Bridge						
20307.6	505.00	634.00	524.00	376.65	377.39	376.76	-0.63
20223	505.00	634.00	524.00	374.56	375.00	374.63	-0.37
20024.2	505.00	634.00	524.00	370.90	371.38	370.97	-0.41
19751	505.00	634.00	524.00	366.22	366.70	366.31	-0.39
19524.2	505.00	634.00	524.00	360.22	360.62	360.27	-0.35
19222	505.00	634.00	524.00	351.56	351.92	351.61	-0.31
19024.2	505.00	634.00	524.00	347.77	348.33	347.86	-0.47
18833	505.00	634.00	524.00	344.27	344.81	344.35	-0.46
18524.2	505.00	634.00	524.00	339.74	340.33	339.83	-0.50
18317	505.00	634.00	524.00	337.67	338.14	337.74	-0.40
18024.2	505.00	634.00	524.00	333.70	334.20	333.78	-0.42
17810	505.00	634.00	524.00	330.53	331.00	330.61	-0.39
17524.2	505.00	634.00	524.00	329.03	329.60	329.11	-0.49
17294	505.00	634.00	524.00	328.00	328.44	328.01	-0.43
17020	505.00	634.00	524.00	325.08	325.44	325.23	-0.21
16807	505.00	634.00	524.00	321.44	321.79	321.34	-0.45
16524.2	603.00	675.00	538.00	318.76	319.04	318.48	-0.56
16219	603.00	675.00	538.00	313.82	314.14	313.50	-0.64
16024.2	603.00	675.00	538.00	309.68	309.99	309.39	-0.60
15740	603.00	675.00	538.00	303.10	303.37	302.86	-0.51
15524.2	603.00	675.00	538.00	300.10	300.45	299.79	-0.66
15291	603.00	675.00	538.00	298.98	299.28	298.76	-0.52
15183.4	603.00	675.00	538.00	298.73	299.02	298.53	-0.49
15150.4	Bridge						
15117.4	603.00	675.00	538.00	297.82	298.03	298.01	-0.02
15024.2	603.00	687.00	542.00	297.73	297.93	297.95	0.02
14764	603.00	687.00	542.00	296.60	296.83	296.55	-0.28
14524.2	603.00	687.00	542.00	296.34	296.55	296.37	-0.18
14034.8	603.00	687.00	542.00	296.37	296.57	296.39	-0.18
13555.6	603.00	687.00	542.00	296.35	296.55	296.38	-0.17
13024.2	603.00	687.00	542.00	296.33	296.52	296.36	-0.16
12524.2	603.00	687.00	542.00	296.31	296.50	296.34	-0.16
12024.2	603.00	687.00	542.00	296.30	296.49	296.34	-0.15
11747.1	603.00	687.00	542.00	296.30	296.49	296.33	-0.16
11352.3	668.00	823.00	697.00	296.30	296.48	296.33	-0.15
11341.3	Inl Struct						

Table B-10: Eastwood Lake
Subwatershed Study - Flow and WSEL Comparison (10-Year)

Station	10-Year Existing Flow (cfs)	10-Year Future Flow (cfs)	10-Year Alternative Flow (cfs)	10-Year Existing WSEL (feet)	10-Year Future WSEL (feet)	10-Year Alternative WSEL (feet)	Difference in 10-Year WSEL: Future vs. Alternative (feet)
BOOKER CREEK							
22230.4	Bridge						
22205.4	734.00	842.00	108.00	426.19	426.52	423.53	-2.99
22061.4	734.00	842.00	108.00	404.82	405.14	402.28	-2.86
21877	734.00	842.00	108.00	393.48	393.78	392.39	-1.39
21577.4	1018.00	1128.00	1006.00	390.07	390.27	390.05	-0.22
21329	1018.00	1128.00	1006.00	387.16	387.38	387.13	-0.25
21024.2	1018.00	1128.00	1006.00	386.21	386.80	384.43	-2.37
20803	1018.00	1128.00	1006.00	385.99	386.59	383.85	-2.74
20582.7	1018.00	1128.00	1006.00	385.99	386.59	383.85	-2.74
20391.6	1018.00	1184.00	1051.00	385.94	386.55	382.87	-3.68
20349.6	Bridge						
20307.6	505.00	1134.00	1028.00	379.17	380.10	379.19	-0.91
20223	505.00	1134.00	1028.00	376.23	376.52	376.25	-0.27
20024.2	505.00	1134.00	1028.00	372.60	372.83	372.62	-0.21
19751	505.00	1134.00	1028.00	367.64	367.97	367.67	-0.30
19524.2	505.00	1134.00	1028.00	361.82	362.11	361.84	-0.27
19222	505.00	1134.00	1028.00	352.80	353.04	352.82	-0.22
19024.2	505.00	1134.00	1028.00	349.57	349.91	349.60	-0.31
18833	505.00	1134.00	1028.00	346.21	346.50	346.23	-0.27
18524.2	505.00	1134.00	1028.00	341.67	341.99	341.71	-0.28
18317	505.00	1134.00	1028.00	339.23	339.58	339.25	-0.33
18024.2	505.00	1134.00	1028.00	335.23	335.44	335.25	-0.19
17810	505.00	1134.00	1028.00	332.20	332.55	332.23	-0.32
17524.2	505.00	1134.00	1028.00	330.92	331.23	330.95	-0.28
17294	505.00	1134.00	1028.00	329.61	329.88	329.63	-0.25
17020	505.00	1134.00	1028.00	326.10	326.31	326.12	-0.19
16807	505.00	1134.00	1028.00	323.00	323.26	323.00	-0.26
16524.2	603.00	1165.00	1057.00	320.29	320.55	320.29	-0.26
16219	603.00	1165.00	1057.00	315.31	315.61	315.30	-0.31
16024.2	603.00	1165.00	1057.00	311.33	311.64	311.33	-0.31
15740	603.00	1165.00	1057.00	304.79	305.05	304.79	-0.26
15524.2	603.00	1165.00	1057.00	302.06	302.44	302.26	-0.18
15291	603.00	1165.00	1057.00	301.31	301.99	301.81	-0.18
15183.4	603.00	1165.00	1057.00	301.06	301.75	301.62	-0.13
15150.4	Bridge						
15117.4	603.00	1165.00	1057.00	298.62	298.78	299.12	0.34
15024.2	603.00	1174.00	1065.00	298.55	298.72	299.14	0.42
14764	603.00	1174.00	1065.00	297.60	297.75	297.58	-0.17
14524.2	603.00	1174.00	1065.00	297.22	297.33	297.18	-0.15
14034.8	603.00	1174.00	1065.00	297.21	297.31	297.16	-0.15
13555.6	603.00	1174.00	1065.00	297.16	297.25	297.12	-0.13
13024.2	603.00	1174.00	1065.00	297.11	297.19	297.06	-0.13
12524.2	603.00	1174.00	1065.00	297.07	297.15	297.02	-0.13
12024.2	603.00	1174.00	1065.00	297.05	297.13	297.01	-0.12
11747.1	603.00	1174.00	1065.00	297.05	297.12	297.00	-0.12
11352.3	668.00	1773.00	1538.00	297.05	297.12	297.00	-0.12
11341.3	Inl Struct						

Table B-11: Eastwood Lake
Subwatershed Study - Flow and WSEL Comparison (25-Year)

Station	25-Year Existing Flow (cfs)	25-Year Future Flow (cfs)	25-Year Alternative Flow (cfs)	25-Year Existing WSEL (feet)	25-Year Future WSEL (feet)	25-Year Alternative WSEL (feet)	Difference in 25-Year WSEL: Future vs. Alternative (feet)
BOOKER CREEK							
22230.4	Bridge						
22205.4	979.00	1065.00	140.00	426.91	427.15	423.86	-3.29
22061.4	979.00	1065.00	140.00	405.49	405.71	402.49	-3.22
21877	979.00	1065.00	140.00	394.05	394.14	393.02	-1.12
21577.4	1318.00	1478.00	1311.00	390.59	390.81	390.60	-0.21
21329	1318.00	1478.00	1311.00	387.71	387.99	387.68	-0.31
21024.2	1318.00	1478.00	1311.00	387.12	387.50	386.38	-1.12
20803	1318.00	1478.00	1311.00	386.87	387.23	386.01	-1.22
20582.7	1318.00	1478.00	1311.00	386.87	387.23	386.02	-1.21
20391.6	1318.00	1537.00	1375.00	386.83	387.19	385.09	-2.10
20349.6	Bridge						
20307.6	1318.00	1519.00	1365.00	380.63	380.80	380.75	-0.05
20223	1318.00	1519.00	1365.00	376.89	377.21	376.97	-0.24
20024.2	1318.00	1519.00	1365.00	373.16	373.46	373.26	-0.20
19751	1318.00	1519.00	1365.00	368.42	368.90	368.51	-0.39
19524.2	1318.00	1519.00	1365.00	362.51	362.91	362.61	-0.30
19222	1318.00	1519.00	1365.00	353.37	353.74	353.46	-0.28
19024.2	1318.00	1519.00	1365.00	350.41	350.83	350.51	-0.32
18833	1318.00	1519.00	1365.00	347.00	347.59	347.14	-0.45
18524.2	1318.00	1519.00	1365.00	342.39	342.79	342.49	-0.30
18317	1318.00	1519.00	1365.00	340.09	340.50	340.20	-0.30
18024.2	1318.00	1519.00	1365.00	335.75	336.07	335.83	-0.24
17810	1318.00	1519.00	1365.00	333.06	333.56	333.18	-0.38
17524.2	1318.00	1519.00	1365.00	331.68	332.12	331.79	-0.33
17294	1318.00	1519.00	1365.00	330.25	330.64	330.35	-0.29
17020	1318.00	1519.00	1365.00	326.65	326.96	326.72	-0.24
16807	1318.00	1519.00	1365.00	323.78	324.07	323.77	-0.30
16524.2	1419.00	1559.00	1407.00	321.12	321.41	321.09	-0.32
16219	1419.00	1559.00	1407.00	316.28	316.62	316.25	-0.37
16024.2	1419.00	1559.00	1407.00	312.30	312.62	312.27	-0.35
15740	1419.00	1559.00	1407.00	305.63	305.92	305.62	-0.30
15524.2	1419.00	1559.00	1407.00	303.01	303.20	303.08	-0.12
15291	1419.00	1559.00	1407.00	302.71	302.92	302.83	-0.09
15183.4	1419.00	1559.00	1407.00	302.31	302.44	302.45	0.01
15150.4	Bridge						
15117.4	1419.00	1559.00	1407.00	299.01	299.13	299.66	0.53
15024.2	1419.00	1570.00	1416.00	299.02	299.19	299.69	0.50
14764	1419.00	1570.00	1416.00	298.10	298.29	298.07	-0.22
14524.2	1419.00	1570.00	1416.00	297.62	297.74	297.57	-0.17
14034.8	1419.00	1570.00	1416.00	297.57	297.67	297.52	-0.15
13555.6	1419.00	1570.00	1416.00	297.50	297.59	297.45	-0.14
13024.2	1419.00	1570.00	1416.00	297.42	297.50	297.37	-0.13
12524.2	1419.00	1570.00	1416.00	297.36	297.43	297.31	-0.12
12024.2	1419.00	1570.00	1416.00	297.33	297.40	297.28	-0.12
11747.1	1419.00	1570.00	1416.00	297.33	297.39	297.28	-0.11
11352.3	2217.00	2353.00	2107.00	297.32	297.38	297.27	-0.11
11341.3	Inl Struct						

Table B-12: Eastwood Lake
Subwatershed Study - Flow and WSEL Comparison (50-Year)

Station	50-Year Existing Flow (cfs)	50-Year Future Flow (cfs)	50-Year Alternative Flow (cfs)	50-Year Existing WSEL (feet)	50-Year Future WSEL (feet)	50-Year Alternative WSEL (feet)	Difference in 50-Year WSEL: Future vs. Alternative (feet)
BOOKER CREEK							
22230.4	Bridge						
22205.4	1158.00	1270.00	165.00	427.40	427.69	424.01	-3.68
22061.4	1158.00	1270.00	165.00	405.95	406.23	402.64	-3.59
21877	1158.00	1270.00	165.00	394.36	394.59	393.56	-1.03
21577.4	1600.00	1750.00	1585.00	390.94	391.14	390.92	-0.22
21329	1600.00	1750.00	1585.00	388.18	388.33	388.16	-0.17
21024.2	1600.00	1750.00	1585.00	387.63	387.92	387.40	-0.52
20803	1600.00	1750.00	1585.00	387.33	387.61	387.07	-0.54
20582.7	1600.00	1750.00	1585.00	387.33	387.6	387.07	-0.53
20391.6	1600.00	1820.00	1648.00	387.28	387.55	387.01	-0.54
20349.6	Bridge						
20307.6	1600.00	1804.00	1642.00	381.46	382.39	382.11	-0.28
20223	1600.00	1804.00	1642.00	377.34	377.65	377.40	-0.25
20024.2	1600.00	1804.00	1642.00	373.55	373.83	373.61	-0.22
19751	1600.00	1804.00	1642.00	369.08	369.46	369.17	-0.29
19524.2	1600.00	1804.00	1642.00	363.05	363.42	363.13	-0.29
19222	1600.00	1804.00	1642.00	353.89	354.25	353.97	-0.28
19024.2	1600.00	1804.00	1642.00	351.03	350.90	351.12	0.22
18833	1600.00	1804.00	1642.00	347.75	348.88	347.84	-1.04
18524.2	1600.00	1804.00	1642.00	342.94	343.33	343.02	-0.31
18317	1600.00	1804.00	1642.00	340.62	340.90	340.69	-0.21
18024.2	1600.00	1804.00	1642.00	336.20	336.51	336.27	-0.24
17810	1600.00	1804.00	1642.00	333.75	334.22	333.86	-0.36
17524.2	1600.00	1804.00	1642.00	332.29	332.68	332.37	-0.31
17294	1600.00	1804.00	1642.00	330.79	331.15	330.86	-0.29
17020	1600.00	1804.00	1642.00	327.08	327.35	327.14	-0.21
16807	1600.00	1804.00	1642.00	324.33	324.58	324.30	-0.28
16524.2	1714.00	1853.00	1689.00	321.71	321.98	321.67	-0.31
16219	1714.00	1853.00	1689.00	316.97	317.26	316.90	-0.36
16024.2	1714.00	1853.00	1689.00	312.95	313.24	312.90	-0.34
15740	1714.00	1853.00	1689.00	306.17	306.36	306.13	-0.23
15524.2	1714.00	1853.00	1689.00	303.40	303.55	303.43	-0.12
15291	1714.00	1853.00	1689.00	303.14	303.30	303.20	-0.10
15183.4	1714.00	1853.00	1689.00	302.52	302.57	302.64	0.07
15150.4	Bridge						
15117.4	1714.00	1853.00	1689.00	299.21	299.34	299.95	0.61
15024.2	1714.00	1865.00	1699.00	299.34	299.48	300.05	0.57
14764	1714.00	1865.00	1699.00	298.47	298.61	298.45	-0.16
14524.2	1714.00	1865.00	1699.00	297.90	298.00	297.88	-0.12
14034.8	1714.00	1865.00	1699.00	297.82	297.90	297.80	-0.10
13555.6	1714.00	1865.00	1699.00	297.73	297.80	297.71	-0.09
13024.2	1714.00	1865.00	1699.00	297.62	297.68	297.61	-0.07
12524.2	1714.00	1865.00	1699.00	297.54	297.58	297.53	-0.05
12024.2	1714.00	1865.00	1699.00	297.51	297.54	297.49	-0.05
11747.1	1714.00	1865.00	1699.00	297.50	297.54	297.49	-0.05
11352.3	2614.00	2685.00	2563.00	297.49	297.53	297.48	-0.05
11341.3	Inl Struct						

Table B-13: Eastwood Lake
Subwatershed Study - Flow and WSEL Comparison (100-Year)

Station	100-Year Existing Flow (cfs)	100-Year Future Flow (cfs)	100-Year Alternative Flow (cfs)	100-Year Existing WSEL (feet)	100-Year Future WSEL (feet)	100-Year Alternative WSEL (feet)	Difference in 100-Year WSEL: Future vs. Alternative (feet)
BOOKER CREEK							
22230.4	Bridge						
22205.4	1321.00	1281.00	190.00	427.82	427.71	424.15	-3.56
22061.4	1321.00	1281.00	190.00	406.35	406.25	402.78	-3.47
21877	1321.00	1281.00	190.00	394.70	394.82	393.81	-1.01
21577.4	1837.00	1976.00	1744.00	391.26	391.44	391.14	-0.30
21329	1837.00	1976.00	1744.00	388.41	388.53	388.32	-0.21
21024.2	1837.00	1976.00	1744.00	387.97	388.01	387.83	-0.18
20803	1837.00	1976.00	1744.00	387.63	387.61	387.51	-0.10
20582.7	1837.00	1976.00	1744.00	387.63	387.61	387.50	-0.11
20391.6	1837.00	2039.00	1805.00	387.57	387.54	387.45	-0.09
20349.6	Bridge						
20307.6	1837.00	2030.00	1803.00	382.44	383.24	382.38	-0.86
20223	1837.00	2030.00	1803.00	377.69	377.94	377.65	-0.29
20024.2	1837.00	2030.00	1803.00	373.88	374.17	373.83	-0.34
19751	1837.00	2030.00	1803.00	369.52	369.81	369.46	-0.35
19524.2	1837.00	2030.00	1803.00	363.47	363.83	363.42	-0.41
19222	1837.00	2030.00	1803.00	354.31	354.61	354.25	-0.36
19024.2	1837.00	2030.00	1803.00	350.94	351.19	350.90	-0.29
18833	1837.00	2030.00	1803.00	348.93	349.20	348.88	-0.32
18524.2	1837.00	2030.00	1803.00	343.39	343.64	343.33	-0.31
18317	1837.00	2030.00	1803.00	340.94	341.38	340.90	-0.48
18024.2	1837.00	2030.00	1803.00	336.56	336.83	336.51	-0.32
17810	1837.00	2030.00	1803.00	334.29	334.67	334.21	-0.46
17524.2	1837.00	2030.00	1803.00	332.74	333.08	332.68	-0.40
17294	1837.00	2030.00	1803.00	331.20	331.51	331.15	-0.36
17020	1837.00	2030.00	1803.00	327.40	327.65	327.35	-0.30
16807	1837.00	2030.00	1803.00	324.74	324.94	324.58	-0.36
16524.2	1950.00	2075.00	1850.00	322.17	322.44	321.98	-0.46
16219	1950.00	2075.00	1850.00	317.43	317.60	317.25	-0.35
16024.2	1950.00	2075.00	1850.00	313.43	313.67	313.23	-0.44
15740	1950.00	2075.00	1850.00	306.47	306.61	306.35	-0.26
15524.2	1950.00	2075.00	1850.00	303.65	303.78	303.59	-0.19
15291	1950.00	2075.00	1850.00	303.41	303.54	303.36	-0.18
15183.4	1950.00	2075.00	1850.00	302.61	302.66	302.69	0.03
15150.4	Bridge						
15117.4	1950.00	2075.00	1850.00	299.54	299.84	300.05	0.21
15024.2	1950.00	2086.00	1863.00	299.54	299.65	300.23	0.58
14764	1950.00	2086.00	1863.00	298.71	298.83	298.63	-0.20
14524.2	1950.00	2086.00	1863.00	298.10	298.19	298.03	-0.16
14034.8	1950.00	2086.00	1863.00	297.99	298.07	297.94	-0.13
13555.6	1950.00	2086.00	1863.00	297.88	297.95	297.83	-0.12
13024.2	1950.00	2086.00	1863.00	297.76	297.80	297.71	-0.09
12524.2	1950.00	2086.00	1863.00	297.66	297.69	297.62	-0.07
12024.2	1950.00	2086.00	1863.00	297.61	297.64	297.58	-0.06
11747.1	1950.00	2086.00	1863.00	297.60	297.63	297.57	-0.06
11352.3	2850.00	2928.00	2789.00	297.59	297.62	297.56	-0.06
11341.3	Inl Struct						

Table B-14: Eastwood Lake Subwatershed Study: At-Risk Properties/Structures (25-Year)

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)		
		Existing 25-Year Flood	Future 25-Year Flood	Alternative 25-Year Flood
BOOKER CREEK				
1818 N LAKESHORE DR	297.10	**297.60**	**297.71**	**297.55**
2144 LAKESHORE CT	296.53	**297.33**	**297.39**	**297.28**
104 DARLIN CR	387.39	**387.71**	**388.04**	**387.68**
107 DARLIN CR	391.62	390.59	390.77	390.60
601 KENSINGTON DR	300.45	**302.71**	**302.92**	**302.83**
606 CONCORDIA CT	307.67	305.63	305.92	305.62
601 ROCK CREEK RD	300.00	**302.71**	**302.92**	**302.83**
603 ROCK CREEK RD	301.94	**302.86**	**303.06**	**302.96**

Table B-14: Eastwood Lake Subwatershed Study: At-Risk Properties/Structures (100-Year)

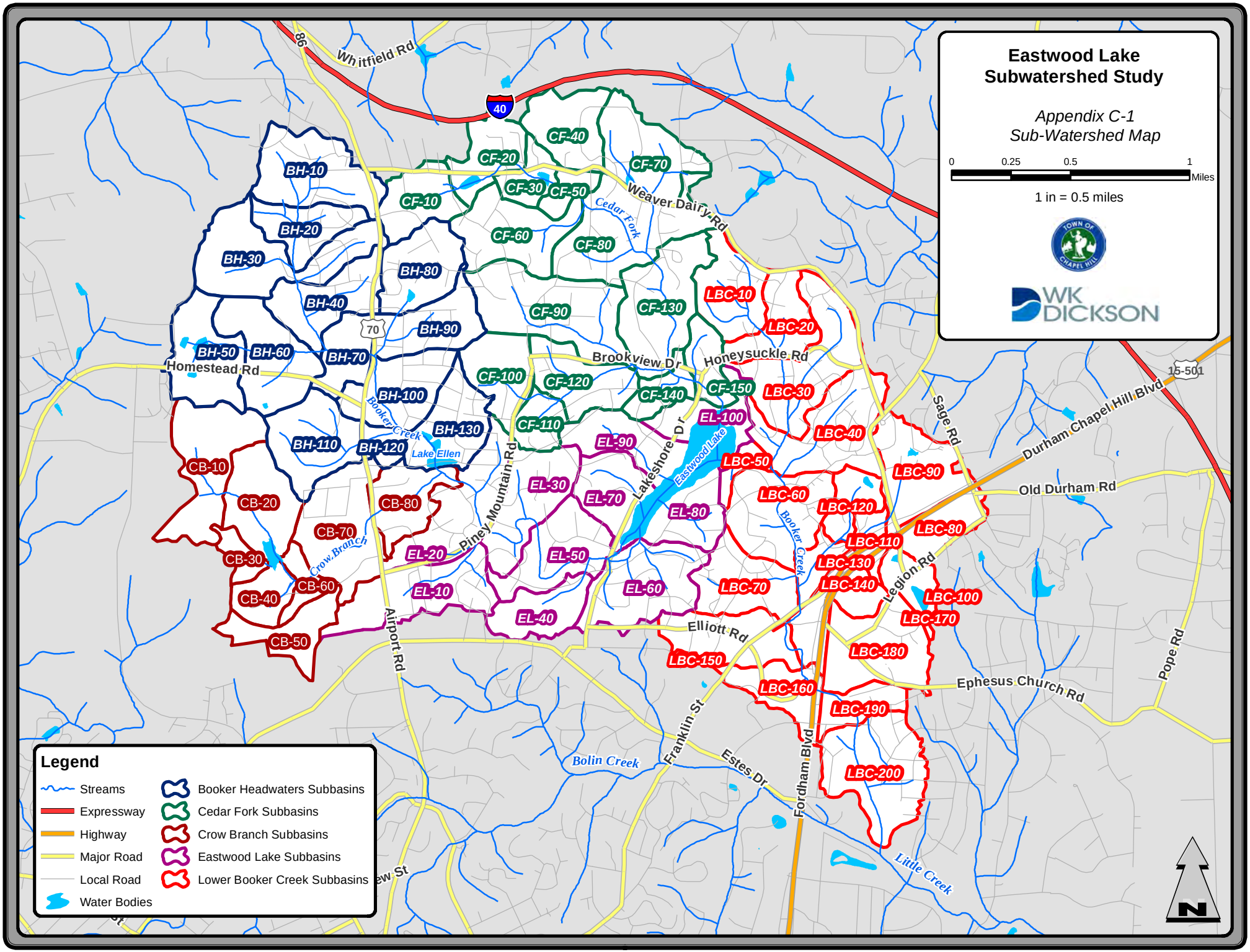
Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)		
		Existing 100-Year Flood	Future 100-Year Flood	Alternative 100-Year Flood
BOOKER CREEK				
1818 N LAKESHORE DR	297.10	**298.05**	**298.13**	**297.99**
2144 LAKESHORE CT	296.53	**297.60**	**297.63**	**297.57**
104 DARLIN CR	387.39	**388.41**	**388.53**	**388.32**
107 DARLIN CR	391.62	**391.78**	**391.94**	**391.66**
601 KENSINGTON DR	300.45	**303.41**	**303.54**	**303.36**
606 CONCORDIA CT	307.67	**307.71**	**307.85**	307.59
601 ROCK CREEK RD	300.00	**303.41**	**303.54**	**303.36**
603 ROCK CREEK RD	301.94	**303.53**	**303.66**	**303.48**

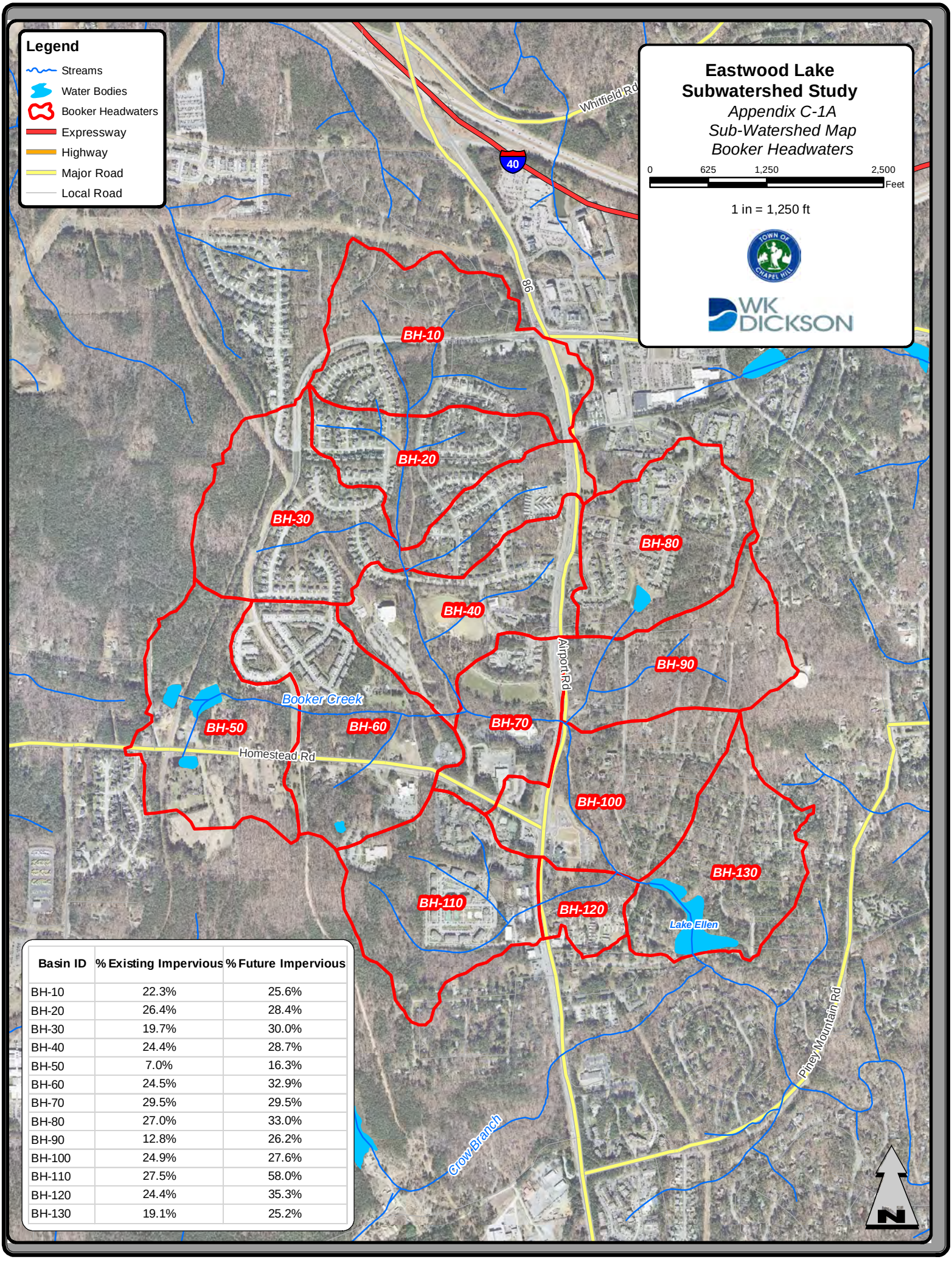
Appendix C:

Watershed, Land Use, and Soils Maps

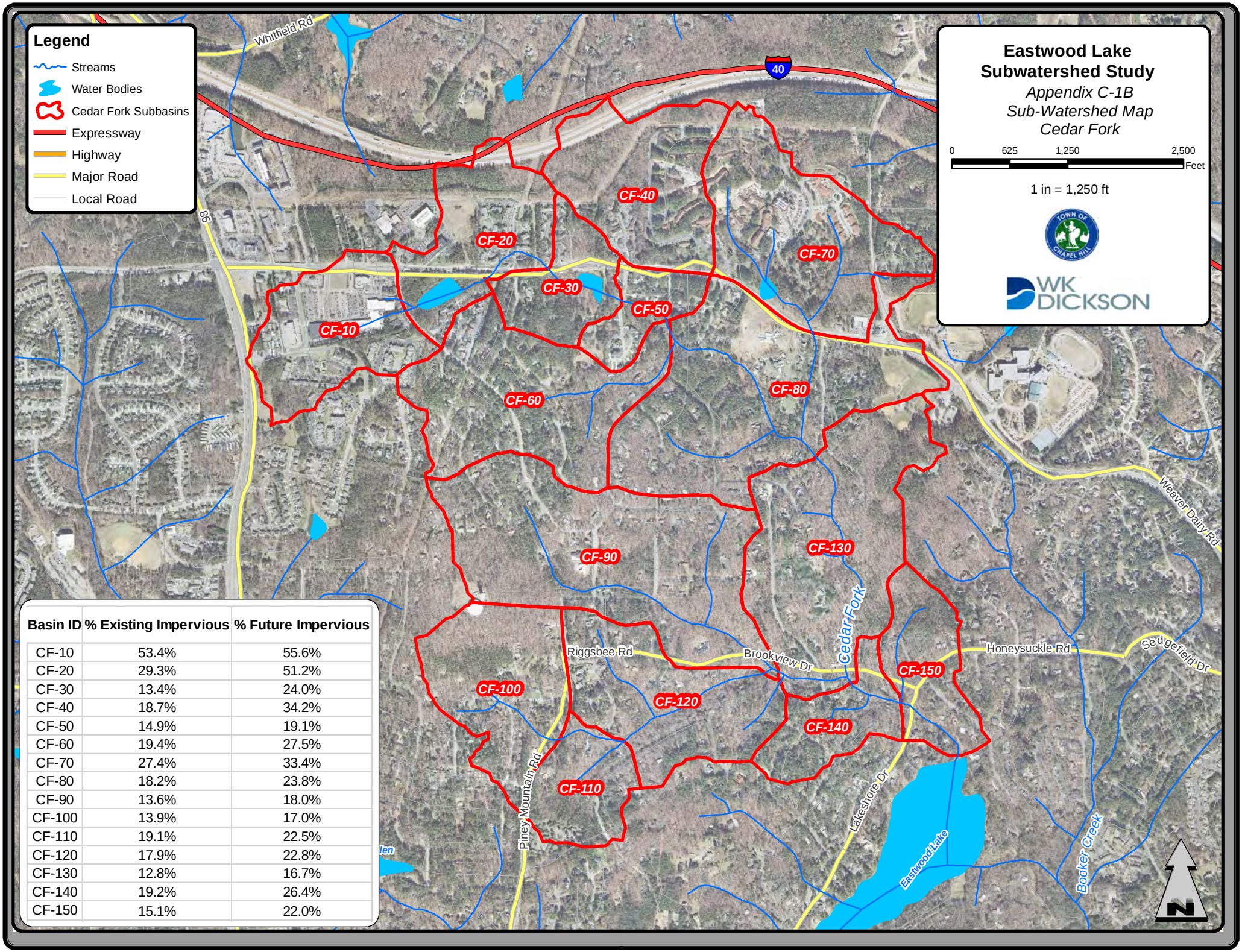
List of Contents:

1. Booker Creek Watershed Map
2. Booker Headwaters Sub-Watershed Map
3. Cedar Fork Sub-Watershed Map
4. Crow Branch Sub-Watershed Map
5. Eastwood Lake Sub-Watershed Map
6. Lower Booker Creek Sub-Watershed Map
7. Booker Creek Existing Land Use Map
8. Booker Creek Future Land Use Map
9. Booker Creek Soils Map

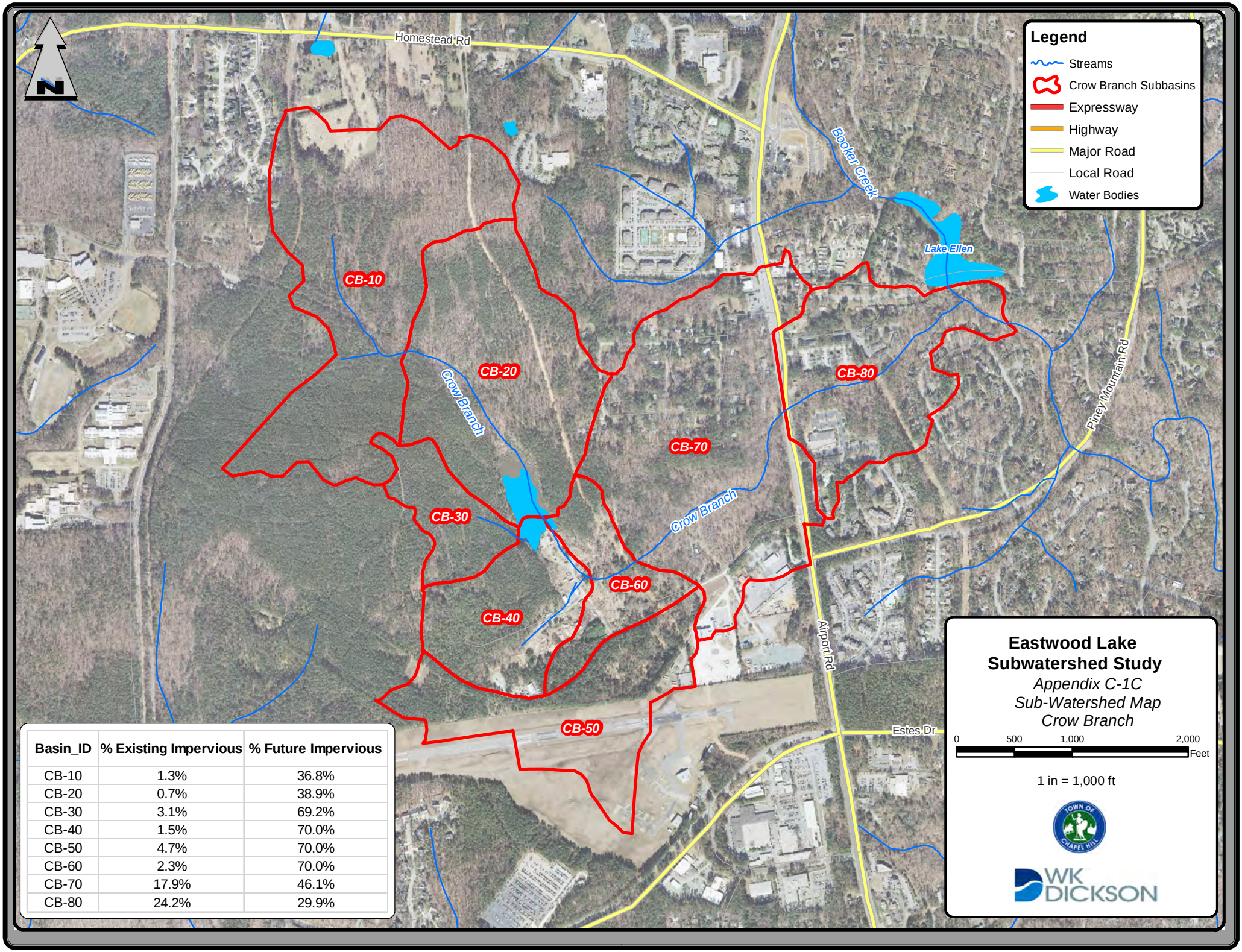

Eastwood Lake
Subwatershed Study
Appendix C-1
Sub-Watershed Map
0
0.25
0.5
1
Miles
1 in = 0.5 miles
WK DICKSON
Legend
Streams
Expressway
Highway
Major Road
Local Road
Water Bodies
Booker Headwaters Subbasins
Cedar Fork Subbasins
Crow Branch Subbasins
Eastwood Lake Subbasins
Lower Booker Creek Subbasins
Whitfield Rd
Weaver Dairy Rd
Cedar Fork
Homestead Rd
Brookview Dr
Honeysuckle Rd
Booker Creek
Lake Ellen
Eastwood Lake
Lakeshore Dr
Piney Mountain Rd
Crow Branch
Airport Rd
Sage Rd
Durham Chapel Hill Blvd
15-501
Old Durham Rd
Legion Rd
Elliott Rd
Franklin St
Estes Dr
Fordham Blvd
Ephesus Church Rd
Pope Rd
Bolin Creek
Little Creek
BH-10
BH-20
BH-30
BH-40
BH-50
BH-60
BH-70
BH-80
BH-90
BH-100
BH-110
BH-120
BH-130
CF-10
CF-20
CF-30
CF-40
CF-50
CF-60
CF-70
CF-80
CF-90
CF-100
CF-110
CF-120
CF-130
CF-140
CF-150
CB-10
CB-20
CB-30
CB-40
CB-50
CB-60
CB-70
CB-80
EL-10
EL-20
EL-30
EL-40
EL-50
EL-60
EL-70
EL-80
EL-90
EL-100
LBC-10
LBC-20
LBC-30
LBC-40
LBC-50
LBC-60
LBC-70
LBC-80
LBC-90
LBC-100
LBC-110
LBC-120
LBC-130
LBC-140
LBC-150
LBC-160
LBC-170
LBC-180
LBC-190
LBC-200



Basin ID	% Existing Impervious	% Future Impervious
BH-10	22.3%	25.6%
BH-20	26.4%	28.4%
BH-30	19.7%	30.0%
BH-40	24.4%	28.7%
BH-50	7.0%	16.3%
BH-60	24.5%	32.9%
BH-70	29.5%	29.5%
BH-80	27.0%	33.0%
BH-90	12.8%	26.2%
BH-100	24.9%	27.6%
BH-110	27.5%	58.0%
BH-120	24.4%	35.3%
BH-130	19.1%	25.2%

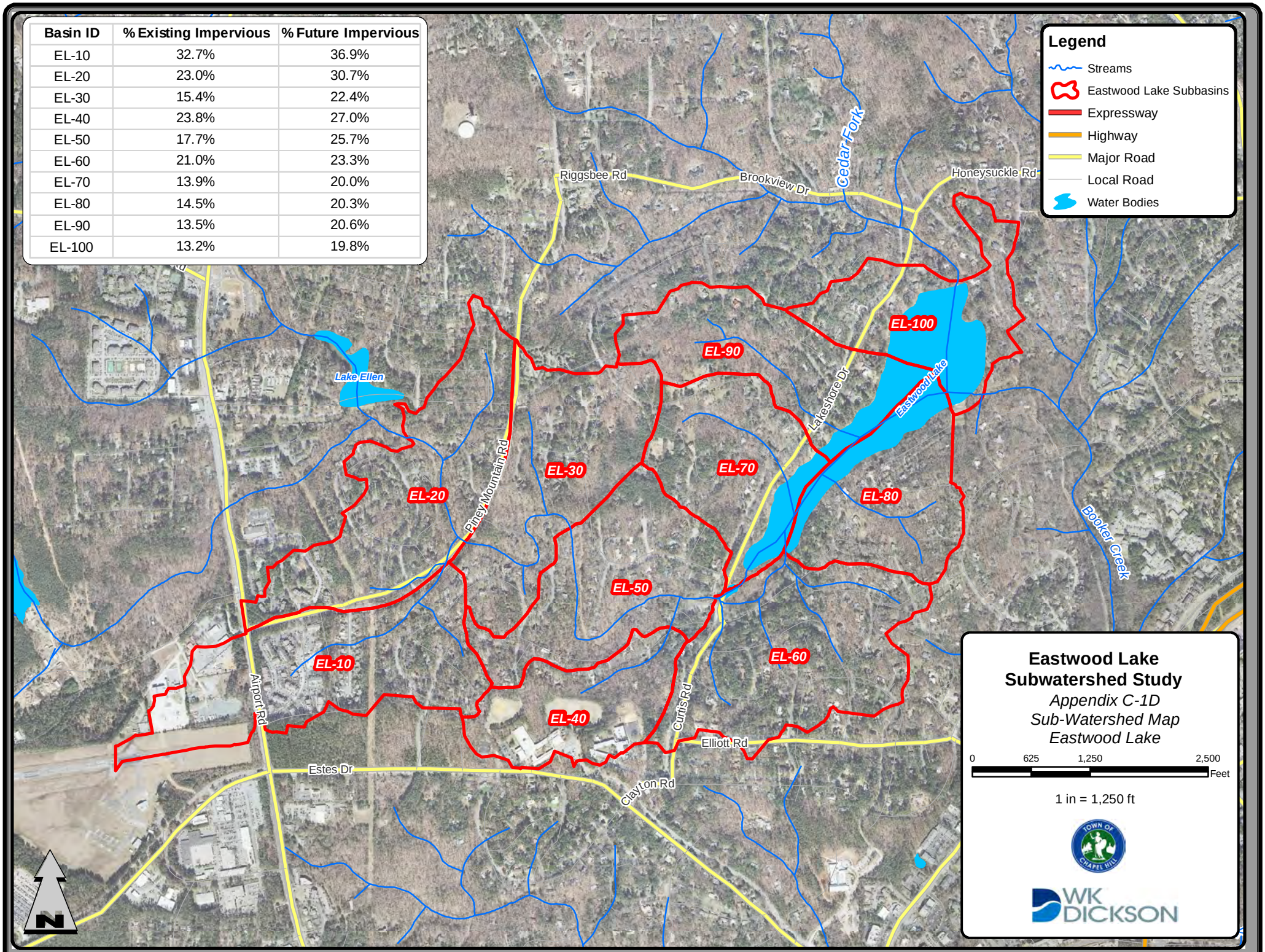


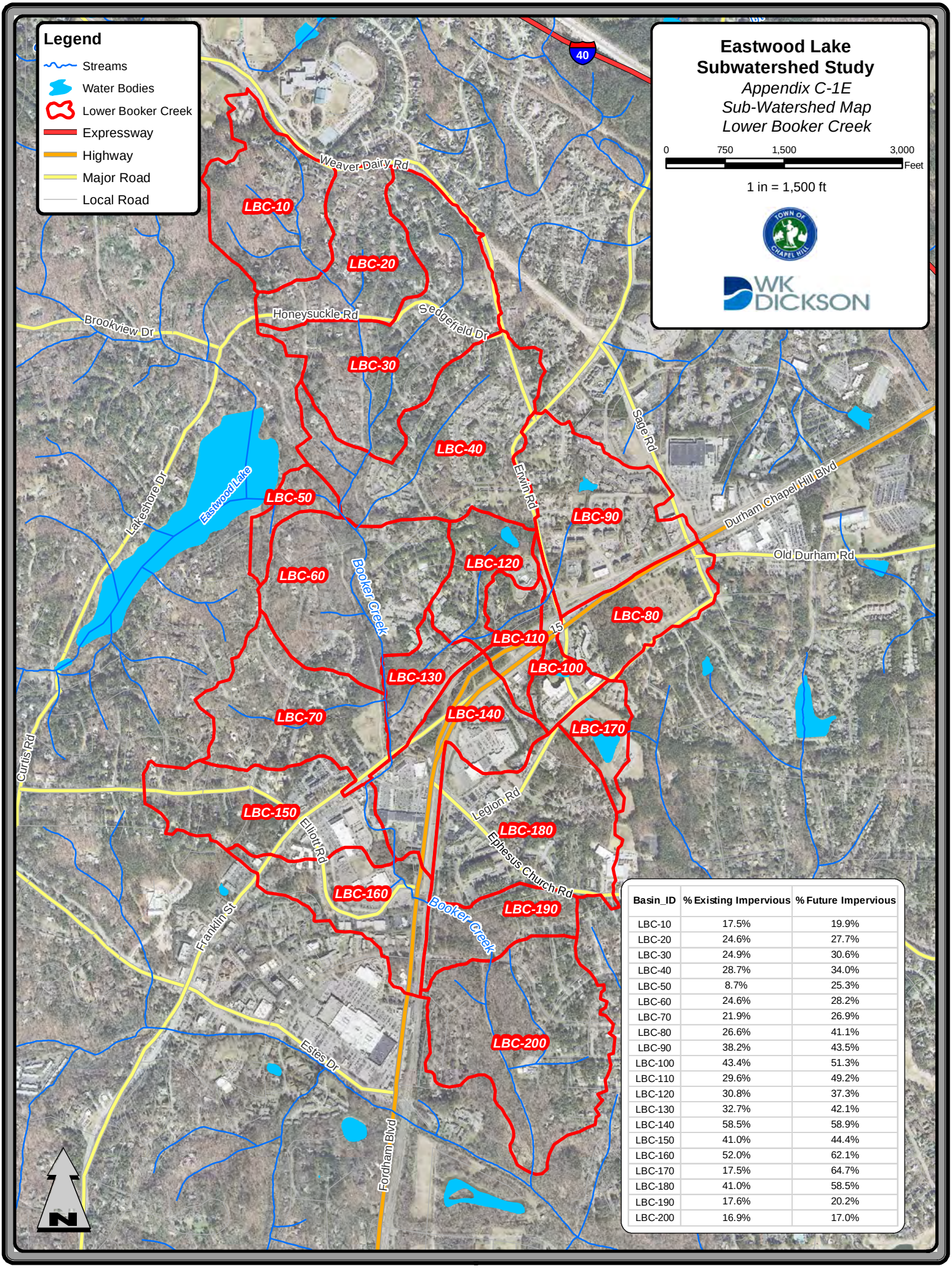
Basin ID	% Existing Impervious	% Future Impervious
CF-10	53.4%	55.6%
CF-20	29.3%	51.2%
CF-30	13.4%	24.0%
CF-40	18.7%	34.2%
CF-50	14.9%	19.1%
CF-60	19.4%	27.5%
CF-70	27.4%	33.4%
CF-80	18.2%	23.8%
CF-90	13.6%	18.0%
CF-100	13.9%	17.0%
CF-110	19.1%	22.5%
CF-120	17.9%	22.8%
CF-130	12.8%	16.7%
CF-140	19.2%	26.4%
CF-150	15.1%	22.0%



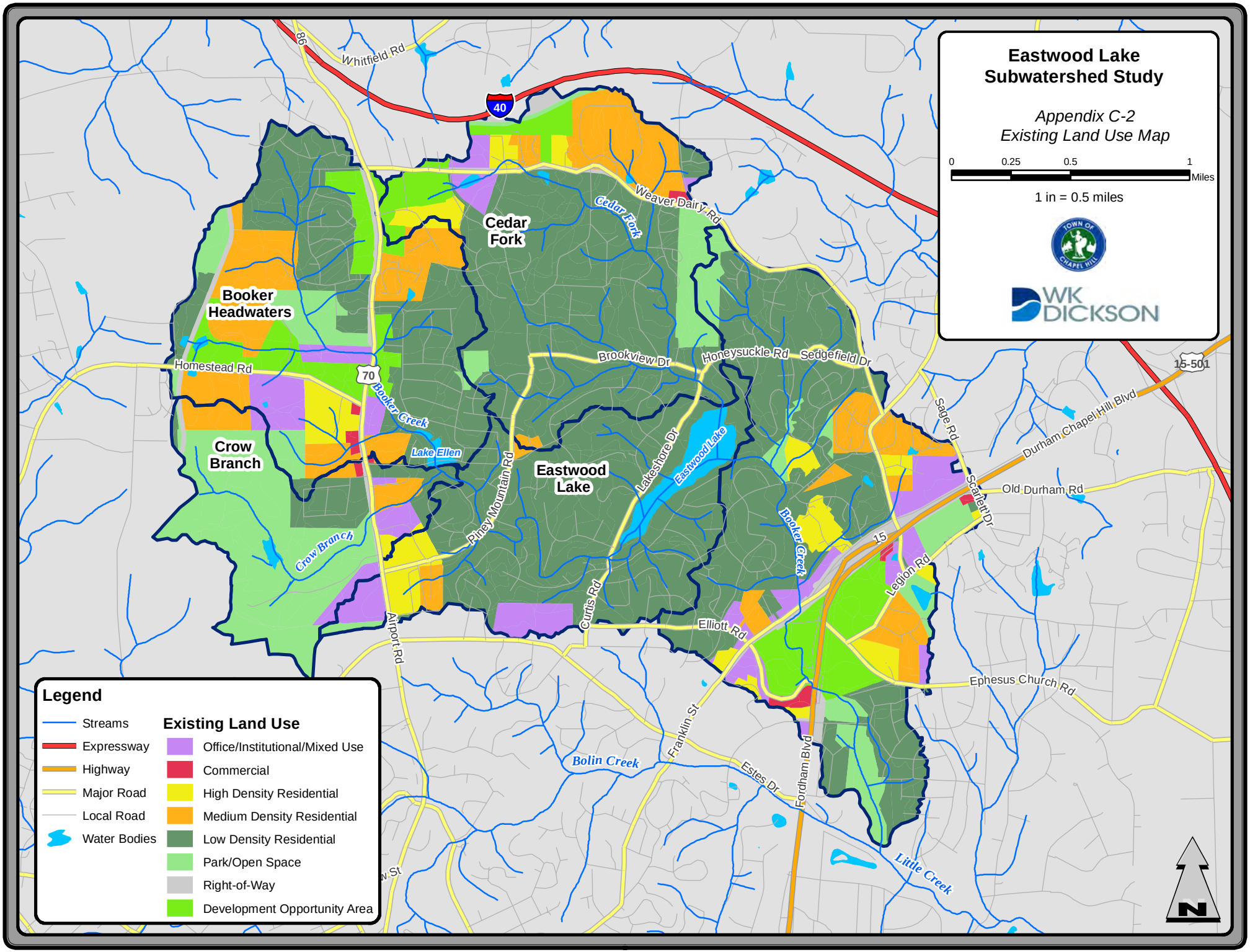
Basin_ID	% Existing Impervious	% Future Impervious
CB-10	1.3%	36.8%
CB-20	0.7%	38.9%
CB-30	3.1%	69.2%
CB-40	1.5%	70.0%
CB-50	4.7%	70.0%
CB-60	2.3%	70.0%
CB-70	17.9%	46.1%
CB-80	24.2%	29.9%

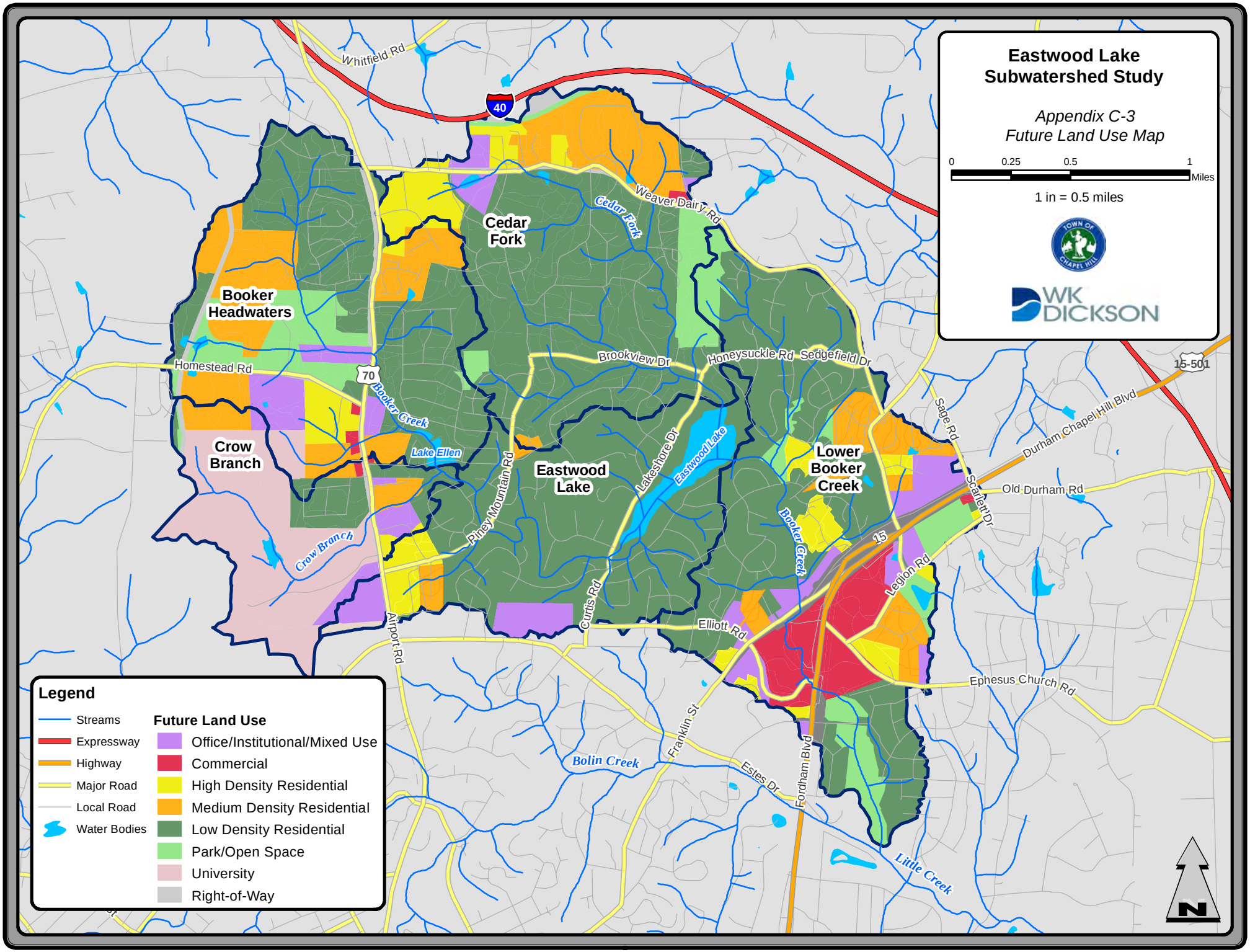
Basin ID	% Existing Impervious	% Future Impervious
EL-10	32.7%	36.9%
EL-20	23.0%	30.7%
EL-30	15.4%	22.4%
EL-40	23.8%	27.0%
EL-50	17.7%	25.7%
EL-60	21.0%	23.3%
EL-70	13.9%	20.0%
EL-80	14.5%	20.3%
EL-90	13.5%	20.6%
EL-100	13.2%	19.8%

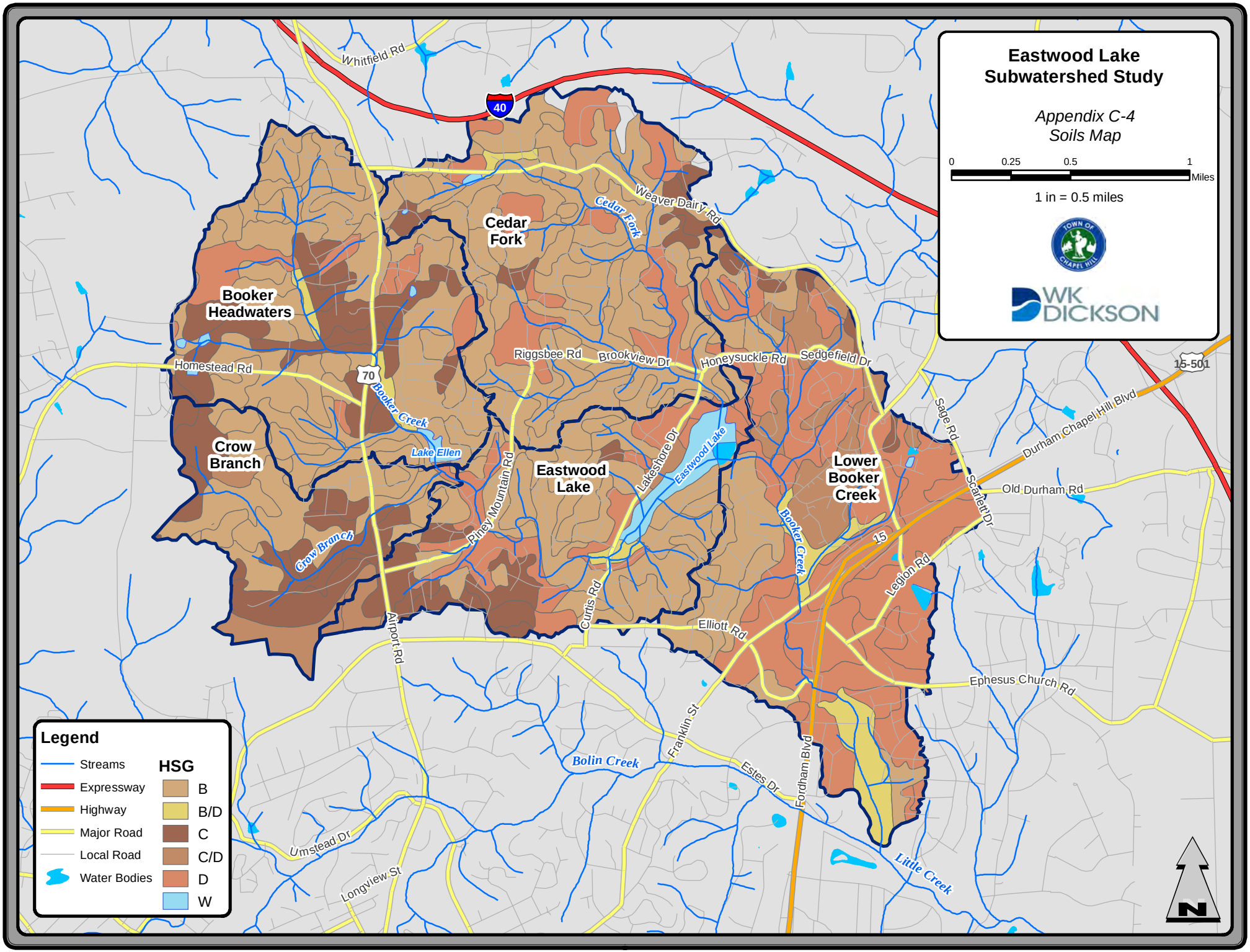




Basin_ID	% Existing Impervious	% Future Impervious
LBC-10	17.5%	19.9%
LBC-20	24.6%	27.7%
LBC-30	24.9%	30.6%
LBC-40	28.7%	34.0%
LBC-50	8.7%	25.3%
LBC-60	24.6%	28.2%
LBC-70	21.9%	26.9%
LBC-80	26.6%	41.1%
LBC-90	38.2%	43.5%
LBC-100	43.4%	51.3%
LBC-110	29.6%	49.2%
LBC-120	30.8%	37.3%
LBC-130	32.7%	42.1%
LBC-140	58.5%	58.9%
LBC-150	41.0%	44.4%
LBC-160	52.0%	62.1%
LBC-170	17.5%	64.7%
LBC-180	41.0%	58.5%
LBC-190	17.6%	20.2%
LBC-200	16.9%	17.0%


Eastwood Lake
Subwatershed Study
Appendix C-2
Existing Land Use Map
0
0.25
0.5
1
Miles
1 in = 0.5 miles
Cedar Fork
Booker Headwaters
Crow Branch
Eastwood Lake
Lake Ellen
Cedar Fork
Booker Creek
Crow Branch
Bolin Creek
Little Creek
Whitfield Rd
Weaver Dairy Rd
Homestead Rd
Brookview Dr
Honeysuckle Rd
Sedgefield Dr
Sage Rd
Durham Chapel Hill Blvd
Old Durham Rd
Scarlett Dr
Legion Rd
Ephesus Church Rd
Elliott Rd
Curtis Rd
Piney Mountain Rd
Lakeshore Dr
Airport Rd
Franklin St
Estes Dr
Fordham Blvd
40
70
86
15
15-501
Legend
Streams
Expressway
Highway
Major Road
Local Road
Water Bodies
Existing Land Use
Office/Institutional/Mixed Use
Commercial
High Density Residential
Medium Density Residential
Low Density Residential
Park/Open Space
Right-of-Way
Development Opportunity Area
N


Eastwood Lake
Subwatershed Study
Appendix C-3
Future Land Use Map
0
0.25
0.5
1
Miles
1 in = 0.5 miles
WK DICKSON
Whitfield Rd
40
Cedar Fork
Cedar Fork
Weaver Dairy Rd
Booker Headwaters
Homestead Rd
70
Booker Creek
Brookview Dr
Honeysuckle Rd
Sedgefield Dr
15-501
Sage Rd
Durham Chapel Hill Blvd
Crow Branch
Lake Ellen
Eastwood Lake
Lakeshore Dr
Eastwood Lake
Lower Booker Creek
Old Durham Rd
Scarlett Dr
Piney Mountain Rd
Crow Branch
Booker Creek
15
Legion Rd
Curtis Rd
Airport Rd
Elliott Rd
Ephesus Church Rd
Franklin St
Bolin Creek
Estes Dr
Fordham Blvd
Little Creek
Legend
Streams
Expressway
Highway
Major Road
Local Road
Water Bodies
Future Land Use
Office/Institutional/Mixed Use
Commercial
High Density Residential
Medium Density Residential
Low Density Residential
Park/Open Space
University
Right-of-Way
N


Eastwood Lake
Subwatershed Study
Appendix C-4
Soils Map
0
0.25
0.5
1
Miles
1 in = 0.5 miles
Legend
Streams
Expressway
Highway
Major Road
Local Road
Water Bodies
HSG
B
B/D
C
C/D
D
W
Booker Headwaters
Cedar Fork
Crow Branch
Eastwood Lake
Lower Booker Creek
Whitfield Rd
Weaver Dairy Rd
Homestead Rd
Riggsbee Rd
Brookview Dr
Honeysuckle Rd
Sedgefield Dr
Sage Rd
Durham Chapel Hill Blvd
Old Durham Rd
Scarlett Dr
Legion Rd
Elliott Rd
Ephesus Church Rd
Airport Rd
Piney Mountain Rd
Curtis Rd
Lakeshore Dr
Franklin St
Estes Dr
Fordham Blvd
Umstead Dr
Longview St
Cedar Fork
Booker Creek
Lake Ellen
Eastwood Lake
Crow Branch
Bolin Creek
Little Creek
40
70
15-501
15

Appendix D:

Citizen Input

List of Contents:

1. General Survey Results

2. Eastwood Lake Subwatershed Questionnaire

3. Eastwood Lake Public Meeting Minutes
    a. Public Meeting 2, Session 1 – December 7, 2017
    b. Public Meeting 2, Session 2 – December 7, 2017

Table D-1A: General Survey Results – Entire Booker Creek Watershed

Survey Question Number	Question	Survey Response				
		Yes	No	No Response	Do Not Know	Maybe
1	Have you ever experienced flooding on your system property?	70	36	11	-	-
4	Do streets and/or common areas in your neighborhood flood?	48	61	12	-	-
5	Have you noticed any increase or decrease in flooding/drainage on your property due to nearby construction, landscaping, or changes to the drainage system?	46	60	14	-	-
6	Do you have a stream or drainage channel near your property?	88	12	10	10	-
8/12	Would you like to learn more about how you could help to prevent erosion and manage stormwater on your property?	60	21	21	-	22

Table D-1B: General Survey Results – Eastwood Lake Subwatershed

Survey Question Number	Question	Survey Response				
		Yes	No	No Response	Do Not Know	Maybe
1	Have you ever experienced flooding on your system property?	27	25	-	-	-
4	Do streets and/or common areas in your neighborhood flood?	16	36	-	-	-
5	Have you noticed any increase or decrease in flooding/drainage on your property due to nearby construction, landscaping, or changes to the drainage system?	18	33	1	-	-
6	Do you have a stream or drainage channel near your property?	39	9	1	3	-
12	Would you like to learn more about how you could help to prevent erosion and manage stormwater on your property?	25	10	2	-	15

Table D-2A: Frequency and Location of Flooding Question Responses (Question 2) Entire Booker Creek Watershed

	Flooding Location							
	Storage Building	HVAC Unit	Crawl Space	Home's First Floor	Basement	Yard flooding from stream/ channel	Yard flooding from street runoff	Yard flooding from adjacent property
Less than once per year	9	15	14	19	20	4	12	9
Once per year	14	1	4	-	1	9	7	6
2-3 times per year	7	3	9	1	7	37	19	34
More than 3 times per year	1	-	4	-	-	5	8	9
Every time it rains	-	-	1	-	-	6	7	6

Table D-2B: Frequency and Location of Flooding Question Responses (Question 2) Eastwood Lake Subwatershed

	Flooding Location							
	Storage Building	HVAC Unit	Crawl Space	Home's First Floor	Basement	Yard flooding from stream/ channel	Yard flooding from street runoff	Yard flooding from adjacent property
Less than once per year	4	2	3	2	4	4	2	3
Once per year	-	-	-	-	1	2	3	-
2-3 times per year	-	-	2	-	2	7	4	6
More than 3 times per year	1	-	2	-	-	3	4	5
Every time it rains	-	-	1	-	-	3	4	3

Table D-3A: Areas Showing Signs of Erosion (Soil Loss) (Question 7) – Entire Booker Creek Watershed

Item	Number of Responses
Road	9
Yard	54
Building/House	7
Fence	7
Driveway	25
Steep Slope	33
Stream of Drainage Channel	64

Table D-3B: Areas Showing Signs of Erosion (Soil Loss) (Question 7) –Eastwood Lake Subwatershed

Item	Number of Responses
Road	2
Yard	24
Building/House	1
Fence	2
Driveway	11
Steep Slope	17
Stream of Drainage Channel	25

Eastwood Lake Subwatershed Study

Questionnaire

Chapel Hill Stormwater Master Plan

The Town of Chapel Hill's Stormwater Management Program has contracted with W. K. Dickson to conduct a study of the Eastwood Lake subwatershed. This study will identify and prioritize stormwater projects that will help lessen drainage and flooding impacts, stabilize streams, and improve water quality.

Please take this brief questionnaire to let us know what you are experiencing. Thank you for your participation!

1. Have you experienced flooding on your property? ❑ Yes ❑ No

2. Please check all conditions below that apply to you and indicate the frequency of occurrence. "Water" pertains only to that coming from creeks or precipitation, not from leaks in the sanitary sewer system or irrigation problems.

   ❑ Water enters storage buildings/sheds _____
   ❑ Water floods HVAC units _____
   ❑ Water stands in crawl space _____
   ❑ Water floods the basement _____
   ❑ Water enters the home's first floor _____
   ❑ Yard floods from nearby stream or drainage channel _____
   ❑ Yard floods from street runoff _____
   ❑ Yard floods because of runoff from adjacent property _____

   FREQUENCY
   A. Less than once a year
   B. Once a year
   C. 2-3 times a year

3. If known, please list dates, locations, and depth of water (ex: On May 10, 2014, at my mailbox it was 2 feet deep) to help us correlate flooding events with rainfall amounts.

   _____
   _____
   _____

4. Do streets in your neighborhood flood? ❑ Yes ❑ No
   If you can, please describe the locations and depth of water. If you have photos, please consider sending them to us via email or attaching labeled copies to this questionnaire.

   _____
   _____
   _____

5. Have you noticed any increase or decrease in flooding/drainage on your property due to nearby construction, landscaping, or changes to the drainage systems? If yes, what were those changes and the approximate timeframe?

   ❑ Yes ❑ No

   Comments: _____

   _____

6. Do you have a stream or drainage channel on or near your property?

   ❑ Yes ❑ No ❑ Don't know

7. If yes, please check below all areas near or on your property that show signs of erosion (soil loss):

   ❑ Road ❑ Yard ❑ Building/House ❑ Fence ❑ Driveway ❑ Steep slope

   ❑ Stream or drainage channel

   ❑ Other _____

8. I would be willing to participate in a stream maintenance program (e.g. allowing for stream bank restoration, sampling for water quality, installing rain gauges, diverting stormwater to cisterns or rain barrels, etc.).

   ❑ Definitely ❑ Maybe ❑ Never ❑ I need assistance ❑ I can't help but I will allow access to the creek through my property ❑ Other_____

10. If a cost-sharing program was made available along with training, would you be willing to install a stormwater BMP (e.g. rain garden, cistern, backyard wetland, etc.)

    ❑ Yes ❑ No ❑ Maybe

11. What is the biggest water quality challenge in your neighborhood?

_____

_____

12 .Would you like to learn more about how you could help prevent erosion and manage stormwater on your property?

❑ Yes ❑ No ❑ Maybe

Name: _____

Property Address: _____

_____

How long have you lived or worked at this location? _____

Primary Residence or Business (if different from Property Address): _____

_____

Phone (Optional): _____

E-mail Address (Optional if you would like ongoing communication during this study):

_____

Is there anything else you would like us to know about stormwater issues in your area?

_____

_____

_____

_____

_____

For more information, visit www.bookercreekplanning.org

Please provide the survey back to us by:

E-mail: comments@eastwoodlakesws.org

By Direct Mail:
c/o PEQ, Inga Kennedy
3205 Huddlestone Drive, Unit 303
Raleigh, NC 27512

Town of Chapel Hill
Stormwater Management Program
Eastwood Lake Subwatershed Study UPDATE

Meeting Summary

Public Meeting 2, Session 1
December 7, 2017, 11:30 AM

Town of Chapel Hill and Consultant Attendees

Sue Burke, Stormwater Engineer, Town of Chapel Hill	Kevin Nunnery, Biohabitats
Tom Murray, Project Manager, WK Dickson	Ted Brown, Biohabitats
Ben Carroll, WK Dickson	Inga Kennedy, PEQ
Ebony Hagans, WK Dickson	

1. Welcome and Purpose of Meeting

   Residents of the Eastwood Lake subwatershed were invited to attend a public meeting on December 7, 2017 at the Chapel Hill public library, to receive an update on the Eastwood Lake subwatershed study including the existing conditions findings and the proposed solutions.

   Two meetings were held, one the morning and evening of the 7th to accommodate residents' work schedules. Each meeting began with a presentation followed by a question and answer session. Following the meeting, attendees were invited to view maps of the Eastwood Lake subwatershed summarizing the proposed solutions and to speak with staff and consultants about any questions or concerns. This summary represents the morning meeting.

2. Overview of PowerPoint Presentation

   Tom Murray kicked off the presentation portion of the meeting and spoke on the following topics:

   - Overall Agenda and Goals.
   - Progress Update.
   - Watershed Characteristics.
   - Public Outreach.
   - Existing Conditions Evaluation.
   - Possible Solutions.
   - Stream Stabilization.
   - Lower Booker Creek Storage Projects.
   - Alternatives Development.

- Neighborhood Retrofits – green street, grass swales, downspout disconnects, rain gardens, cisterns.
- Outfall Screening.
- Next steps moving forward.

A copy of this presentation can be found on the project website.

3. Verbal Questions/Comments by Participants during and following the Presentation

- **Question**: Are the recommended 200-foot buffer widths achievable in the Eastwood Lake subwatershed for the proposed projects?
  Response: The achievable buffer width will vary for each project. For most of the projects identified in the project area, 200-ft is not feasible. The restored buffer width will be evaluated on a case-by-case basis for each of the identified projects. (Tom Murray)
- **Question**: The bulldozing taking place along Piney Mountain Road near Lake Ellen, is it associated with the proposed WK Dickson projects?
  Response: No, this is an OWASA project with no connection to the discussed projects. (Sue Burke)
- **Question**: Was there erosion before the breach at Lake Ellen?
  Response: Yes, it is an ongoing issue. The erosion has occurred over many years. After the breach, it is less frequent but once breach is repaired similar erosion will occur. (Tom Murray)
- **Comment**: Piney Mountain Road resident (adjacent to bridge crossing) that would be impacted by Woodshire/Huntington restoration/stabilization project expressed concerns about the feasibility of the project as shown. It would be difficult to relocate the stream as proposed due to sewer line/easement, topography, and loss of land.
  Response: We are aware of these constraints and want to reiterate that these projects are conceptual. Upon further evaluation, if project is not feasible then it will not be included in the report. (Tom Murray)
- **Question**: Have you contacted individual property owners that will be impacted by retrofits?
  Response: Some individual property owners have been contacted, those who requested contact to provide feedback but none regarding retrofits. It is premature for acquisitions coordination until project moves to design phase. (Tom Murray)
- **Question**: Could pedestrian trails and greenways be considered with the stream stabilization easements?
  Response: It depends. It is more likely for larger projects but could be considered where the opportunity presents itself; always looking for multi-purpose projects. (Tom Murray)
- **Question**: Is the entire study area being looked at for neighborhood retrofits or just Forest Creek as shown on slide?
  Response: Forest Creek is just an example, more will be identified in the report. (Tom Murray)

- **Question**: What type of feedback are you interested in receiving at this point?
  Response: Any that you would like to provide. Feedback about the overall process, stormwater in Town, individual concerns about the identified project, etc. (Tom Murray)
- **Question**: For the spot stabilization projects, what happens if property owners do not want construction on their property?
  Response: It will be handled on a case-by case basis; the project may need to be re-evaluated to determine if the project would still make sense without full property owner involvement. It can be challenging to get all property owners on board. (Tom Murray)
- **Question**: Any quantitative maps with flows and how much water to lake and in watershed?
  Response: This type of information will be included in the report which will be available on the website. (Tom Murray)
- **Question**: Aren't most people in Chapel Hill enthusiastic about protecting the environment?
  Response: There is a lot of positive engagement, but some just need educating about pet waste disposal, mowing habits, disconnected downspouts, etc. (Tom Murray)
- **Comment:** Reach out to organized homeowners associations to get more involvement and participation.
  Response: The meeting flyer is forwarded to the HOA presidents. Several of them post it to list-servs. This is how several meeting attendees found out about today's meeting. As part of sign-in, we poll how participants found out about the meeting. (Inga Kennedy)

Town of Chapel Hill
Stormwater Management Program
Eastwood Lake Subwatershed Study UPDATE

Meeting Summary

Public Meeting 2, Session 2
December 7, 2017, 5:30 PM

Town of Chapel Hill and Consultant Attendees

Sue Burke, Stormwater Engineer, Town of Chapel Hill	Kevin Nunnery, Biohabitats
Tom Murray, Project Manager, WK Dickson	Ted Brown, Biohabitats
Ben Carroll, WK Dickson	Inga Kennedy, PEQ
Ebony Hagans, WK Dickson	

1. Welcome and Purpose of Meeting

   Residents of the Eastwood Lake subwatershed were invited to attend a public meeting on December 7, 2017 at the Chapel Hill public library, to receive an update on the Eastwood Lake subwatershed study including the existing conditions findings and the proposed solutions.

   Two meetings were held, one the morning and evening of the 7th to accommodate residents' work schedules. Each meeting began with a presentation followed by a question and answer session. Following the meeting, attendees were invited to view maps of the Eastwood Lake subwatershed summarizing the proposed solutions and to speak with staff and consultants about any questions or concerns. This summary represents the evening meeting.

2. Overview of PowerPoint Presentation

   Tom Murray kicked off the presentation portion of the meeting and spoke on the following topics:

   - Overall Agenda and Goals.
   - Progress Update.
   - Watershed Characteristics.
   - Public Outreach.
   - Existing Conditions Evaluation.
   - Possible Solutions.
   - Stream Stabilization.
   - Lower Booker Creek Storage Projects.
   - Alternatives Development.

- Neighborhood Retrofits – green street, grass swales, downspout disconnects, rain gardens, cisterns.
- Outfall Screening.
- Next steps moving forward.

A copy of this presentation can be found on the project website.

3. Verbal Questions/Comments by Participants during and following the Presentation

- **Question**: Are there concerns about the North Lakeshore bridge accommodating flow?
  Response: Not currently, the bridge is providing a 10-year level of service. Ideally, we would like for this bridge crossing to provide a 25-year level of service. However, it is a new bridge, about 15-16 years old with no known structural issues. (Tom Murray)
- **Question**: Is there the potential for Eastwood Lake to be considered for detention/storage?
  Response: This was evaluated as part of the Lower Booker Creek Study. To provide a benefit, the lake would need to be lowered 1 to 2 feet. It is private lake and therefore would require buy-in from the surrounding property owners. There is not an interest to pursue this by the HOA. (Tom Murray/Sue Burke)
- **Question**: Is there a plan to work more closely with OWASA?
  Response: Yes, it makes sense to coordinate more closely with them. More communication is necessary between OWASA and the Town regarding project coordination. There is also a need to help OWASA better understand stormwater impacts on easement maintenance. (Tom Murray/Sue Burke)
- **Question**: Explain Lake Ellen retrofits.
  Response: Similar to Eastwood Lake, it is a private lake. Lake Ellen has been breached and the HOA has expressed an interest in partnering with the Town to restore it. It is still conceptual. (Tom Murray)
- **Question**: What would the Piney Mountain storage entail?
  Response: It is in HOA common area. The floodplain would be graded out to reduce downstream flows. There would be tree removal and excavation to increase floodplain volume accessible to flows as shown on slide. (Tom Murray)
- **Question**: Please comment on the relative ranking and timeline for implementation.
  Response: The ranking will be included with the draft report. It will be merged with the Lower Booker Creek list and reevaluated on a continuous basis based on funding and needs. The timeline for implementation depends on a combination of funding and ranking. (Tom Murray)

Appendix E:

SCS Hydrology Calculations

List of Contents:

1. Existing Curve Number Calculations
    a. Booker Headwaters
    b. Cedar Fork
    c. Crow Branch
    d. Eastwood Lake
    e. Lower Booker Creek

2. Future Curve Number Calculations
    a. Booker Headwaters
    b. Cedar Fork
    c. Crow Branch
    d. Eastwood Lake
    e. Lower Booker Creek

3. Impervious Calculations
    a. Booker Headwaters – Existing and Future Conditions
    b. Cedar Fork – Existing and Future Conditions
    c. Crow Branch – Existing and Future Conditions
    d. Eastwood Lake – Existing and Future Conditions
    e. Lower Booker Creek – Existing and Future Conditions

BOOKER HEADWATERS

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: BH-10

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	12.86	0.02009	1260
Open Space, Good	B	61	13.84	0.02163	844
Woods, Good	B	55	55.36	0.08650	3045
		Totals =	82.06	0.12822	5149

Total (weighted) RCN = total product/total area = 62.75

RCN used = 63

Basin: BH-20

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	6.30	0.00984	617
Open Space, Good	B	61	14.46	0.02259	882
Woods, Good	B	55	14.15	0.02211	778
Woods, Good	C	70	6.32	0.00988	442
Woods, Good	D	77	1.13	0.00177	87
Woods, Good	B/D	77	0.08	0.00013	6
		Totals =	42.44	0.06631	2813

Total (weighted) RCN = total product/total area = 66.29

RCN used = 66

Basin: BH-30

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	11.59	0.01811	1136
Open Space, Good	B	61	9.65	0.01508	589
Open Space, Good	C	74	1.40	0.00219	104
Open Space, Good	D	80	5.91	0.00923	473
Woods, Good	B	55	34.47	0.05385	1896
Woods, Good	C	70	5.60	0.00875	392
Woods, Good	D	77	26.38	0.04122	2031
Woods, Good	B/D	77	1.40	0.00218	107
		Totals =	96.39	0.15061	6727

Total (weighted) RCN = total product/total area = 69.79

RCN used = 70

BOOKER HEADWATERS

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: BH-40

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	8.35	0.01305	818
Open Space, Good	B	61	23.47	0.03666	1431
Open Space, Good	C	74	10.46	0.01635	774
Open Space, Good	D	80	0.10	0.00016	8
Open Space, Good	B/D	80	1.74	0.00272	139
Woods, Good	B	55	2.37	0.00371	131
Woods, Good	C	70	8.91	0.01392	623
Woods, Good	B/D	77	4.05	0.00633	312
		Totals =	59.45	0.09289	4237

Total (weighted) RCN = total product/total area = 71.27

RCN used = 71

Basin: BH-50

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	4.89	0.00764	479
Open Space, Good	B	61	2.51	0.00392	153
Open Space, Good	C	74	21.02	0.03284	1555
Woods, Good	B	55	28.23	0.04410	1552
Woods, Good	C	70	10.79	0.01687	756
Woods, Good	D	77	4.67	0.00730	360
Water	-	100	2.71	0.00424	271
		Totals =	74.82	0.11691	5127

Total (weighted) RCN = total product/total area = 68.52

RCN used = 69

Basin: BH-60

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	12.69	0.01983	1244
Open Space, Good	C	74	24.43	0.03817	1808
Open Space, Good	D	80	0.65	0.00101	52
Woods, Good	B	55	36.49	0.05702	2007
Woods, Good	C	70	0.94	0.00147	66
		Totals =	75.20	0.11750	5176

Total (weighted) RCN = total product/total area = 68.83

RCN used = 69

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: BH-70

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	5.43	0.00848	532
Open Space, Good	B	61	2.44	0.00381	149
Open Space, Good	C	74	8.90	0.01391	659
Woods, Good	B	55	7.79	0.01216	428
Woods, Good	C	70	9.22	0.01441	646
		Totals =	33.78	0.05278	2414

Total (weighted) RCN = total product/total area = 71.45

RCN used = 71

Basin: BH-80

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	8.51	0.01330	834
Open Space, Good	B	61	18.78	0.02935	1146
Open Space, Good	C	74	0.13	0.00020	9
Woods, Good	B	55	5.52	0.00863	304
Woods, Good	C	70	14.82	0.02315	1037
Woods, Good	D	77	8.03	0.01255	618
Water	-	100	0.64	0.00101	64
		Totals =	56.43	0.08818	4013

Total (weighted) RCN = total product/total area = 71.11

RCN used = 71

Basin: BH-90

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	5.89	0.00920	577
Open Space, Good	B	61	26.40	0.04125	1610
Woods, Good	B	55	4.05	0.00633	223
Woods, Good	C	70	12.23	0.01911	856
Woods, Good	D	71	9.64	0.01506	684
Woods, Good	B/D	77	0.48	0.00075	37
		Totals =	58.69	0.09170	3988

Total (weighted) RCN = total product/total area = 67.95

RCN used = 68

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: BH-100

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	10.95	0.01711	1073
Open Space, Good	B	61	14.23	0.02223	868
Open Space, Good	C	74	8.54	0.01335	632
Open Space, Good	D	80	0.92	0.00144	74
Woods, Good	B	55	15.06	0.02353	828
Woods, Good	C	70	6.96	0.01088	487
Woods, Good	B/D	77	7.56	0.01181	582
		Totals =	64.23	0.10035	4545

Total (weighted) RCN = total product/total area = 70.76

RCN used = 71

Basin: BH-110

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	9.82	0.01534	962
Open Space, Good	B	61	10.94	0.01710	667
Open Space, Good	C	74	1.28	0.00200	95
Open Space, Good	D	80	1.34	0.00209	107
Woods, Good	B	55	40.88	0.06388	2249
		Totals =	64.27	0.10041	4080

Total (weighted) RCN = total product/total area = 63.49

RCN used = 63

Basin: BH-120

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	2.68	0.00419	263
Open Space, Good	B	61	5.96	0.00932	364
Open Space, Good	C	74	1.13	0.00177	84
Woods, Good	B	55	5.06	0.00791	278
Woods, Good	C	70	1.13	0.00177	79
Woods, Good	B/D	77	0.02	0.00003	1
		Totals =	15.98	0.02497	1069

Total (weighted) RCN = total product/total area = 66.88

RCN used = 67

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: BH-130

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	8.40	0.01313	823
Open Space, Good	C	74	32.34	0.05053	2393
Woods, Good	B	55	12.08	0.01888	664
Woods, Good	C	70	1.00	0.00156	70
Woods, Good	D	77	0.73	0.00113	56
Woods, Good	B/D	77	0.21	0.00033	16
Water	-	100	5.72	0.00894	572
		Totals =	60.48	0.09450	4595

Total (weighted) RCN = total product/total area = 75.98

RCN used = 76

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: CF-10

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	3.07	0.00480	301
Open Space, Good	B	61	15.03	0.02348	917
Open Space, Good	C	74	2.09	0.00327	155
Open Space, Good	D	80	0.07	0.00012	6
Woods, Good	B	55	7.25	0.01133	399
Woods, Good	C	70	2.09	0.00327	146
Water	-	100	0.07	0.00011	7
		Totals =	29.67	0.04637	1930

Total (weighted) RCN = total product/total area = 65.05

RCN used = 65

Basin: CF-20

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	6.62	0.01034	649
Open Space, Good	B	61	7.65	0.01196	467
Open Space, Good	D	80	2.09	0.00327	167
Open Space, Good	B/D	80	2.24	0.00350	179
Woods, Good	B	55	10.38	0.01622	571
Woods, Good	D	77	8.30	0.01296	639
Woods, Good	B/D	77	2.22	0.00347	171
Water	-	100	1.90	0.00296	190
		Totals =	41.40	0.06469	3033

Total (weighted) RCN = total product/total area = 73.25

RCN used = 73

Basin: CF-30

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	3.34	0.00522	327
Open Space, Good	B	61	10.54	0.01647	643
Open Space, Good	B/D	80	0.49	0.00077	39
Woods, Good	B	55	10.09	0.01577	555
Woods, Good	D	77	3.23	0.00504	249
Woods, Good	B/D	77	0.49	0.00077	38
		Totals =	28.18	0.04403	1851

Total (weighted) RCN = total product/total area = 65.68

RCN used = 66

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: CF-40

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	7.66	0.01197	751
Open Space, Good	A	39	0.75	0.00117	29
Open Space, Good	B	61	4.86	0.00760	297
Open Space, Good	D	80	3.26	0.00509	261
Woods, Good	A	30	2.97	0.00464	89
Woods, Good	B	55	23.43	0.03661	1289
Woods, Good	D	77	13.05	0.02039	1005
		Totals =	55.98	0.08747	3720

Total (weighted) RCN = total product/total area = 66.45

RCN used = 66

Basin: CF-50

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	1.71	0.00267	168
Open Space, Good	B	61	6.16	0.00962	376
Open Space, Good	D	80	0.28	0.00044	22
Woods, Good	B	55	9.15	0.01430	503
Woods, Good	D	77	0.28	0.00044	21
		Totals =	17.58	0.02747	1090

Total (weighted) RCN = total product/total area = 62.03

RCN used = 62

Basin: CF-60

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	10.43	0.01630	1022
Open Space, Good	B	61	18.46	0.02885	1126
Open Space, Good	C	74	0.19	0.00030	14
Open Space, Good	D	80	0.95	0.00148	76
Woods, Good	B	55	32.47	0.05074	1786
Woods, Good	C	70	0.58	0.00090	40
Woods, Good	D	77	11.00	0.01718	847
		Totals =	74.08	0.11575	4912

Total (weighted) RCN = total product/total area = 66.30

RCN used = 66

CEDAR FORK

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: CF-70

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	10.05	0.01570	985
Open Space, Good	A	39	6.34	0.00991	247
Open Space, Good	B	61	10.56	0.01650	644
Open Space, Good	C	74	1.92	0.00299	142
Open Space, Good	D	80	6.57	0.01027	526
Woods, Good	A	30	1.96	0.00306	59
Woods, Good	B	55	15.84	0.02476	871
Woods, Good	C	70	2.87	0.00449	201
Woods, Good	D	77	9.82	0.01535	756
		Totals =	65.95	0.10304	4432

Total (weighted) RCN = total product/total area = 67.21

RCN used = 67

Basin: CF-80

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	14.34	0.02241	1405
Open Space, Good	A	39	0.03	0.00004	1
Open Space, Good	B	61	41.38	0.06465	2524
Open Space, Good	C	74	6.80	0.01062	503
Open Space, Good	D	80	5.57	0.00870	445
Woods, Good	A	30	0.03	0.00004	1
Woods, Good	B	55	30.51	0.04767	1678
Woods, Good	C	70	5.84	0.00912	408
Woods, Good	D	77	2.39	0.00373	184
		Totals =	106.86	0.16697	7149

Total (weighted) RCN = total product/total area = 66.90

RCN used = 67

Basin: CF-90

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	12.10	0.01891	1186
Open Space, Good	B	61	35.69	0.05576	2177
Open Space, Good	C	74	0.51	0.00080	38
Open Space, Good	D	80	4.86	0.00759	389
Woods, Good	B	55	43.17	0.06745	2374
Woods, Good	C	70	4.63	0.00724	324
Woods, Good	D	71	13.26	0.02072	942
		Totals =	114.23	0.17848	7430

Total (weighted) RCN = total product/total area = 65.05

RCN used = 65

CEDAR FORK

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: CF-100

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	5.69	0.00889	558
Open Space, Good	B	61	4.70	0.00734	287
Woods, Good	B	55	29.43	0.04598	1619
Woods, Good	D	77	12.89	0.02014	992
		Totals =	52.71	0.08235	3455

Total (weighted) RCN = total product/total area = 65.56

RCN used = 66

Basin: CF-110

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	3.69	0.00577	362
Open Space, Good	B	61	19.42	0.03034	1185
Woods, Good	B	55	3.43	0.00536	189
		Totals =	26.54	0.04147	1735

Total (weighted) RCN = total product/total area = 65.37

RCN used = 65

Basin:CF-120

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	7.68	0.01200	753
Open Space, Good	B	61	14.62	0.02285	892
Open Space, Good	D	80	2.64	0.00412	211
Woods, Good	B	55	30.60	0.04782	1683
Woods, Good	D	77	2.64	0.00412	203
		Totals =	58.18	0.09091	3742

Total (weighted) RCN = total product/total area = 64.32

RCN used = 64

CEDAR FORK

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: CF-130

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	10.84	0.01694	1062
Open Space, Good	B	61	27.70	0.04328	1690
Open Space, Good	C	74	1.86	0.00291	138
Woods, Good	B	55	22.89	0.03577	1259
Woods, Good	C	70	1.45	0.00227	102
Woods, Good	D	77	30.55	0.04774	2352
		Totals =	95.30	0.14891	6603

Total (weighted) RCN = total product/total area = 69.29

RCN used = 69

Basin: CF-140

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	3.57	0.00558	350
Open Space, Good	B	61	5.91	0.00924	361
Open Space, Good	D	80	1.11	0.00173	89
Woods, Good	B	55	13.83	0.02161	761
Woods, Good	D	77	1.11	0.00173	85
		Totals =	25.53	0.03989	1645

Total (weighted) RCN = total product/total area = 64.44

RCN used = 64

Basin: CF-150

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	3.60	0.00563	353
Open Space, Good	B	61	4.25	0.00664	259
Open Space, Good	D	80	2.10	0.00328	168
Woods, Good	B	55	18.36	0.02869	1010
Woods, Good	D	77	2.91	0.00454	224
		Totals =	31.22	0.04879	2014

Total (weighted) RCN = total product/total area = 64.51

RCN used = 65

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: CB-10

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	1.21	0.00189	119
Woods, Good	B	55	41.01	0.06408	2256
Woods, Good	C	70	44.78	0.06997	3135
Woods, Good	C/D	77	4.37	0.00683	337
		Totals =	91.37	0.14277	5845

Total (weighted) RCN = total product/total area = 63.97

RCN used = 64

Basin: CB-20

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	0.50	0.00078	49
Woods, Good	B	55	62.59	0.09779	3442
Woods, Good	C	70	2.41	0.00376	168
Woods, Good	C/D	77	6.51	0.01017	501
		Totals =	72.00	0.11250	4161

Total (weighted) RCN = total product/total area = 57.79

RCN used = 58

Basin: CB-30

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	0.00	0.00000	0
Woods, Good	B	55	13.64	0.02130	750
Woods, Good	C	70	3.55	0.00555	249
		Totals =	17.19	0.02686	999

Total (weighted) RCN = total product/total area = 58.10

RCN used = 58

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: CB-40

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	0.49	0.00077	48
Open Space, Good	B	61	0.80	0.00125	49
Open Space, Good	C	74	4.94	0.00772	366
Woods, Good	B	55	7.20	0.01126	396
Woods, Good	C	70	18.61	0.02907	1302
Woods, Good	C/D	77	0.32	0.00050	25
		Totals =	32.37	0.05057	2186

Total (weighted) RCN = total product/total area = 67.54

RCN used = 68

Basin: CB-50

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	2.08	0.00325	204
Open Space, Good	C/D	80	11.86	0.01853	949
Woods, Good	C	70	12.16	0.01900	851
Woods, Good	C/D	77	17.79	0.02780	1370
		Totals =	43.89	0.06858	3374

Total (weighted) RCN = total product/total area = 76.87

RCN used = 77

Basin: CB-60

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	0.47	0.00073	46
Open Space, Good	C	74	5.12	0.00799	379
Woods, Good	B	55	0.65	0.00101	36
Woods, Good	C	70	14.22	0.02222	996
		Totals =	20.46	0.03196	1456

Total (weighted) RCN = total product/total area = 71.17

RCN used = 71

CROW BRANCH

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: CB-70

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	11.99	0.01873	1175
Open Space, Good	B	61	4.65	0.00727	284
Open Space, Good	C	74	8.37	0.01308	619
Open Space, Good	C/D	80	1.17	0.00182	93
Woods, Good	B	55	19.96	0.03119	1098
Woods, Good	C	70	32.66	0.05103	2286
		Totals =	78.79	0.12312	5555

Total (weighted) RCN = total product/total area = 70.50

RCN used = 71

Basin: CB-80

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	8.09	0.01264	793
Open Space, Good	B	61	8.69	0.01359	530
Open Space, Good	C	74	0.65	0.00101	48
Woods, Good	B	55	20.86	0.03259	1147
Woods, Good	C	70	7.20	0.01126	504
Woods, Good	D	77	2.87	0.00449	221
		Totals =	48.37	0.07557	3244

Total (weighted) RCN = total product/total area = 67.07

RCN used = 67

EASTWOOD LAKE

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: EL-10

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	12.53	0.01958	1228
Open Space, Good	B	61	1.35	0.00211	82
Open Space, Good	C	74	6.72	0.01049	497
Open Space, Good	D	80	2.59	0.00405	207
Open Space, Good	C/D	80	10.21	0.01595	817
Woods, Good	B	55	6.48	0.01013	357
Woods, Good	C	70	22.49	0.03514	1574
Woods, Good	D	77	9.38	0.01465	722
		Totals =	71.75	0.11211	5484

Total (weighted) RCN = total product/total area = 76.44

RCN used = 76

Basin: EL-20

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	12.86	0.02009	1260
Open Space, Good	B	61	10.55	0.01649	644
Open Space, Good	C	74	2.19	0.00342	162
Open Space, Good	D	80	4.95	0.00773	396
Woods, Good	B	55	22.18	0.03466	1220
Woods, Good	C	70	8.40	0.01313	588
Woods, Good	D	77	19.80	0.03094	1525
		Totals =	80.93	0.12646	5795

Total (weighted) RCN = total product/total area = 71.60

RCN used = 72

Basin: EL-30

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	8.61	0.01345	844
Open Space, Good	B	61	16.80	0.02626	1025
Open Space, Good	C	74	0.52	0.00082	39
Open Space, Good	D	80	1.72	0.00268	137
Woods, Good	B	55	36.83	0.05755	2026
Woods, Good	C	70	2.09	0.00327	146
Woods, Good	D	77	6.86	0.01073	529
		Totals =	73.44	0.11475	4746

Total (weighted) RCN = total product/total area = 64.62

RCN used = 65

EASTWOOD LAKE

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: EL-40

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	7.22	0.01128	708
Open Space, Good	B	61	3.50	0.00547	214
Open Space, Good	C	74	3.06	0.00478	226
Open Space, Good	D	80	5.00	0.00781	400
Woods, Good	B	55	5.77	0.00902	317
Woods, Good	C	70	12.23	0.01911	856
Woods, Good	D	77	6.94	0.01084	534
		Totals =	43.72	0.06831	3255

Total (weighted) RCN = total product/total area = 74.46

RCN used = 74

Basin: EL-50

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	9.20	0.01438	902
Open Space, Good	B	61	12.90	0.02015	787
Open Space, Good	C	74	1.61	0.00251	119
Open Space, Good	D	80	1.28	0.00201	103
Open Space, Good	B/D	80	1.13	0.00177	91
Woods, Good	B	55	24.90	0.03891	1370
Woods, Good	C	70	6.43	0.01005	450
Woods, Good	D	77	11.55	0.01805	889
Woods, Good	B/D	77	1.13	0.00177	87
		Totals =	70.14	0.10959	4797

Total (weighted) RCN = total product/total area = 68.39

RCN used = 68

Basin: EL-60

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	12.66	0.01978	1241
Open Space, Good	B	61	15.40	0.02407	940
Open Space, Good	D	80	0.45	0.00070	36
Woods, Good	B	55	48.87	0.07636	2688
Woods, Good	D	77	2.67	0.00418	206
Woods, Good	B/D	77	4.23	0.00662	326
Water	-	100	0.18	0.00029	18
		Totals =	84.47	0.13198	5454

Total (weighted) RCN = total product/total area = 64.57

RCN used = 65

EASTWOOD LAKE

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: EL-70

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	6.25	0.00977	613
Open Space, Good	B	61	7.44	0.01163	454
Open Space, Good	C	74	1.24	0.00194	92
Open Space, Good	D	80	0.87	0.00136	70
Open Space, Good	C/D	80	0.18	0.00028	15
Woods, Good	B	55	22.31	0.03486	1227
Woods, Good	C	70	1.24	0.00194	87
Woods, Good	D	77	8.70	0.01360	670
Woods, Good	B/D	77	1.49	0.00233	115
Woods, Good	C/D	77	0.18	0.00028	14
Water	-	100	8.19	0.01280	819
		Totals =	58.11	0.09080	4175

Total (weighted) RCN = total product/total area = 71.85

RCN used = 72

Basin: EL-80

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	6.29	0.00983	616
Open Space, Good	B	61	9.32	0.01456	568
Woods, Good	B	55	28.61	0.04470	1573
Water	-	100	12.30	0.01922	1230
		Totals =	56.51	0.08830	3988

Total (weighted) RCN = total product/total area = 70.57

RCN used = 71

Basin: EL-90

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	6.52	0.01019	639
Open Space, Good	B	61	5.45	0.00851	332
Open Space, Good	C	74	0.72	0.00112	53
Open Space, Good	D	80	1.33	0.00207	106
Open Space, Good	C/D	80	2.02	0.00315	161
Woods, Good	B	55	23.57	0.03683	1296
Woods, Good	C	70	0.72	0.00112	50
Woods, Good	D	77	6.85	0.01070	527
Woods, Good	C/D	77	6.05	0.00945	466
Water	-	100	8.77	0.01370	877
		Totals =	61.98	0.09684	4508

Total (weighted) RCN = total product/total area = 72.74

RCN used = 73

EASTWOOD LAKE

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: EL-100

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	5.56	0.00869	545
Open Space, Good	B	61	4.11	0.00641	250
Open Space, Good	D	80	5.11	0.00798	409
Open Space, Good	C/D	80	0.04	0.00006	3
Woods, Good	B	55	3.00	0.00469	165
Woods, Good	D	77	17.53	0.02739	1350
Woods, Good	C/D	77	0.10	0.00015	7
Water	-	100	18.52	0.02895	1852
		Totals =	53.96	0.08431	4581

Total (weighted) RCN = total product/total area = 84.90

RCN used = 85

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: LBC-10

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	6.34	0.00991	621
Open Space, Good	B	61	4.66	0.00728	284
Open Space, Good	C	74	1.40	0.00219	104
Open Space, Good	D	80	1.91	0.00299	153
Open Space, Good	C/D	80	0.44	0.00068	35
Woods, Good	B	55	20.33	0.03177	1118
Woods, Good	C	70	5.43	0.00848	380
Woods, Good	D	77	17.22	0.02690	1326
		Totals =	57.73	0.09020	4021

Total (weighted) RCN = total product/total area = 69.66

RCN used = 70

Basin: LBC-20

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	8.29	0.01295	812
Open Space, Good	B	61	4.92	0.00770	300
Open Space, Good	C	74	1.62	0.00254	120
Open Space, Good	D	80	1.55	0.00242	124
Open Space, Good	C/D	80	2.36	0.00369	189
Woods, Good	B	55	13.38	0.02090	736
Woods, Good	C	70	1.17	0.00183	82
Woods, Good	D	77	4.71	0.00737	363
Woods, Good	C/D	77	11.09	0.01733	854
		Totals =	49.10	0.07672	3580

Total (weighted) RCN = total product/total area = 72.92

RCN used = 73

Basin: LBC-30

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	15.80	0.02469	1548
Open Space, Good	B	61	0.00	0.00001	0
Open Space, Good	C	74	1.09	0.00170	81
Open Space, Good	D	80	13.85	0.02164	1108
Open Space, Good	C/D	80	4.91	0.00767	393
Woods, Good	B	55	1.70	0.00265	93
Woods, Good	C	70	4.89	0.00763	342
Woods, Good	D	77	32.47	0.05074	2500
Woods, Good	C/D	77	17.87	0.02792	1376
		Totals =	92.58	0.14465	7442

Total (weighted) RCN = total product/total area = 80.38

RCN used = 80

LOWER BOOKER CREEK

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: LBC-40

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	13.35	0.02086	1308
Open Space, Good	D	80	12.85	0.02008	1028
Open Space, Good	C/D	80	8.95	0.01398	716
Woods, Good	D	77	28.70	0.04485	2210
Woods, Good	C/D	77	20.88	0.03263	1608
		Totals =	84.74	0.13240	6870

Total (weighted) RCN = total product/total area = 81.08

RCN used = 81

Basin: LBC-50

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	1.13	0.00177	111
Woods, Good	B	55	8.73	0.01364	480
Woods, Good	D	77	4.56	0.00712	351
		Totals =	14.42	0.02253	942

Total (weighted) RCN = total product/total area = 65.32

RCN used = 65

Basin: LBC-60

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	13.95	0.02180	1367
Open Space, Good	B	61	9.52	0.01487	580
Open Space, Good	B/D	80	1.06	0.00166	85
Open Space, Good	C/D	80	3.82	0.00597	306
Woods, Good	B	55	24.01	0.03752	1321
Woods, Good	D	77	12.65	0.01977	974
Woods, Good	B/D	77	6.01	0.00939	463
Woods, Good	C/D	77	11.46	0.01791	882
		Totals =	82.48	0.12887	5978

Total (weighted) RCN = total product/total area = 72.48

RCN used = 72

LOWER BOOKER CREEK

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: LBC-70

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	9.87	0.01542	967
Open Space, Good	B	61	7.84	0.01225	478
Open Space, Good	D	80	8.77	0.01371	702
Woods, Good	B	55	27.89	0.04357	1534
Woods, Good	D	77	9.14	0.01428	704
Woods, Good	B/D	77	0.28	0.00043	21
		Totals =	63.78	0.09966	4406

Total (weighted) RCN = total product/total area = 69.08

RCN used = 69

Basin: LBC-80

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	5.29	0.00827	518
Open Space, Good	D	80	15.07	0.02355	1206
Woods, Good	D	77	15.07	0.02355	1160
		Totals =	35.43	0.05536	2884

Total (weighted) RCN = total product/total area = 81.41

RCN used = 81

Basin: LBC-90

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	10.75	0.01680	1054
Open Space, Good	C	74	2.75	0.00430	204
Open Space, Good	D	80	31.02	0.04846	2481
Open Space, Good	C/D	80	0.42	0.00065	33
Woods, Good	D	77	8.77	0.01371	676
Woods, Good	C/D	77	1.67	0.00261	129
Water	-	100	0.84	0.00132	84
		Totals =	56.23	0.08786	4661

Total (weighted) RCN = total product/total area = 82.89

RCN used = 83

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: LBC-100

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	1.21	0.00189	119
Open Space, Good	D	80	7.47	0.01167	598
Woods, Good	D	77	2.67	0.00417	206
Water	-	100	0.40	0.00063	40
		Totals =	11.75	0.01836	962

Total (weighted) RCN = total product/total area = 81.85

RCN used = 82

Basin: LBC-110

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	2.88	0.00450	282
Open Space, Good	D	80	5.98	0.00934	478
Open Space, Good	B/D	80	0.50	0.00078	40
Woods, Good	D	77	7.21	0.01127	555
Woods, Good	B/D	77	1.32	0.00206	102
		Totals =	17.89	0.02795	1457

Total (weighted) RCN = total product/total area = 81.47

RCN used = 81

Basin: LBC-120

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	4.37	0.00683	428
Open Space, Good	D	80	1.56	0.00244	125
Open Space, Good	C/D	80	2.37	0.00370	189
Woods, Good	D	77	6.24	0.00975	480
Woods, Good	B/D	77	1.80	0.00281	139
Woods, Good	C/D	77	9.46	0.01478	729
Water	-	100	0.65	0.00102	65
		Totals =	26.45	0.04132	2155

Total (weighted) RCN = total product/total area = 81.48

RCN used = 81

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: LBC-130

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	3.23	0.00505	317
Open Space, Good	D	80	3.74	0.00585	300
Open Space, Good	B/D	80	2.02	0.00316	162
Open Space, Good	C/D	80	0.33	0.00051	26
Woods, Good	D	77	0.27	0.00042	21
Woods, Good	B/D	77	8.19	0.01280	631
Woods, Good	C/D	77	0.98	0.00153	76
		Totals =	18.77	0.02932	1531

Total (weighted) RCN = total product/total area = 81.59

RCN used = 82

Basin: LBC-140

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	3.23	0.00505	317
Open Space, Good	D	80	10.22	0.01597	818
Woods, Good	D	77	13.30	0.02078	1024
		Totals =	26.75	0.04180	2158

Total (weighted) RCN = total product/total area = 80.68

RCN used = 81

Basin: LBC-150

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	10.18	0.01591	998
Open Space, Good	B	61	7.02	0.01097	428
Open Space, Good	D	80	5.80	0.00906	464
Woods, Good	B	55	18.68	0.02919	1027
Woods, Good	D	77	9.30	0.01454	716
		Totals =	50.99	0.07966	3634

Total (weighted) RCN = total product/total area = 71.27

RCN used = 71

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: LBC-160

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	3.06	0.00478	300
Open Space, Good	B	61	2.58	0.00404	158
Open Space, Good	D	80	6.58	0.01028	526
Open Space, Good	B/D	80	0.05	0.00008	4
Woods, Good	B	55	2.96	0.00463	163
Woods, Good	D	77	11.66	0.01821	898
		Totals =	26.89	0.04202	2049

Total (weighted) RCN = total product/total area = 76.17

RCN used = 76

Basin: LBC-170

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	1.79	0.00280	175
Open Space, Good	D	80	2.90	0.00453	232
Woods, Good	D	77	8.66	0.01353	667
Water	-	100	2.92	0.00456	292
		Totals =	16.27	0.02542	1366

Total (weighted) RCN = total product/total area = 83.97

RCN used = 84

Basin: LBC-180

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	5.95	0.00930	583
Open Space, Good	D	80	8.06	0.01259	645
Open Space, Good	B/D	80	0.09	0.00014	7
Woods, Good	D	77	45.49	0.07108	3503
Woods, Good	B/D	77	0.09	0.00014	7
		Totals =	59.68	0.09325	4745

Total (weighted) RCN = total product/total area = 79.50

RCN used = 80

SCS Runoff Curve Number - Existing Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 3/18/2016 (Revised 12/12/2016)

Basin: LBC-190

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	4.01	0.00627	393
Open Space, Good	D	80	3.99	0.00623	319
Woods, Good	D	77	11.81	0.01845	909
Woods, Good	B/D	77	10.94	0.01710	843
		Totals =	30.75	0.04805	2464

Total (weighted) RCN = total product/total area = 80.13

RCN used = 80

Basin: LBC-200

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	12.93	0.02020	1267
Open Space, Good	B	61	3.40	0.00531	207
Open Space, Good	D	80	11.63	0.01817	930
Woods, Good	B	55	7.93	0.01239	436
Woods, Good	D	77	27.13	0.04239	2089
Woods, Good	B/D	77	39.28	0.06137	3024
		Totals =	102.29	0.15982	7954

Total (weighted) RCN = total product/total area = 77.76

RCN used = 78

BOOKER HEADWATERS

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/26/2016 (Revised 12/12/2106)

Basin: BH-10

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	13.98	0.02184	1370
Open Space, Good	B	61	17.71	0.02767	1080
Woods, Good	B	55	49.79	0.07780	2738
		Totals =	81.48	0.12731	5189

Total (weighted) RCN = total product/total area = 63.68

RCN used = 64

Basin: BH-20

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	6.51	0.01017	638
Open Space, Good	B	61	14.46	0.02259	882
Woods, Good	B	55	13.15	0.02055	723
Woods, Good	C	70	6.32	0.00988	442
Woods, Good	D	77	1.13	0.00177	87
Woods, Good	B/D	77	0.08	0.00013	6
		Totals =	41.65	0.06508	2779

Total (weighted) RCN = total product/total area = 66.72

RCN used = 67

Basin: BH-30

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	14.33	0.02239	1404
Open Space, Good	B	61	12.99	0.02030	792
Open Space, Good	C	74	1.40	0.00219	104
Open Space, Good	D	80	6.62	0.01034	530
Woods, Good	B	55	25.09	0.03920	1380
Woods, Good	C	70	5.60	0.00875	392
Woods, Good	D	77	21.03	0.03286	1619
Woods, Good	B/D	77	1.40	0.00218	107
		Totals =	88.45	0.13820	6328

Total (weighted) RCN = total product/total area = 71.55

RCN used = 72

BOOKER HEADWATERS

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/26/2016 (Revised 12/12/2106)

Basin: BH-40

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	9.01	0.01408	883
Open Space, Good	B	61	23.47	0.03667	1432
Open Space, Good	C	74	10.46	0.01634	774
Open Space, Good	D	80	0.10	0.00016	8
Open Space, Good	B/D	80	1.74	0.00272	139
Woods, Good	C	70	8.46	0.01322	592
Woods, Good	B/D	77	4.05	0.00633	312
		Totals =	57.29	0.08952	4140

Total (weighted) RCN = total product/total area = 72.26

RCN used = 72

Basin: BH-50

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	7.32	0.01144	717
Open Space, Good	B	61	2.51	0.00392	153
Open Space, Good	C	74	21.02	0.03284	1555
Woods, Good	B	55	21.53	0.03363	1184
Woods, Good	C	70	10.79	0.01687	756
Woods, Good	D	77	4.67	0.00730	360
Water	-	100	2.71	0.00424	271
		Totals =	70.55	0.11024	4997

Total (weighted) RCN = total product/total area = 70.82

RCN used = 71

Basin: BH-60

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	14.69	0.02295	1440
Open Space, Good	C	74	24.42	0.03816	1807
Open Space, Good	D	80	0.65	0.00101	52
Woods, Good	B	55	29.53	0.04614	1624
Woods, Good	C	70	0.94	0.00147	66
		Totals =	70.23	0.10973	4989

Total (weighted) RCN = total product/total area = 71.03

RCN used = 71

BOOKER HEADWATERS

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/26/2016 (Revised 12/12/2106)

Basin: BH-70

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	5.43	0.00848	532
Open Space, Good	B	61	2.44	0.00381	149
Open Space, Good	C	74	8.90	0.01391	659
Woods, Good	B	55	7.79	0.01216	428
Woods, Good	C	70	9.22	0.01441	646
		Totals =	33.78	0.05278	2414

Total (weighted) RCN = total product/total area = 71.45

RCN used = 71

Basin: BH-80

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	9.22	0.01441	904
Open Space, Good	B	61	18.78	0.02935	1146
Open Space, Good	C	74	0.13	0.00020	9
Woods, Good	B	55	2.53	0.00396	139
Woods, Good	C	70	14.82	0.02315	1037
Woods, Good	D	77	7.83	0.01223	603
Water	-	100	0.64	0.00101	64
		Totals =	53.95	0.08430	3902

Total (weighted) RCN = total product/total area = 72.33

RCN used = 72

Basin: BH-90

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	9.63	0.01505	944
Open Space, Good	B	61	26.40	0.04125	1610
Woods, Good	B	55	4.05	0.00633	223
Woods, Good	C	70	5.93	0.00926	415
Woods, Good	D	71	9.64	0.01506	684
Woods, Good	B/D	77	0.48	0.00075	37
		Totals =	56.13	0.08770	3913

Total (weighted) RCN = total product/total area = 69.72

RCN used = 70

BOOKER HEADWATERS

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/26/2016 (Revised 12/12/2106)

Basin: BH-100

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	11.58	0.01809	1135
Open Space, Good	B	61	14.23	0.02223	868
Open Space, Good	C	74	8.54	0.01335	632
Open Space, Good	D	80	0.92	0.00144	74
Woods, Good	B	55	14.16	0.02213	779
Woods, Good	C	70	6.96	0.01088	487
Woods, Good	B/D	77	6.56	0.01025	505
		Totals =	62.96	0.09837	4480

Total (weighted) RCN = total product/total area = 71.16

RCN used = 71

Basin: BH-110

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	10.38	0.01622	1017
Open Space, Good	B	61	10.24	0.01600	625
Open Space, Good	C	74	1.28	0.00200	95
Open Space, Good	D	80	1.34	0.00209	107
Woods, Good	B	55	20.88	0.03263	1149
		Totals =	44.13	0.06895	2993

Total (weighted) RCN = total product/total area = 67.82

RCN used = 68

Basin: BH-120

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	3.20	0.00500	314
Open Space, Good	B	61	5.07	0.00792	309
Open Space, Good	C	74	1.13	0.00177	84
Woods, Good	B	55	4.17	0.00652	229
Woods, Good	C	70	1.13	0.00177	79
Woods, Good	B/D	77	0.02	0.00003	1
		Totals =	14.72	0.02300	1016

Total (weighted) RCN = total product/total area = 69.05

RCN used = 69

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/26/2016 (Revised 12/12/2106)

Basin: BH-130

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	10.00	0.01563	980
Open Space, Good	C	74	32.34	0.05053	2393
Woods, Good	B	55	12.08	0.01888	664
Woods, Good	C	70	1.00	0.00156	70
Woods, Good	D	77	0.73	0.00113	56
Woods, Good	B/D	77	0.21	0.00033	16
Water	-	100	5.72	0.00894	572
		Totals =	62.08	0.09700	4752

Total (weighted) RCN = total product/total area = 76.55

RCN used = 77

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date:05/02/2016 (Revised 12/12/2016)

Basin: CB-10

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	13.82	0.02159	1354
Open Space, Good	B	61	16.94	0.02647	1033
Open Space, Good	C	74	17.18	0.02684	1271
Open Space, Good	C/D	80	0.65	0.00102	52
Woods, Good	B	55	6.23	0.00973	343
Woods, Good	C	70	12.48	0.01950	873
Woods, Good	C/D	77	2.21	0.00345	170
		Totals =	69.50	0.10860	5097

Total (weighted) RCN = total product/total area = 73.33

RCN used = 73

Basin: CB-20

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	10.54	0.01647	1033
Open Space, Good	B	61	13.32	0.02081	813
Open Space, Good	C	74	0.72	0.00113	53
Open Space, Good	C/D	80	0.62	0.00097	50
Woods, Good	B	55	25.03	0.03911	1377
Woods, Good	C/D	77	4.43	0.00692	341
		Totals =	54.66	0.08541	3666

Total (weighted) RCN = total product/total area = 67.07

RCN used = 67

Basin: CB-30

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	2.14	0.00334	210
Open Space, Good	B	61	3.91	0.00611	239
Open Space, Good	C	74	0.83	0.00130	61
Open Space, Good	D	80	0.15	0.00023	12
Woods, Good	B	55	0.60	0.00094	33
		Totals =	7.63	0.01192	555

Total (weighted) RCN = total product/total area = 72.69

RCN used = 73

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date:05/02/2016 (Revised 12/12/2016)

Basin: CB-40

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	4.35	0.00680	426
Open Space, Good	B	61	2.40	0.00375	146
Open Space, Good	C	74	7.21	0.01127	534
Open Space, Good	D	80	0.10	0.00016	8
		Totals =	14.06	0.02197	1114

Total (weighted) RCN = total product/total area = 79.25

RCN used = 79

Basin: CB-50

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	5.27	0.00823	516
Open Space, Good	C	74	3.84	0.00600	284
Open Space, Good	C/D	80	10.00	0.01563	800
		Totals =	19.11	0.02986	1601

Total (weighted) RCN = total product/total area = 83.76

RCN used = 84

Basin: CB-60

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	3.11	0.00486	305
Open Space, Good	B	61	0.20	0.00031	12
Open Space, Good	C	74	5.95	0.00930	440
		Totals =	9.26	0.01447	757

Total (weighted) RCN = total product/total area = 81.78

RCN used = 82

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date:05/02/2016 (Revised 12/12/2016)

Basin: CB-70

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	22.66	0.03541	2221
Open Space, Good	B	61	20.13	0.03145	1228
Open Space, Good	C	74	26.10	0.04078	1931
Open Space, Good	C/D	80	1.82	0.00284	146
		Totals =	70.71	0.11048	5526

Total (weighted) RCN = total product/total area = 78.14

RCN used = 78

Basin: CB-80

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	9.03	0.01411	885
Open Space, Good	B	61	8.69	0.01359	530
Open Space, Good	C	74	0.65	0.00101	48
Woods, Good	B	55	20.86	0.03259	1147
Woods, Good	C	70	7.20	0.01126	504
Woods, Good	D	77	2.87	0.00449	221
		Totals =	49.31	0.07704	3336

Total (weighted) RCN = total product/total area = 67.66

RCN used = 68

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/28/16 (Revised 12/12/2016)

Basin: CF-10

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	2.99	0.00467	293
Open Space, Good	B	61	15.03	0.02348	917
Open Space, Good	C	74	2.09	0.00327	155
Open Space, Good	D	80	0.07	0.00012	6
Woods, Good	B	55	3.15	0.00492	173
Woods, Good	C	70	2.09	0.00327	146
Water	-	100	0.07	0.00011	7
		Totals =	25.49	0.03984	1697

Total (weighted) RCN = total product/total area = 66.57

RCN used = 67

Basin: CF-20

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	7.17	0.01120	703
Open Space, Good	B	61	7.65	0.01196	467
Open Space, Good	D	80	2.09	0.00327	167
Open Space, Good	B/D	80	2.24	0.00350	179
Woods, Good	B	55	5.38	0.00841	296
Woods, Good	D	77	2.60	0.00406	200
Woods, Good	B/D	77	2.22	0.00347	171
Water	-	100	1.90	0.00296	190
		Totals =	31.25	0.04883	2373

Total (weighted) RCN = total product/total area = 75.92

RCN used = 76

Basin: CF-30

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	4.34	0.00678	425
Open Space, Good	B	61	10.54	0.01647	643
Open Space, Good	B/D	80	0.49	0.00077	39
Woods, Good	B	55	7.85	0.01227	432
Woods, Good	D	77	3.23	0.00504	249
Woods, Good	B/D	77	0.49	0.00077	38
		Totals =	26.94	0.04209	1826

Total (weighted) RCN = total product/total area = 67.77

RCN used = 68

CEDAR FORK

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/28/16 (Revised 12/12/2016)

Basin: CF-40

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	10.69	0.01670	1048
Open Space, Good	A	39	0.75	0.00117	29
Open Space, Good	B	61	4.86	0.00760	297
Open Space, Good	D	80	3.26	0.00509	261
Woods, Good	A	30	2.97	0.00464	89
Woods, Good	B	55	14.21	0.02220	782
Woods, Good	D	77	13.05	0.02039	1005
		Totals =	49.79	0.07780	3510

Total (weighted) RCN = total product/total area = 70.49

RCN used = 70

Basin: CF-50

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	2.01	0.00314	197
Open Space, Good	B	61	6.16	0.00962	376
Open Space, Good	D	80	0.28	0.00044	22
Woods, Good	B	55	8.79	0.01374	484
Woods, Good	D	77	0.28	0.00044	21
		Totals =	17.52	0.02737	1100

Total (weighted) RCN = total product/total area = 62.79

RCN used = 63

Basin: CF-60

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	12.87	0.02011	1261
Open Space, Good	B	61	18.46	0.02885	1126
Open Space, Good	C	74	0.19	0.00030	14
Open Space, Good	D	80	0.95	0.00148	76
Woods, Good	B	55	30.39	0.04749	1671
Woods, Good	C	70	0.58	0.00090	40
Woods, Good	D	77	11.00	0.01718	847
		Totals =	74.44	0.11631	5036

Total (weighted) RCN = total product/total area = 67.66

RCN used = 68

CEDAR FORK

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/28/16 (Revised 12/12/2016)

Basin: CF-70

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	10.85	0.01695	1063
Open Space, Good	A	39	6.34	0.00991	247
Open Space, Good	B	61	10.56	0.01650	644
Open Space, Good	C	74	1.92	0.00299	142
Open Space, Good	D	80	6.57	0.01027	526
Woods, Good	A	30	1.96	0.00306	59
Woods, Good	B	55	11.84	0.01851	651
Woods, Good	C	70	2.87	0.00449	201
Woods, Good	D	77	9.82	0.01535	756
		Totals =	62.75	0.09804	4290

Total (weighted) RCN = total product/total area = 68.38

RCN used = 68

Basin: CF-80

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	17.04	0.02663	1670
Open Space, Good	A	39	0.03	0.00004	1
Open Space, Good	B	61	41.38	0.06465	2524
Open Space, Good	C	74	6.80	0.01062	503
Open Space, Good	D	80	5.57	0.00870	445
Woods, Good	A	30	0.03	0.00004	1
Woods, Good	B	55	30.51	0.04767	1678
Woods, Good	C	70	5.84	0.00912	408
Woods, Good	D	77	2.39	0.00373	184
		Totals =	109.56	0.17119	7414

Total (weighted) RCN = total product/total area = 67.67

RCN used = 68

CEDAR FORK

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/28/16 (Revised 12/12/2016)

Basin: CF-90

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	14.86	0.02322	1456
Open Space, Good	B	61	35.69	0.05576	2177
Open Space, Good	C	74	0.51	0.00080	38
Open Space, Good	D	80	4.86	0.00759	389
Woods, Good	B	55	43.17	0.06745	2374
Woods, Good	C	70	4.63	0.00724	324
Woods, Good	D	71	13.26	0.02072	942
		Totals =	116.99	0.18279	7700

Total (weighted) RCN = total product/total area = 65.82

RCN used = 66

Basin: CF-100

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	6.60	0.01031	647
Open Space, Good	B	61	4.70	0.00734	287
Woods, Good	B	55	29.43	0.04598	1619
Woods, Good	D	77	12.89	0.02014	992
		Totals =	53.62	0.08378	3544

Total (weighted) RCN = total product/total area = 66.11

RCN used = 66

Basin: CF-110

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	4.11	0.00642	403
Open Space, Good	B	61	19.42	0.03034	1185
Woods, Good	B	55	3.43	0.00536	189
		Totals =	26.96	0.04213	1776

Total (weighted) RCN = total product/total area = 65.88

RCN used = 66

CEDAR FORK

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/28/16 (Revised 12/12/2016)

Basin:CF-120

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	9.01	0.01408	883
Open Space, Good	B	61	14.62	0.02285	892
Open Space, Good	D	80	2.64	0.00412	211
Woods, Good	B	55	30.60	0.04782	1683
Woods, Good	D	77	2.64	0.00412	203
		Totals =	59.51	0.09299	3872

Total (weighted) RCN = total product/total area = 65.07

RCN used = 65

Basin: CF-130

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	13.50	0.02109	1323
Open Space, Good	B	61	27.70	0.04328	1690
Open Space, Good	C	74	1.86	0.00291	138
Woods, Good	B	55	22.89	0.03577	1259
Woods, Good	C	70	1.45	0.00227	102
Woods, Good	D	77	30.55	0.04774	2352
		Totals =	97.96	0.15307	6864

Total (weighted) RCN = total product/total area = 70.07

RCN used = 70

CEDAR FORK

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/28/16 (Revised 12/12/2016)

Basin: CF-140

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	4.33	0.00677	424
Open Space, Good	B	61	5.91	0.00924	361
Open Space, Good	D	80	1.11	0.00173	89
Woods, Good	B	55	13.83	0.02161	761
Woods, Good	D	77	1.11	0.00173	85
		Totals =	26.29	0.04108	1720

Total (weighted) RCN = total product/total area = 65.41

RCN used = 65

Basin: CF-150

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	4.67	0.00730	458
Open Space, Good	B	61	4.25	0.00664	259
Open Space, Good	D	80	2.10	0.00328	168
Woods, Good	B	55	18.36	0.02869	1010
Woods, Good	D	77	2.91	0.00454	224
		Totals =	32.29	0.05046	2119

Total (weighted) RCN = total product/total area = 65.62

RCN used = 66

EASTWOOD LAKE

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/28/16 (Revised 12/12/2016)

Basin: EL-10

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	12.78	0.01997	1252
Open Space, Good	B	61	1.35	0.00211	82
Open Space, Good	C	74	6.72	0.01049	497
Open Space, Good	D	80	2.59	0.00405	207
Open Space, Good	C/D	80	8.19	0.01279	655
Woods, Good	B	55	6.48	0.01013	357
Woods, Good	C	70	22.49	0.03514	1574
Woods, Good	D	77	9.38	0.01465	722
		Totals =	69.97	0.10933	5347

Total (weighted) RCN = total product/total area = 76.41

RCN used = 76

Basin: EL-20

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	13.74	0.02147	1347
Open Space, Good	B	61	10.55	0.01649	644
Open Space, Good	C	74	2.19	0.00342	162
Open Space, Good	D	80	4.95	0.00773	396
Woods, Good	B	55	21.18	0.03309	1165
Woods, Good	C	70	8.76	0.01370	614
Woods, Good	D	77	18.00	0.02812	1386
		Totals =	79.38	0.12403	5713

Total (weighted) RCN = total product/total area = 71.97

RCN used = 72

Basin: EL-30

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	11.11	0.01736	1089
Open Space, Good	B	61	16.80	0.02626	1025
Open Space, Good	C	74	0.52	0.00082	39
Open Space, Good	D	80	1.72	0.00268	137
Woods, Good	B	55	34.45	0.05384	1895
Woods, Good	C	70	2.09	0.00327	146
Woods, Good	D	77	6.86	0.01073	529
		Totals =	73.56	0.11494	4860

Total (weighted) RCN = total product/total area = 66.06

RCN used = 66

EASTWOOD LAKE

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/28/16 (Revised 12/12/2016)

Basin: EL-40

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	7.74	0.01209	759
Open Space, Good	B	61	3.50	0.00547	214
Open Space, Good	C	74	3.06	0.00478	226
Open Space, Good	D	80	5.00	0.00781	400
Woods, Good	B	55	5.77	0.00902	317
Woods, Good	C	70	12.23	0.01911	856
Woods, Good	D	77	6.94	0.01084	534
		Totals =	44.24	0.06913	3306

Total (weighted) RCN = total product/total area = 74.73

RCN used = 75

Basin: EL-50

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	11.64	0.01819	1141
Open Space, Good	B	61	12.90	0.02015	787
Open Space, Good	C	74	1.61	0.00251	119
Open Space, Good	D	80	1.28	0.00201	103
Open Space, Good	B/D	80	1.13	0.00177	91
Woods, Good	B	55	24.90	0.03891	1370
Woods, Good	C	70	6.43	0.01005	450
Woods, Good	D	77	11.55	0.01805	889
Woods, Good	B/D	77	1.13	0.00177	87
		Totals =	72.58	0.11340	5036

Total (weighted) RCN = total product/total area = 69.39

RCN used = 69

Basin: EL-60

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	13.51	0.02111	1324
Open Space, Good	B	61	15.40	0.02407	940
Open Space, Good	D	80	0.45	0.00070	36
Woods, Good	B	55	48.87	0.07636	2688
Woods, Good	D	77	2.67	0.00418	206
Woods, Good	B/D	77	4.23	0.00662	326
Water	-	100	0.18	0.00029	18
		Totals =	85.32	0.13331	5537

Total (weighted) RCN = total product/total area = 64.90

RCN used = 65

EASTWOOD LAKE

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/28/16 (Revised 12/12/2016)

Basin: EL-70

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	8.12	0.01269	796
Open Space, Good	B	61	7.44	0.01163	454
Open Space, Good	C	74	1.24	0.00194	92
Open Space, Good	D	80	0.87	0.00136	70
Open Space, Good	C/D	80	0.18	0.00028	15
Woods, Good	B	55	22.31	0.03486	1227
Woods, Good	C	70	1.24	0.00194	87
Woods, Good	D	77	8.70	0.01360	670
Woods, Good	B/D	77	1.49	0.00233	115
Woods, Good	C/D	77	0.18	0.00028	14
Water	-	100	8.19	0.01280	819
		Totals =	59.98	0.09372	4358

Total (weighted) RCN = total product/total area = 72.66

RCN used = 73

Basin: EL-80

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	8.01	0.01252	785
Open Space, Good	B	61	9.32	0.01456	568
Woods, Good	B	55	28.61	0.04470	1573
Water	-	100	12.32	0.01925	1232
		Totals =	58.25	0.09102	4159

Total (weighted) RCN = total product/total area = 71.39

RCN used = 71

Basin: EL-90

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	8.81	0.01377	863
Open Space, Good	B	61	5.45	0.00851	332
Open Space, Good	C	74	0.72	0.00112	53
Open Space, Good	D	80	1.33	0.00207	106
Open Space, Good	C/D	80	2.02	0.00315	161
Woods, Good	B	55	23.57	0.03683	1296
Woods, Good	C	70	0.72	0.00112	50
Woods, Good	D	77	6.85	0.01070	527
Woods, Good	C/D	77	6.05	0.00945	466
Water	-	100	8.77	0.01370	877
		Totals =	64.27	0.10042	4733

Total (weighted) RCN = total product/total area = 73.64

RCN used = 74

EASTWOOD LAKE

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/28/16 (Revised 12/12/2016)

Basin: EL-100

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	7.47	0.01167	732
Open Space, Good	B	61	4.11	0.00641	250
Open Space, Good	D	80	5.11	0.00798	409
Open Space, Good	C/D	80	0.04	0.00006	3
Woods, Good	B	55	3.00	0.00469	165
Woods, Good	D	77	17.53	0.02739	1350
Woods, Good	C/D	77	0.10	0.00015	7
Water	-	100	18.52	0.02895	1852
		Totals =	55.87	0.08730	4769

Total (weighted) RCN = total product/total area = 85.35

RCN used = 85

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/28/16 (Revised 12/12/2016)

Basin: LBC-10

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	6.87	0.01073	673
Open Space, Good	B	61	4.66	0.00728	284
Open Space, Good	C	74	1.40	0.00219	104
Open Space, Good	D	80	1.91	0.00299	153
Open Space, Good	C/D	80	0.44	0.00068	35
Woods, Good	B	55	20.33	0.03177	1118
Woods, Good	C	70	5.43	0.00848	380
Woods, Good	D	77	17.22	0.02690	1326
		Totals =	58.26	0.09103	4073

Total (weighted) RCN = total product/total area = 69.92

RCN used = 70

Basin: LBC-20

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	8.86	0.01384	868
Open Space, Good	B	61	4.92	0.00770	300
Open Space, Good	C	74	1.62	0.00254	120
Open Space, Good	D	80	1.55	0.00242	124
Open Space, Good	C/D	80	2.36	0.00369	189
Woods, Good	B	55	13.38	0.02090	736
Woods, Good	C	70	1.17	0.00183	82
Woods, Good	D	77	4.71	0.00737	363
Woods, Good	C/D	77	11.09	0.01733	854
		Totals =	49.67	0.07761	3636

Total (weighted) RCN = total product/total area = 73.21

RCN used = 73

Basin: LBC-30

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	17.58	0.02747	1723
Open Space, Good	B	61	0.00	0.00001	0
Open Space, Good	C	74	1.09	0.00170	81
Open Space, Good	D	80	13.85	0.02164	1108
Open Space, Good	C/D	80	4.91	0.00767	393
Woods, Good	B	55	1.70	0.00265	93
Woods, Good	C	70	4.89	0.00763	342
Woods, Good	D	77	32.47	0.05074	2500
Woods, Good	C/D	77	17.87	0.02792	1376
		Totals =	94.36	0.14743	7616

Total (weighted) RCN = total product/total area = 80.72

RCN used = 81

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/28/16 (Revised 12/12/2016)

Basin: LBC-40

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	14.20	0.02219	1392
Open Space, Good	D	80	12.85	0.02008	1028
Open Space, Good	C/D	80	8.95	0.01398	716
Woods, Good	D	77	28.70	0.04485	2210
Woods, Good	C/D	77	20.88	0.03263	1608
		Totals =	85.59	0.13373	6954

Total (weighted) RCN = total product/total area = 81.25

RCN used = 81

Basin: LBC-50

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	2.22	0.00347	218
Woods, Good	B	55	8.73	0.01364	480
Woods, Good	D	77	4.56	0.00712	351
		Totals =	15.51	0.02423	1049

Total (weighted) RCN = total product/total area = 67.62

RCN used = 68

Basin: LBC-60

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	15.01	0.02345	1471
Open Space, Good	B	61	9.52	0.01487	580
Open Space, Good	B/D	80	1.06	0.00166	85
Open Space, Good	C/D	80	3.82	0.00597	306
Woods, Good	B	55	24.01	0.03752	1321
Woods, Good	D	77	12.65	0.01977	974
Woods, Good	B/D	77	6.01	0.00939	463
Woods, Good	C/D	77	11.46	0.01791	882
		Totals =	83.54	0.13053	6082

Total (weighted) RCN = total product/total area = 72.80

RCN used = 73

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/28/16 (Revised 12/12/2016)

Basin: LBC-70

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	11.15	0.01742	1093
Open Space, Good	B	61	7.84	0.01225	478
Open Space, Good	D	80	8.77	0.01371	702
Woods, Good	B	55	27.89	0.04357	1534
Woods, Good	D	77	9.14	0.01428	704
Woods, Good	B/D	77	0.28	0.00043	21
		Totals =	65.06	0.10166	4532

Total (weighted) RCN = total product/total area = 69.65

RCN used = 70

Basin: LBC-80

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	6.06	0.00947	594
Open Space, Good	D	80	9.75	0.01523	780
Woods, Good	D	77	15.07	0.02355	1160
		Totals =	30.88	0.04825	2534

Total (weighted) RCN = total product/total area = 82.07

RCN used = 82

Basin: LBC-90

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	10.91	0.01705	1069
Open Space, Good	C	74	2.75	0.00430	204
Open Space, Good	D	80	31.02	0.04846	2481
Open Space, Good	C/D	80	0.42	0.00065	33
Woods, Good	D	77	8.77	0.01371	676
Woods, Good	C/D	77	1.67	0.00261	129
Water	-	100	0.84	0.00132	84
		Totals =	56.39	0.08811	4676

Total (weighted) RCN = total product/total area = 82.93

RCN used = 83

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/28/16 (Revised 12/12/2016)

Basin: LBC-100

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	1.15	0.00180	113
Open Space, Good	D	80	7.47	0.01167	598
Woods, Good	D	77	2.19	0.00342	169
Water	-	100	0.40	0.00063	40
		Totals =	11.21	0.01752	919

Total (weighted) RCN = total product/total area = 81.97

RCN used = 82

Basin: LBC-110

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	3.13	0.00489	307
Open Space, Good	D	80	5.40	0.00844	432
Open Space, Good	B/D	80	2.01	0.00314	161
Woods, Good	D	77	3.01	0.00470	232
Woods, Good	B/D	77	0.15	0.00023	12
		Totals =	13.70	0.02141	1143

Total (weighted) RCN = total product/total area = 83.42

RCN used = 83

Basin: LBC-120

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	4.63	0.00723	454
Open Space, Good	D	80	1.56	0.00244	125
Open Space, Good	C/D	80	2.37	0.00370	189
Woods, Good	D	77	6.24	0.00975	480
Woods, Good	B/D	77	1.80	0.00281	139
Woods, Good	C/D	77	8.41	0.01314	648
Water	-	100	0.65	0.00102	65
		Totals =	25.66	0.04009	2100

Total (weighted) RCN = total product/total area = 81.83

RCN used = 82

LOWER BOOKER CREEK

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/28/16 (Revised 12/12/2016)

Basin: LBC-130

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	3.41	0.00533	334
Open Space, Good	D	80	3.74	0.00585	300
Open Space, Good	B/D	80	2.02	0.00316	162
Open Space, Good	C/D	80	0.33	0.00051	26
Woods, Good	D	77	0.27	0.00042	21
Woods, Good	B/D	77	8.19	0.01280	631
Woods, Good	C/D	77	0.98	0.00153	76
		Totals =	18.95	0.02960	1549

Total (weighted) RCN = total product/total area = 81.74

RCN used = 82

Basin: LBC-140

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	3.21	0.00502	315
Open Space, Good	D	80	10.02	0.01566	802
Woods, Good	D	77	13.17	0.02057	1014
		Totals =	26.40	0.04125	2130

Total (weighted) RCN = total product/total area = 80.69

RCN used = 81

Basin: LBC-150

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	10.22	0.01597	1002
Open Space, Good	B	61	7.02	0.01097	428
Open Space, Good	D	80	5.80	0.00906	464
Woods, Good	B	55	16.47	0.02574	906
Woods, Good	D	77	9.30	0.01454	716
		Totals =	48.82	0.07627	3516

Total (weighted) RCN = total product/total area = 72.03

RCN used = 72

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/28/16 (Revised 12/12/2016)

Basin: LBC-160

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	2.67	0.00417	262
Open Space, Good	B	61	2.58	0.00404	158
Open Space, Good	D	80	6.58	0.01028	526
Open Space, Good	B/D	80	0.05	0.00008	4
Woods, Good	B	55	2.96	0.00463	163
Woods, Good	D	77	11.66	0.01821	898
		Totals =	26.50	0.04141	2010

Total (weighted) RCN = total product/total area = 75.85

RCN used = 76

Basin: LBC-170

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	2.94	0.00459	288
Open Space, Good	D	80	2.90	0.00453	232
Woods, Good	D	77	3.29	0.00514	253
		Totals =	9.13	0.01427	773

Total (weighted) RCN = total product/total area = 84.72

RCN used = 85

Basin: LBC-180

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	12.52	0.01956	1227
Open Space, Good	D	80	8.06	0.01259	645
Open Space, Good	B/D	80	0.09	0.00014	7
Woods, Good	D	77	37.62	0.05878	2897
		Totals =	58.29	0.09108	4776

Total (weighted) RCN = total product/total area = 81.93

RCN used = 82

LOWER BOOKER CREEK

SCS Runoff Curve Number - Future Conditions

Project: Lower Booker Creek Subwatershed Study and Plan
Prepared by :EVH
Checked by: TLM
Date: 4/28/16 (Revised 12/12/2016)

Basin: LBC-190

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	4.41	0.00689	432
Open Space, Good	D	80	3.99	0.00623	319
Woods, Good	D	77	11.04	0.01725	850
Woods, Good	B/D	77	10.84	0.01694	835
		Totals =	30.28	0.04732	2436

Total (weighted) RCN = total product/total area = 80.45

RCN used = 80

Basin: LBC-200

Landuse	Soil Group	RCN	Area (Acres)	Area (Sq. Mi.)	Product of RCN and Area
Impervious Surface	-	98	12.97	0.02027	1271
Open Space, Good	B	61	3.40	0.00531	207
Open Space, Good	D	80	11.63	0.01817	930
Woods, Good	B	55	7.93	0.01239	436
Woods, Good	D	77	27.13	0.04239	2089
Woods, Good	B/D	77	39.28	0.06137	3024
		Totals =	102.33	0.15989	7958

Total (weighted) RCN = total product/total area = 77.77

RCN used = 78

BOOKER HEADWATERS - EXISTING CONDITIONS					
Basin_ID	Total Area (Acres)	Impervious Area (Acres)	% Impervious	Assumed Land Use	DCIA%
BH-10	89.01	19.81	22.3%	LDR	7.8
BH-20	49.08	12.94	26.4%	MDR	13.5
BH-30	105.65	20.85	19.7%	MDR	8.8
BH-40	67.59	16.49	24.4%	MDR	12.1
BH-50	75.19	5.26	7.0%	DIS	0.5
BH-60	82.84	20.33	24.5%	LDR	9.2
BH-70	40.25	11.89	29.5%	MDR	16.1
BH-80	65.63	17.70	27.0%	MDR	14.0
BH-90	60.53	7.73	12.8%	LDR	3.0
BH-100	70.93	17.64	24.9%	LDR	9.4
BH-110	75.11	20.66	27.5%	MDR	14.4
BH-120	17.58	4.28	24.4%	LDR	9.1
BH-130	64.34	12.26	19.1%	LDR	6.0

BOOKER HEADWATERS - FUTURE CONDITIONS					
Basin_ID	Total Area (Acres)	Impervious Area (Acres)	% Impervious	Assumed Land Use	DCIA%
BH-10	89.01	22.82	25.6%	LDR	9.9
BH-20	49.08	13.95	28.4%	MDR	15.1
BH-30	105.65	31.67	30.0%	MDR	16.4
BH-40	67.59	19.43	28.7%	MDR	15.4
BH-50	75.19	12.29	16.3%	MDR	6.6
BH-60	82.84	27.29	32.9%	LDR	15.2
BH-70	40.25	11.89	29.5%	MDR	16.1
BH-80	65.63	21.66	33.0%	MDR	19.0
BH-90	60.53	15.88	26.2%	LDR	10.3
BH-100	70.93	19.55	27.6%	LDR	11.2
BH-110	75.11	43.57	58.0%	MDR	44.2
BH-120	17.58	6.21	35.3%	LDR	17.1
BH-130	64.34	16.19	25.2%	LDR	9.6

Table 1. Sutherland Equations to Determine DCIA (%)

Watershed Selection Criteria	Assumed Land Use	Equation *(where IA(%) ≥1)*
Average: Mostly storm sewered with curb & gutter, no dry wells or infiltration, residential rooftops not directly connected	Commercial, Industrial, Institutional, Open land, and Med. density residential	$DCIA=0.1(IA)^{1.5}$
Highly connected: Same as above, but residential rooftops are connected	High density residential	$DCIA=0.4(IA)^{1.2}$
Totally connected: 100% storm sewered with all IA connected	--	DCIA=IA
Somewhat connected: 50% not storm sewered, but open section roads, grassy swales, residential rooftops not connected, some infiltration	Low density residential	$DCIA=0.04(IA)^{1.7}$
Mostly disconnected: Small percentage of urban area is storm sewered, or 70% or more infiltrate/disconnected	Agricultural; Forested	$DCIA=0.01(IA)^{2}$

Source: Estimating Change in Impervious Area (IA) and Directly Connected Impervious Areas (DCIA) for Massachussetts Small MS4 P

CEDAR FORK - EXISTING CONDITIONS					
Basin_ID	Total Area (Acres)	Impervious Area (Acres)	% Impervious	Assumed Land Use	DCIA%
CF-10	50.49	26.95	53.4%	HDR	47.3
CF-20	49.21	14.43	29.3%	MDR	15.9
CF-30	28.70	3.85	13.4%	DIS	1.8
CF-40	59.43	11.10	18.7%	LDR	5.8
CF-50	18.65	2.79	14.9%	MDR	5.8
CF-60	78.95	15.31	19.4%	LDR	6.2
CF-70	76.95	21.08	27.4%	MDR	14.3
CF-80	113.17	20.64	18.2%	LDR	5.6
CF-90	118.24	16.11	13.6%	LDR	3.4
CF-100	54.63	7.61	13.9%	LDR	3.5
CF-110	28.23	5.38	19.1%	LDR	6.0
CF-120	61.50	10.99	17.9%	LDR	5.4
CF-130	96.90	12.44	12.8%	DIS	1.6
CF-140	27.19	5.22	19.2%	LDR	6.1
CF-150	32.54	4.91	15.1%	LDR	4.0

CEDAR FORK - FUTURE CONDITIONS					
Basin_ID	Total Area (Acres)	Impervious Area (Acres)	% Impervious	Assumed Land Use	DCIA%
CF-10	50.49	28.09	55.6%	HDR	49.7
CF-20	49.21	25.18	51.2%	MDR	36.6
CF-30	28.70	6.88	24.0%	LDR	8.9
CF-40	59.43	20.34	34.2%	LDR	16.2
CF-50	18.65	3.57	19.1%	MDR	8.4
CF-60	78.95	21.70	27.5%	LDR	11.2
CF-70	76.95	25.72	33.4%	MDR	19.3
CF-80	113.17	26.97	23.8%	LDR	8.8
CF-90	118.24	21.32	18.0%	LDR	5.5
CF-100	54.63	9.31	17.0%	LDR	5.0
CF-110	28.23	6.36	22.5%	LDR	8.0
CF-120	61.50	14.00	22.8%	LDR	8.1
CF-130	96.90	16.22	16.7%	DIS	2.8
CF-140	27.19	7.16	26.4%	LDR	10.4
CF-150	32.54	7.17	22.0%	LDR	7.7

Table 1. Sutherland Equations to Determine DCIA (%)

Watershed Selection Criteria	Assumed Land Use	Equation *(where IA(%) ≥1)*
Average: Mostly storm sewered with curb & gutter, no dry wells or infiltration, residential rooftops not directly connected	Commercial, Industrial, Institutional, Open land, and Med. density residential	$DCIA=0.1(IA)^{1.5}$
Highly connected: Same as above, but residential rooftops are connected	High density residential	$DCIA=0.4(IA)^{1.2}$
Totally connected: 100% storm sewered with all IA connected	--	DCIA=IA
Somewhat connected: 50% not storm sewered, but open section roads, grassy swales, residential rooftops not connected, some infiltration	Low density residential	$DCIA=0.04(IA)^{1.7}$
Mostly disconnected: Small percentage of urban area is storm sewered, or 70% or more infiltrate/disconnected	Agricultural; Forested	$DCIA=0.01(IA)^{2}$

Source: Estimating Change in Impervious Area (IA) and Directly Connected Impervious Areas (DCIA) for Massachussetts Small MS4 Permi

CROW BRANCH - EXISTING CONDITIONS					
Basin_ID	Total Area (Acres)	Impervious Area (Acres)	% Impervious	Assumed Land Use	DCIA%
CB-10	92.60	1.23	1.3%	DIS	0.0
CB-20	72.01	0.51	0.7%	DIS	0.0
CB-30	17.27	0.53	3.1%	DIS	0.0
CB-40	32.87	0.50	1.5%	DIS	0.0
CB-50	46.08	2.19	4.7%	DIS	0.2
CB-60	20.46	0.48	2.3%	DIS	0.1
CB-70	95.93	17.15	17.9%	LDR	5.4
CB-80	53.16	12.89	24.2%	LDR	9.0

CROW BRANCH - FUTURE CONDITIONS					
Basin_ID	Total Area (Acres)	Impervious Area (Acres)	% Impervious	Assumed Land Use	DCIA%
CB-10	92.60	28.63	36.8%	MDR	24.9
CB-20	72.01	28.02	38.9%	MDR	24.3
CB-30	17.27	34.46	69.2%	MDR	53.5
CB-40	32.87	21.96	70.0%	MDR	57.2
CB-50	46.08	25.99	70.0%	MDR	58.6
CB-60	20.46	14.33	70.0%	LDR	54.8
CB-70	95.93	42.82	46.1%	LDR	26.3
CB-80	53.16	15.89	29.9%	LDR	12.9

Table 1. Sutherland Equations to Determine DCIA (%)

Watershed Selection Criteria	Assumed Land Use	Equation *(where IA(%) ≥1)*
Average: Mostly storm sewered with curb & gutter, no dry wells or infiltration, residential rooftops not directly connected	Commercial, Industrial, Institutional, Open land, and Med. density residential	$DCIA=0.1(IA)^{1.5}$
Highly connected: Same as above, but residential rooftops are connected	High density residential	$DCIA=0.4(IA)^{1.2}$
Totally connected: 100% storm sewered with all IA connected	--	DCIA=IA
Somewhat connected: 50% not storm sewered, but open section roads, grassy swales, residential rooftops not connected, some infiltration	Low density residential	$DCIA=0.04(IA)^{1.7}$
Mostly disconnected: Small percentage of urban area is storm sewered, or 70% or more infiltrate/disconnected	Agricultural; Forested	$DCIA=0.01(IA)^{2}$

Source: Estimating Change in Impervious Area (IA) and Directly Connected Impervious Areas (DCIA) for Massachussetts Small MS4 P

EASTWOOD LAKE - EXISTING CONDITIONS					
Basin_ID	Total Area (Acres)	Impervious Area (Acres)	% Impervious	Assumed Land Use	DCIA%
EL-10	88.88	29.06	32.7%	MDR	19.3
EL-20	88.02	20.21	23.0%	LDR	8.1
EL-30	76.64	11.82	15.4%	LDR	4.2
EL-40	47.93	11.42	23.8%	LDR	8.8
EL-50	74.07	13.13	17.7%	LDR	5.3
EL-60	90.90	19.09	21.0%	LDR	7.1
EL-70	60.22	8.36	13.9%	LDR	3.5
EL-80	58.71	8.49	14.5%	LDR	3.8
EL-90	64.09	8.67	13.5%	LDR	3.4
EL-100	55.77	7.34	13.2%	LDR	3.2

EASTWOOD LAKE - FUTURE CONDITIONS					
Basin_ID	Total Area (Acres)	Impervious Area (Acres)	% Impervious	Assumed Land Use	DCIA%
EL-10	88.88	31.81	36.9%	MDR	21.4
EL-20	88.02	27.22	30.7%	LDR	9.8
EL-30	76.64	17.15	22.4%	LDR	7.9
EL-40	47.93	12.92	27.0%	LDR	10.8
EL-50	74.07	19.00	25.7%	LDR	9.9
EL-60	90.90	21.20	23.3%	LDR	8.5
EL-70	60.22	12.04	20.0%	LDR	6.5
EL-80	58.71	11.94	20.3%	LDR	6.7
EL-90	64.09	13.19	20.6%	LDR	6.8
EL-100	55.77	11.05	19.8%	LDR	6.4

Table 1. Sutherland Equations to Determine DCIA (%)

Watershed Selection Criteria	Assumed Land Use	Equation *(where IA(%) ≥1)*
Average: Mostly storm sewered with curb & gutter, no dry wells or infiltration, residential rooftops not directly connected	Commercial, Industrial, Institutional, Open land, and Med. density residential	$DCIA=0.1(IA)^{1.5}$
Highly connected: Same as above, but residential rooftops are connected	High density residential	$DCIA=0.4(IA)^{1.2}$
Totally connected: 100% storm sewered with all IA connected	--	DCIA=IA
Somewhat connected: 50% not storm sewered, but open section roads, grassy swales, residential rooftops not connected, some infiltration	Low density residential	$DCIA=0.04(IA)^{1.7}$
Mostly disconnected: Small percentage of urban area is storm sewered, or 70% or more infiltrate/disconnected	Agricultural; Forested	$DCIA=0.01(IA)^{2}$

Source: Estimating Change in Impervious Area (IA) and Directly Connected Impervious Areas (DCIA) for Massachussetts Small MS4

LOWER BOOKER CREEK - EXISTING CONDITIONS					
Basin_ID	Total Area (Acres)	Impervious Area (Acres)	% Impervious	Assumed Land Use	DCIA%
LBC-10	62.29	10.91	17.5%	MDR	7.3
LBC-20	54.09	13.28	24.6%	LDR	9.2
LBC-30	102.27	25.47	24.9%	LDR	9.5
LBC-40	100.15	28.78	28.7%	MDR	15.4
LBC-50	14.22	1.24	8.7%	DIS	0.8
LBC-60	90.92	22.39	24.6%	LDR	9.3
LBC-70	69.09	15.10	21.9%	LDR	7.6
LBC-80	41.07	10.93	26.6%	MDR	13.7
LBC-90	73.64	28.16	38.2%	MDR	23.7
LBC-100	18.60	8.08	43.4%	HDR	36.9
LBC-110	21.31	6.31	29.6%	MDR	16.1
LBC-120	31.87	9.82	30.8%	MDR	17.1
LBC-130	23.08	7.55	32.7%	MDR	18.7
LBC-140	56.73	33.21	58.5%	HDR	52.9
LBC-150	69.01	28.27	41.0%	MDR	26.2
LBC-160	49.68	25.85	52.0%	HDR	45.9
LBC-170	17.56	3.08	17.5%	MDR	7.3
LBC-180	91.01	37.28	41.0%	HDR	34.4
LBC-190	32.44	5.71	17.6%	LDR	5.2
LBC-200	107.57	18.21	16.9%	LDR	4.9

LOWER BOOKER CREEK - FUTURE CONDITIONS					
Basin_ID	Total Area (Acres)	Impervious Area (Acres)	% Impervious	Assumed Land Use	DCIA%
LBC-10	62.29	12.42	19.9%	MDR	8.9
LBC-20	54.09	15.01	27.7%	LDR	11.4
LBC-30	102.27	31.34	30.6%	LDR	13.5
LBC-40	100.15	34.06	34.0%	MDR	19.8
LBC-50	14.22	3.59	25.3%	LDR	9.7
LBC-60	90.92	25.60	28.2%	LDR	11.6
LBC-70	69.09	18.61	26.9%	LDR	10.8
LBC-80	41.07	16.86	41.1%	MDR	26.3
LBC-90	73.64	32.07	43.5%	MDR	28.7
LBC-100	18.60	9.54	51.3%	HDR	45.1
LBC-110	21.31	10.49	49.2%	MDR	34.6
LBC-120	31.87	11.90	37.3%	MDR	22.8
LBC-130	23.08	9.72	42.1%	MDR	27.3
LBC-140	56.73	33.43	58.9%	HDR	53.3
LBC-150	69.01	30.65	44.4%	MDR	29.6
LBC-160	49.68	30.83	62.1%	HDR	56.7
LBC-170	17.56	11.37	64.7%	LDR	48.0
LBC-180	91.01	53.24	58.5%	MDR	44.7
LBC-190	32.44	6.57	20.2%	LDR	6.7
LBC-200	107.57	18.28	17.0%	LDR	4.9

Table 1. Sutherland Equations to Determine DCIA (%)

Watershed Selection Criteria	Assumed Land Use	Equation *(where IA(%) >1)*
Average: Mostly storm sewered with curb & gutter, no dry wells or infiltration, residential rooftops not directly connected	Commercial, Industrial, Institutional, Open land, and Med. density residential	$DCIA=0.1(IA)^{1.5}$
Highly connected: Same as above, but residential rooftops are connected	High density residential	$DCIA=0.4(IA)^{1.2}$
Totally connected: 100% storm sewered with all IA connected	--	DCIA=IA
Somewhat connected: 50% not storm sewered, but open section roads, grassy swales, residential rooftops not connected, some infiltration	Low density residential	$DCIA=0.04(IA)^{1.7}$
Mostly disconnected: Small percentage of urban area is storm sewered, or 70% or more infiltrate/disconnected	Agricultural; Forested	$DCIA=0.01(IA)^{2}$

Source: Estimating Change in Impervious Area (IA) and Directly Connected Impervious Areas (DCIA) for Massa

Appendix F:

Time of Concentration Calculations

List of Contents:

1. Booker Headwaters
2. Cedar Fork
3. Crow Branch
4. Eastwood Lake
5. Lower Booker Creek

Project: Lower Booker Creek Subwatershed Study
Prepared by: EVH
Checked by: TLM
Date: 3/31/2016 (Revised 12/12/2016)

Time of Concentration - Booker Creek Watershed

Sub-basin	Sheet Flow						Shallow Concentration					Channel Flow									Lag	Validation
	Description	n	Flow Length (ft)	P-2 (in)	Land Slope (ft/ft)	Tt (min)	Surface Description 0--Unpaved/1-Paved	Flow Length (ft)	Slope (ft/ft)	Velocity (ft/s)	Tt (min)	Channel Area (ft2)	Channel Perimeter (ft)	Hydraulic Radius (ft)	Slope (ft/ft)	n	Velocity (ft/s)	Flow Length (ft)	Tt (min)	Tc (min)		(min)	(min)
BOOKER HEADWATERS																						
BH-10	Woods	0.40	300	3.58	0.023	45.97	0	488	0.033	2.92	2.78	8	7.7	1.04	0.022	0.045	5.01	1332	4.43	53.18		31.91	47.86
BH-20	Woods	0.40	300	3.58	0.027	43.58	0	543	0.048	3.53	2.56	Pipe			0.054	0.013	5.00	739	2.46	53.66		32.20	
												8	7.7	1.04	0.013	0.045	3.93	1193	5.05				
BH-30	Woods	0.40	300	3.58	0.047	34.84	0	419	0.074	4.39	1.59	Pipe			0.044	0.013	5.00	180	0.60	61.74		37.05	55.57
												8	7.7	1.04	0.001	0.04	1.16	1076.75	15.41			
												Pipe			0.056	0.013	5.00	89	0.30			
												8	7.7	1.04	0.013	0.04	4.36	1076.75	4.12			
												Pipe			0.027	0.013	5.00	73	0.24			
												8	7.7	1.04	0.010	0.04	3.86	1076.75	4.65			
BH-40	Woods	0.40	291	3.58	0.072	28.56	1	226	0.053	4.68	0.80	Pipe			0.037	0.013	5.00	709	2.36	37.09		22.26	16.69
												8	7.7	1.04	0.028	0.03	8.49	396	0.78			
												Pipe			0.029	0.013	5.00	175	0.58			
												8	7.7	1.04	0.042	0.04	7.87	212	0.45			
												16.5	10.7	1.54	0.012	0.045	4.79	1023	3.56			
BH-50	Woods	0.40	300	3.58	0.037	38.37	0	172	0.035	3.01	0.95	16.5	10.7	1.54	0.017	0.04	6.42	1385	3.60	43.16		25.89	
												Pipe			0.027	0.013	5.00	73	0.24			
BH-60	Woods	0.40	300	3.58	0.047	34.84	1	195	0.031	3.57	0.91	8	7.7	1.04	0.001	0.04	0.99	1088	18.32	57.73		34.64	51.96
												16.5	10.7	1.54	0.002	0.04	2.02	444	3.67			
BH-70	Woods	0.40	230	3.58	0.074	23.43	0	605	0.010	1.61	6.28	8	7.7	1.04	0.033	0.04	6.95	302	0.72	30.81		18.49	
												16.5	10.7	1.54	0.015	0.04	6.02	137	0.38			
BH-80	Woods	0.40	300	3.58	0.020	48.89	0	398	0.020	2.29	2.90	Pipe			0.014	0.013	5.00	359	1.20	58.51		35.10	
												8	7.7	1.04	0.026	0.04	6.20	1408	3.79			
												16.5	10.7	1.54	0.006	0.045	3.36	348	1.73			
BH-90	Woods	0.40	300	3.58	0.050	33.89	0	209	0.115	5.47	0.64	16.5	10.7	1.54	0.032	0.04	8.90	188	0.35	64.06		38.43	57.65
												Pipe			0.019	0.013	5.00	106	0.35			
												16.5	10.7	1.54	0.001	0.045	1.50	2600	28.82			
BH-100	Woods	0.40	300	3.58	0.073	29.08	1	174	0.126	7.23	0.40	8	7.7	1.04	0.053	0.04	8.83	900	1.70	39.21		23.53	35.29
												16.5	10.7	1.54	0.008	0.045	4.02	1939	8.04			
BH-110	Woods	0.40	300	3.58	0.100	25.68	0	465	0.099	5.07	1.53	16.5	10.7	1.54	0.013	0.045	5.11	1948	6.35	33.56		20.14	
BH-120	Woods	0.40	192	3.58	0.042	25.51	1	289	0.035	3.78	1.27	8	7.7	1.04	0.067	0.04	9.91	387	0.65	29.07		17.44	
												16.5	10.7	1.54	0.009	0.045	4.31	422	1.63			
BH-130	Woods	0.40	296	3.58	0.068	29.72	0	400	0.068	4.19	1.59	8	7.7	1.04	0.030	0.04	6.62	900	2.27	41.16		24.69	37.04
												16.5	10.7	1.54	0.009	0.045	4.26	1939	7.58			

Project: Lower Booker Creek Subwatershed Study
Prepared by: EVH
Checked by: TLM
Date: 3/31/2016 (Revised 12/12/2016)

Time of Concentration - Booker Creek Watershed

Sub-basin	Sheet Flow						Shallow Concentration					Channel Flow									Lag	Validation
	Description	n	Flow Length (ft)	P-2 (in)	Land Slope (ft/ft)	Tt (min)	Surface Description 0--Unpaved/1-Paved	Flow Length (ft)	Slope (ft/ft)	Velocity (ft/s)	Tt (min)	Channel Area (ft2)	Channel Perimeter (ft)	Hydraulic Radius (ft)	Slope (ft/ft)	n	Velocity (ft/s)	Flow Length (ft)	Tt (min)	Tc (min)	(min)	(min)
CROW BRANCH																						
CB-10	Woods	0.40	300	3.58	0.027	43.58	0	685	0.026	2.62	4.37	108.5	27.7	3.92	0.014	0.045	9.94	1867	3.13	51.07	30.64	61.29
CB-20	Woods	0.40	300	3.58	0.053	33.03	0	309	0.078	4.50	1.15	16.5	10.7	1.54	0.049	0.045	9.79	900	1.53	39.59	23.75	47.50
												108.5	27.7	3.92	0.008	0.045	7.43	1731	3.88			
CB-30	Woods	0.40	219	3.58	0.023	36.05	0	297	0.044	3.38	1.47	16.5	10.7	1.54	0.067	0.045	11.48	862	1.25	38.77	23.26	46.52
CB-40	Woods	0.40	258	3.58	0.039	33.26	0	291	0.027	2.68	1.81	16.5	10.7	1.54	0.016	0.045	5.56	507	1.52	36.59	21.95	
CB-50	Woods	0.40	300	3.58	0.013	57.50	0	532	0.004	0.99	8.96	8	7.7	1.04	0.006	0.035	3.48	629	3.01	72.81	43.69	
												16.5	10.7	1.54	0.012	0.045	4.90	981	3.34			
CB-60	Woods	0.40	300	3.58	0.027	43.58	0	316	0.022	2.40	2.19	16.5	10.7	1.54	0.022	0.045	6.56	683	1.74	47.51	28.50	
CB-70	Woods	0.40	300	3.58	0.027	43.58	0	141	0.071	4.30	0.55	16.5	10.7	1.54	0.026	0.04	7.96	1017	2.13	52.42	31.45	62.90
												108.5	27.7	3.92	0.003	0.045	4.80	1776	6.16			
CB-80	Woods	0.40	300	3.58	0.027	43.58	0	155	0.039	3.17	0.81	16.5	10.7	1.54	0.035	0.04	9.32	428	0.77	48.57	29.14	
												108.5	27.7	3.92	0.012	0.045	9.15	1875	3.41			

Project: Lower Booker Creek Subwatershed Study
Prepared by: EVH
Checked by: TLM
Date: 3/31/2016 (Revised 12/12/2016)

Time of Concentration - Booker Creek Watershed

Sub-basin	Sheet Flow						Shallow Concentration					Channel Flow									Lag	Validation
	Description	n	Flow Length (ft)	P-2 (in)	Land Slope (ft/ft)	Tt (min)	Surface Description 0--Unpaved/1-Paved	Flow Length (ft)	Slope (ft/ft)	Velocity (ft/s)	Tt (min)	Channel Area (ft2)	Channel Perimeter (ft)	Hydraulic Radius (ft)	Slope (ft/ft)	n	Velocity (ft/s)	Flow Length (ft)	Tt (min)	Tc (min)	(min)	(min)
CEDAR FORK																						
CF-10	Grass	0.24	300	3.58	0.053	21.95	0	197	0.030	2.82	1.17	Pipe			0.008	0.013	5.00	711	2.37	27.81	16.69	
												16.5	10.7	1.54	0.019	0.045	6.08	849	2.33			
CF-20	Woods	0.40	300	3.58	0.027	43.58	0	177	0.023	2.43	1.22	8	7.7	1.04	0.030	0.04	6.62	934	2.35	49.29	29.57	59.15
												16.5	10.7	1.54	0.020	0.045	6.25	803	2.14			
CF-30	Woods	0.40	300	3.58	0.030	41.57	0	458	0.035	3.02	2.53	16.5	10.7	1.54	0.031	0.045	7.75	881	1.90	46.00	27.60	41.40
CF-40	Woods	0.40	300	3.58	0.027	43.58	0	591	0.024	2.48	3.97	16.5	10.7	1.54	0.023	0.045	6.76	1844	4.55	52.09	31.25	46.88
CF-50	Grass	0.24	203	3.58	0.010	31.55	0	385	0.052	3.68	1.74	16.5	10.7	1.54	0.014	0.04	5.99	276	0.77	34.07	20.44	
CF-60	Woods	0.40	300	3.58	0.043	35.89	0	562	0.041	3.26	2.87	16.5	10.7	1.54	0.015	0.045	5.42	2404	7.40	46.15	27.69	55.38
CF-70	Woods	0.40	300	3.58	0.020	48.89	0	596	0.062	4.02	2.47	16.5	10.7	1.54	0.020	0.045	6.23	1917	5.13	56.49	33.89	67.79
CF-80	Woods	0.40	300	3.58	0.027	43.58	0	446	0.058	3.90	1.91	16.5	10.7	1.54	0.028	0.04	8.32	1288	2.58	49.50	29.70	
												108.5	27.7	3.92	0.007	0.045	6.82	588	1.44			
CF-90	Woods	0.40	300	3.58	0.077	28.56	0	383	0.133	5.89	1.08	8	7.7	1.04	0.037	0.04	7.33	136	0.31	36.29	21.77	43.55
												16.5	10.7	1.54	0.047	0.045	9.64	3664	6.33			
CF-100	Woods	0.40	300	3.58	0.100	25.68	0	570	0.154	6.34	1.50	8	7.7	1.04	0.046	0.04	8.23	474	0.96	30.05	18.03	13.52
												16.5	10.7	1.54	0.011	0.045	4.68	537	1.91			
CF-110	Woods	0.40	300	3.58	0.043	35.89	0	126	0.095	4.98	0.42	8	7.7	1.04	0.043	0.04	7.92	1071	2.25	38.56	23.14	
CF-120	Woods	0.40	300	3.58	0.077	28.56	0	222	0.045	3.42	1.08	8	7.7	1.04	0.063	0.04	9.60	887	1.54	34.60	20.76	
												16.5	10.7	1.54	0.022	0.045	6.60	1351	3.41			
CF-130	Woods	0.40	300	3.58	0.060	31.51	0	325	0.037	3.10	1.75	8	7.7	1.04	0.051	0.04	8.60	711	1.38	35.90	21.54	43.08
												16.5	10.7	1.54	0.046	0.045	9.48	720	1.27			
CF-140	Woods	0.40	300	3.58	0.140	22.45	0	592	0.068	4.19	2.35	8	7.7	1.04	0.029	0.04	6.49	971	2.49	46.67	28.00	
												108.5	27.7	3.92	0.001	0.045	2.27	2643	19.37			
CF-150	Woods	0.40	256	3.58	0.109	21.83	0	249	0.064	4.09	1.01	8	7.7	1.04	0.046	0.04	8.23	1079	2.19	26.77	16.06	
												108.5	27.7	3.92	0.009	0.045	8.05	843	1.74			

Project: Lower Booker Creek Subwatershed Study
Prepared by: EVH
Checked by: TLM
Date: 3/31/2016 (Revised 12/12/2016)

Time of Concentration - Booker Creek Watershed

Sub-basin	Sheet Flow						Shallow Concentration					Channel Flow									Lag	Validation
	Description	n	Flow Length (ft)	P-2 (in)	Land Slope (ft/ft)	Tt (min)	Surface Description 0--Unpaved/1-Paved	Flow Length (ft)	Slope (ft/ft)	Velocity (ft/s)	Tt (min)	Channel Area (ft2)	Channel Perimeter (ft)	Hydraulic Radius (ft)	Slope (ft/ft)	n	Velocity (ft/s)	Flow Length (ft)	Tt (min)	Tc (min)	(min)	(min)
EASTWOOD LAKE																						
EL-10	Grass	0.40	300	3.58	0.027	43.58	0	321	0.012	1.80	2.97	Pipe			0.030	0.013	5.00	1456	4.85	54.29	32.57	16.29
												16.5	10.7	1.54	0.026	0.045	7.12	1235	2.89			
EL-20	Grass	0.24	300	3.58	0.043	23.85	0	338	0.071	4.30	1.31	8	7.7	1.04	0.048	0.04	8.35	1466	2.93	30.66	18.40	13.80
												108.5	27.7	3.92	0.006	0.045	6.42	994	2.58			
EL-30	Grass	0.24	300	3.58	0.047	23.15	0	577	0.087	4.75	2.02	Pipe			0.094	0.013	5.00	278	0.93	28.93	17.36	
												16.5	10.7	1.54	0.019	0.045	6.14	1040	2.82			
EL-40	Woods	0.40	300	3.58	0.107	25.03	0	486	0.175	6.75	1.20	16.5	10.7	1.54	0.036	0.04	9.45	1305	2.30	28.53	17.12	
EL-50	Woods	0.40	300	3.58	0.140	22.45	0	57	0.175	6.76	0.14	16.5	10.7	1.54	0.030	0.04	8.63	2462	4.75	27.34	16.41	
EL-60	Woods	0.40	300	3.58	0.040	37.05	1	101	0.158	8.09	0.21	16.5	10.7	1.54	0.036	0.04	9.49	1760	3.09	40.35	24.21	
EL-70	Woods	0.40	300	3.58	0.043	35.89	0	275	0.065	4.13	1.11	16.5	10.7	1.54	0.037	0.04	9.56	1627	2.84	39.83	23.90	
EL-80	Woods	0.40	300	3.58	0.113	24.43	0	462	0.100	5.09	1.51	16.5	10.7	1.54	0.034	0.04	9.22	1166	2.11	28.05	16.83	
EL-90	Woods	0.40	300	3.58	0.103	25.35	0	350	0.123	5.66	1.03	16.5	10.7	1.54	0.038	0.04	9.69	2111	3.63	30.01	18.01	
EL-100	Woods	0.40	300	3.58	0.113	24.43	1	469	0.051	4.60	1.70	16.5	10.7	1.54	0.039	0.04	9.81	1133	1.92	28.05	16.83	25.25

Project: Lower Booker Creek Subwatershed Study
Prepared by: EVH
Checked by: TLM
Date: 3/31/2016 (Revised 12/12/2016)

Time of Concentration - Booker Creek Watershed

Sub-basin	Sheet Flow						Shallow Concentration					Channel Flow									Lag	Validation
	Description	n	Flow Length (ft)	P-2 (in)	Land Slope (ft/ft)	Tt (min)	Surface Description 0--Unpaved/1-Paved	Flow Length (ft)	Slope (ft/ft)	Velocity (ft/s)	Tt (min)	Channel Area (ft2)	Channel Perimeter (ft)	Hydraulic Radius (ft)	Slope (ft/ft)	n	Velocity (ft/s)	Flow Length (ft)	Tt (min)	Tc (min)	(min)	(min)
LOWER BOOKER CREEK																						
LBC-10	Woods	0.40	300	3.58	0.027	43.58	0	448	0.067	4.18	1.79	Pipe			0.171	0.013	5.00	490	1.63	48.74	29.25	
												16.5	10.7	1.54	0.042	0.045	9.08	950	1.74			
LBC-20	Woods	0.40	300	3.58	0.033	39.86	0	377	0.082	4.63	1.36	Pipe			0.050	0.013	5.00	382	1.27	44.40	26.64	
												16.5	10.7	1.54	0.016	0.045	5.55	637	1.91			
LBC-30	Woods	0.40	300	3.58	0.100	25.68	0	590	0.037	3.12	3.16	Pipe			0.014	0.013	5.00	1867	6.22	36.77	22.06	66.19
												16.5	10.7	1.54	0.040	0.045	8.82	906	1.71			
LBC-40	Woods	0.40	300	3.58	0.063	30.83	0	440	0.059	3.92	1.87	16.5	10.7	1.54	0.016	0.045	5.64	985	2.91	38.22	22.93	17.20
												Pipe			0.008	0.013	5.00	385	1.28			
												108.5	27.7	3.92	0.012	0.045	9.19	728	1.32			
LBC-50	Woods	0.40	300	3.58	0.127	23.37	0	143	0.210	7.39	0.32	108.5	27.7	3.92	0.013	0.045	9.27	1112	2.00	25.69	15.41	
LBC-60	Woods	0.40	300	3.58	0.103	25.35	0	239	0.167	6.60	0.60	8	7.7	1.04	0.064	0.045	8.60	859	1.67	32.65	19.59	
												108.5	27.7	3.92	0.003	0.045	4.49	1355	5.03			
LBC-70	Woods	0.40	300	3.58	0.107	25.03	0	187	0.246	8.00	0.39	16.5	10.7	1.54	0.048	0.045	9.74	1960	3.35	28.77	17.26	
LBC-80	Woods	0.40	300	3.58	0.067	30.21	0	196	0.087	4.75	0.69	8	7.7	1.04	0.021	0.04	5.51	674	2.04	32.93	19.76	39.52
LBC-90	Woods	0.40	259	3.58	0.046	31.06	1	204	0.039	4.03	0.84	Pipe			0.015	0.013	5.00	1306	4.35	38.24	22.95	57.37
												8	7.7	1.04	0.015	0.04	4.61	549	1.98			
LBC-100	Woods	0.40	243	3.58	0.029	35.70	1	614	0.008	1.83	5.58	8	7.7	1.04	0.029	0.04	6.54	1263	3.22	44.49	26.70	53.40
LBC-110	Woods	0.40	200	3.58	0.015	39.66	1	283	0.011	2.09	2.25	Pipe			0.039	0.013	5.00	563	1.88	45.27	27.16	54.32
												8	7.7	1.04	0.008	0.045	2.96	263	1.48			
LBC-120	Woods	0.40	300	3.58	0.030	41.57	1	225	0.027	3.32	1.13	16.5	10.7	1.54	0.009	0.045	4.10	1168	4.75	47.46	28.47	56.95
LBC-130	Woods	0.40	300	3.58	0.013	57.50	0	427	0.019	2.21	3.22	108.5	27.7	3.92	0.003	0.045	4.50	676	2.51	63.23	37.94	
LBC-140	Woods	0.40	300	3.58	0.027	43.58	0	259	0.039	3.17	1.36	16.5	10.7	1.54	0.015	0.045	5.33	1379	4.31	53.58	32.15	
												108.5	27.7	3.92	0.003	0.045	4.72	1226	4.33			
LBC-150	Woods	0.40	300	3.58	0.027	43.58	0	261	0.169	6.62	0.66	8	7.7	1.04	0.048	0.045	7.42	692	1.55	53.03	31.82	
												Pipe			0.022	0.013	5.00	1856	6.19			
												108.5	27.7	3.92	0.013	0.045	9.52	603	1.06			
LBC-160	Woods	0.40	300	3.58	0.027	43.58	0	355	0.051	3.63	1.63	Pipe			0.019	0.013	5.00	1261	4.20	50.27	30.16	
												108.5	27.7	3.92	0.013	0.045	9.26	478	0.86			
LBC-170	Woods	0.40	190	3.58	0.032	28.26	0	122	0.082	4.62	0.44	108.5	27.7	3.92	0.013	0.045	9.49	835	1.47	30.17	18.10	
LBC-180	Woods	0.40	300	3.58	0.070	29.62	0	318	0.057	3.84	1.38	108.5	27.7	3.92	0.011	0.045	8.55	2427	4.73	35.73	21.44	
LBC-190	Grass	0.24	300	3.58	0.007	50.42	0	403	0.010	1.61	4.18	108.5	27.7	3.92	0.013	0.045	9.47	990	1.74	56.34	33.80	
LBC-200	Woods	0.40	300	3.58	0.007	75.87	0	388	0.028	2.72	2.38	108.5	27.7	3.92	0.004	0.045	5.33	2164	6.77	85.02	51.01	

Appendix G:

Preliminary Opinion of Probable Construction Costs

List of Contents:

1. Unit Cost Table

2. Flood Control Projects

Unit Costs - Eastwood Lake Subwatershed Plan

	Item Description	*Unit*	*Unit Price*
1	Mobilization (10%)	LS	
2	Comprehensive Grading (20%)	LS	
3	Excavation	CY	$ 25.00
4	Hauling	CY	$ 4.00
5	Clearing & Grubbing	AC	$ 20,000.00
6	Channel Grading including seeding	SY	$ 15.00
7	Construction Staking (0-300000)	LS	$ 3,000.00
8	Construction Staking (300000-800000)	LS	$ 6,000.00
9	Construction Staking (Greater than 800000)	LS	$ 10,000.00
10	Select Material	CY	$ 25.00
11	Flowable Fill	CY	$ 500.00
12	8" Perforated PVC Underdrain	LF	$ 10.00
13	8" PVC Pipe, SDR 35	LF	$ 10.00
14	15" PVC Pipe, SDR 35	LF	$ 18.00
15	18" PVC Pipe, SDR 35	LF	$ 25.00
16	24" PVC Pipe, SDR 35	LF	$ 28.00
17	12" R.C. Pipe Culvert, Class III	LF	$ 70.00
18	15" R.C. Pipe Culvert, Class III	LF	$ 80.00
19	18" R.C. Pipe Culvert, Class III	LF	$ 90.00
20	18" R.C. Pipe Culvert, Class IV	LF	$ 100.00
21	24" R.C. Pipe Culvert, Class III	LF	$ 110.00
22	24" R.C. Pipe Culvert, Class IV	LF	$ 120.00
23	30" R.C. Pipe Culvert, Class III	LF	$ 130.00
24	30" R.C. Pipe Culvert, Class IV, 0' - 6' depth	LF	$ 140.00
25	36" R.C. Pipe Culvert, Class III	LF	$ 150.00
26	36" R.C. Pipe Culvert, Class IV	LF	$ 160.00
27	36" Steel Pipe Culvert (Tunnel Installation)	LF	$ 800.00
28	42" R.C. Pipe Culvert, Class III	LF	$ 180.00
29	42" R.C. Pipe Culvert, Class IV	LF	$ 190.00
30	48" R.C. Pipe Culvert, Class III	LF	$ 210.00
31	48" R.C. Pipe Culvert, Class IV	LF	$ 220.00
32	48" Steel Pipe Culvert (Tunnel Installation)	LF	$ 1,100.00
33	54" R.C. Pipe Culvert, Class III	LF	$ 240.00
34	60" R.C. Pipe Culvert, Class III	LF	$ 260.00
35	60" Steel Pipe Culvert (Tunnel Installation)	LF	$ 1,500.00
36	66" R.C. Pipe Culverts, Class III	LF	$ 280.00
37	72" R.C. Pipe Culvert, Class III	LF	$ 320.00
38	72" R.C. Pipe Culvert, Class IV	LF	$ 370.00
39	72" Steel Pipe Culvert (Tunnel Installation)	LF	$ 1,800.00
40	78" R.C. Pipe Culvert, Class III	LF	$ 350.00
41	4' x 4' Precast R.C. Box Culvert	LF	$ 600.00
42	5' x 3' Precast R.C. Box Culvert	LF	$ 650.00
43	5' x 4' Precast R.C. Box Culvert	LF	$ 700.00
44	6' x 3' Precast R.C. Box Culvert	LF	$ 800.00
45	6' x 4' Precast R.C. Box Culvert	LF	$ 850.00
46	6' x 5' Precast R.C. Box Culvert	LF	$ 900.00
47	6' x 6' Precast R.C. Box Culvert	LF	$ 950.00
48	7' x 5' Precast R.C. Box Culvert	LF	$ 950.00
49	7' x 6' Precast R.C. Box Culvert	LF	$ 1,100.00
50	7' x 7' Reinforced Concrete Box Culvert	LF	$ 1,400.00
51	8’ x 4’ Precast R.C. Box Culvert	LF	$ 900.00
52	8’ x 5’ Precast R.C. Box Culvert	LF	$ 1,000.00
53	8' X 6' Reinforced Concrete Box Culvert	LF	$ 1,400.00
54	9' x 5' Precast R.C. Box Culvert	LF	$ 1,300.00
55	9' X 6' Reinforced Concrete Box Culvert	LF	$ 1,500.00
56	10 x 5' Precast R.C. Box Culvert	LF	$ 1,500.00
57	11' x 6' Precast R.C. Box Culvert	LF	$ 1,800.00
58	11’ x 7’ Precast R.C. Box Culvert	LF	$ 2,000.00
59	Drainage Structures, Manhole	EA	$ 5,000.00
60	Drainage Structures, Inlet	EA	$ 3,500.00
61	Drainage Structures, DOT Standard Endwall	EA	$ 6,000.00
62	Drainage Structures, Box Culvert Custom Endwall	EA	$ 20,000.00
63	BMP Outlet Structure	EA	$ 6,000.00
64	Convert Yard Inlet to Junction Box	EA	$ 1,500.00
65	Curb Cut	EA	$ 400.00
66	Flared End Section, 18 inch	EA	$ 1,000.00
67	Flared End Section, 36 inch	EA	$ 2,500.00
68	Flared End Section, 42 inch	EA	$ 2,500.00
69	Flared End Section, 48 inch	EA	$ 3,000.00
70	Custom Junction Box	EA	$ 15,000.00
71	Concrete Curb and Gutter	LF	$ 35.00
72	6" Concrete Driveway Replacement	EA	$ 1,500.00
73	4" Concrete Sidewalk	LF	$ 40.00
74	Concrete Pipe Plug	EA	$ 450.00

	Item Description	*Unit*	*Unit Price*
75	Asphalt Milling/Overlay	SY	$ 30.00
76	Asphalt Replacement (Surface, Base Course, & Milling)	SY	$ 70.00
77	ABC Stone	TN	$ 35.00
78	Rip Rap Stone, Class B	TN	$ 65.00
79	Rip Rap Stone, Class 1	TN	$ 70.00
80	Rip Rap Stone, Class A	TN	$ 65.00
81	#5 stone	TN	$ 50.00
82	#57 stone	TN	$ 65.00
83	Gravel Walkway #78 stone	TN	$ 65.00
84	Stone Boulder	TN	$ 200.00
85	Sand 2S	CY	$ 60.00
86	Rock Grade Control	EA	$ 10,000.00
87	Traffic Control (Single 2-lane road)	LS	$ 15,000.00
88	Traffic Control (4+ lane road or multiple 2-lane roads)	LS	$ 30,000.00
89	Erosion Control (1-2 acre LOD)	LS	$ 15,000.00
90	Erosion Control (2-5 acre LOD)	LS	$ 30,000.00
91	Erosion Control (Greater than 5 acre LOD)	LS	$ 50,000.00
92	Erosion Control Matting	SY	$ 10.00
93	Fence Removal / Replacement	LF	$ 50.00
94	4' Personnel Gates	EA	$ 375.00
95	20' Roadway Gates	EA	$ 400.00
96	Soil Media	CY	$ 50.00
97	BMP Plantings	SF	$ 2.00
98	Riparian Seed Mix	SY	$ 1.50
99	Live Staking	SY	$ 15.00
100	Seeding and Mulching	AC	$ 7,500.00
101	Wood Retaining Wall (4' high)	LF	$ 100.00
102	Log Grade Control Structure	EA	$ 2,000.00
103	Gabion Wall	LF	$ 300.00
104	Foundation Protection	EA	$ 15,000.00
105	Utility Relocations (Minor Water line adjustments)	LS	$ 15,000.00
106	Utility Relocations (Substantial Water line adjustements including)	LS	$ 3,000.00
107	Utility Relocations (Substantial sanitary sewer and water line adjustments)	LS	$ 50,000.00
108	Buffer Plantings	SY	$ 4.00
109	PICP (Permeable Pavers), 3.5" thick	SF	$ 20.00
110	Hauling	CY	$ 45.00
111	Cascade Boulder	TN	$ 75.00
112	Cobble	TN	$ 75.00

Shady Lawn System

Item Number	*Item Description*	*Quantities*	*Unit*	*Unit Price*	*Amount*
1	Mobilization (10%)	1	LS	$ 8,200.00	$ 8,200.00
2	Comprehensive Grading (20%)*	1	LS	$ 13,800.00	$ 13,800.00
3	Construction Staking (0-300000)	1	LS	$ 3,000.00	$ 3,000.00
4	Select Material	71	CY	$ 25.00	$ 1,780.00
5	18" R.C. Pipe Culvert, Class III	143	LF	$ 90.00	$ 12,870.00
6	Drainage Structures, Inlet	2	EA	$ 3,500.00	$ 7,000.00
7	Flared End Section, 18 inch	2	EA	$ 1,000.00	$ 2,000.00
8	Asphalt Replacement (Surface, Base Course, & Milling)	86	SY	$ 70.00	$ 5,990.00
9	Concrete Curb and Gutter	30	LF	$ 35.00	$ 1,050.00
10	Traffic Control (Single 2-lane road)	1	LS	$ 15,000.00	$ 15,000.00
11	Erosion Control (1-2 acre LOD)	1	LS	$ 5,000.00	$ 5,000.00
12	Utility Relocations (Minor Water line adjustments)	1	LS	$ 15,000.00	$ 15,000.00
				Subtotal	$ 90,700.00
				30% Contingency	$27,200.00
				Total	**$ 117,900.00**
				Design, Administration, Fiscal and Legal (30% of Construction Costs)	35,400.00
				Total Opinion of Project Cost	**$ 153,300.00**

* Cost for comprehensive grading includes roadway excavation, saw cutting, compaction of select material, geotechnical recommendations, home owner coordination, tree and structure protection, structure removal and disposal, shoring, and culvert excavation.

** Cost for utility conflicts includes all utilities that need to be moved including sanitary sewer and potable water lines. Additional survey may be required to locate pressurized utilities.

The Engineer's opinions of probable construction costs are made on the basis of the Engineer's experience and qualifications and represent the Engineer's best judgment as a professional generally familiar with the construction industry. Since the Engineer has no control over the cost of labor, materials, equipment, or services furnished by others; over the contractors methods of determining prices; or over competitive bidding or marketing conditions, the Engineer's cannot and does not guarantee that proposal, bids or actual construction costs will not vary from opinions of probable construction costs prepared by the Engineer.

Arlington Street #1 System

Item Number	*Item Description*	*Quantities*	*Unit*	*Unit Price*	*Amount*
1	Mobilization (10%)	1	LS	$ 5,600.00	$ 5,600.00
2	Comprehensive Grading (20%)*	1	LS	$ 9,400.00	$ 9,400.00
3	Construction Staking (0-300000)	1	LS	$ 3,000.00	$ 3,000.00
4	Select Material	81	CY	$ 25.00	$ 2,040.00
5	Channel Grading including seeding	367	SY	$ 15.00	$ 5,500.00
6	24" R.C. Pipe Culvert, Class III	22	LF	$ 110.00	$ 2,420.00
7	Drainage Structures, Inlet	2	EA	$ 3,500.00	$ 7,000.00
8	Asphalt Replacement (Surface, Base Course, & Milling)	27	SY	$ 70.00	$ 1,880.00
9	Traffic Control (Single 2-lane road)	1	LS	$ 5,000.00	$ 5,000.00
10	Erosion Control (1-2 acre LOD)	1	LS	$ 5,000.00	$ 5,000.00
11	Utility Relocations (Minor Water line adjustments)	1	LS	$ 15,000.00	$ 15,000.00
				Subtotal	$ 61,800.00
				30% Contingency	$18,500.00
				Total	**$ 80,300.00**
				Design, Administration, Fiscal and Legal (30% of Construction Costs)	24,100.00
				Total Opinion of Project Cost	**$ 104,400.00**

* Cost for comprehensive grading includes roadway excavation, saw cutting, compaction of select material, geotechnical recommendations, home owner coordination, tree and structure protection, structure removal and disposal, shoring, and culvert excavation.

** Cost for utility conflicts includes all utilities that need to be moved including sanitary sewer and potable water lines. Additional survey may be required to locate pressurized utilities.

The Engineer's opinions of probable construction costs are made on the basis of the Engineer's experience and qualifications and represent the Engineer's best judgment as a professional generally familiar with the construction industry. Since the Engineer has no control over the cost of labor, materials, equipment, or services furnished by others; over the contractors methods of determining prices; or over competitive bidding or marketing conditions, the Engineer's cannot and does not guarantee that proposal, bids or actual construction costs will not vary from opinions of probable construction costs prepared by the Engineer.

Arlington Street #2 System

Item Number	*Item Description*	*Quantities*	*Unit*	*Unit Price*	*Amount*
1	Mobilization (10%)	1	LS	$ 7,200.00	$ 7,200.00
2	Comprehensive Grading (20%)*	1	LS	$ 12,000.00	$ 12,000.00
3	Construction Staking (0-300000)	1	LS	$ 3,000.00	$ 3,000.00
4	Select Material	63	CY	$ 25.00	$ 1,590.00
5	24" R.C. Pipe Culvert, Class III	102	LF	$ 110.00	$ 11,220.00
6	Drainage Structures, Inlet	1	EA	$ 3,500.00	$ 3,500.00
7	Asphalt Replacement (Surface, Base Course, & Milling)	61	SY	$ 70.00	$ 4,270.00
8	Concrete Curb and Gutter	30	LF	$ 35.00	$ 1,050.00
9	Traffic Control (Single 2-lane road)	1	LS	$ 15,000.00	$ 15,000.00
10	Erosion Control (1-2 acre LOD)	1	LS	$ 5,000.00	$ 5,000.00
11	Utility Relocations (Minor Water line adjustments)	1	LS	$ 15,000.00	$ 15,000.00
				Subtotal	$ 78,800.00
				30% Contingency	$23,600.00
				Total	**$ 102,400.00**
				Design, Administration, Fiscal and Legal (30% of Construction Costs)	30,700.00
				Total Opinion of Project Cost	**$ 133,100.00**

* Cost for comprehensive grading includes roadway excavation, saw cutting, compaction of select material, geotechnical recommendations, home owner coordination, tree and structure protection, structure removal and disposal, shoring, and culvert excavation.

** Cost for utility conflicts includes all utilities that need to be moved including sanitary sewer and potable water lines. Additional survey may be required to locate pressurized utilities.

The Engineer's opinions of probable construction costs are made on the basis of the Engineer's experience and qualifications and represent the Engineer's best judgment as a professional generally familiar with the construction industry. Since the Engineer has no control over the cost of labor, materials, equipment, or services furnished by others; over the contractors methods of determining prices; or over competitive bidding or marketing conditions, the Engineer's cannot and does not guarantee that proposal, bids or actual construction costs will not vary from opinions of probable construction costs prepared by the Engineer.

South Lakeshore Drive/Ridgecrest Drive System

Item Number	*Item Description*	*Quantities*	*Unit*	*Unit Price*	*Amount*
1	Mobilization (10%)	1	LS	$ 6,700.00	$ 6,700.00
2	Comprehensive Grading (20%)*	1	LS	$ 11,200.00	$ 11,200.00
3	Construction Staking (0-300000)	1	LS	$ 3,000.00	$ 3,000.00
4	Select Material	63	CY	$ 25.00	$ 1,580.00
5	18" R.C. Pipe Culvert, Class III	127	LF	$ 90.00	$ 11,430.00
6	Asphalt Replacement (Surface, Base Course, & Milling)	74	SY	$ 70.00	$ 5,190.00
7	Traffic Control (Single 2-lane road)	1	LS	$ 15,000.00	$ 15,000.00
8	Erosion Control (1-2 acre LOD)	1	LS	$ 5,000.00	$ 5,000.00
9	Utility Relocations (Minor Water line adjustments)	1	LS	$ 15,000.00	$ 15,000.00
				Subtotal	$ 74,100.00
				30% Contingency	$22,200.00
				Total	**$ 96,300.00**
				Design, Administration, Fiscal and Legal (30% of Construction Costs)	28,900.00
				Total Opinion of Project Cost	**$ 125,200.00**

* Cost for comprehensive grading includes roadway excavation, saw cutting, compaction of select material, geotechnical recommendations, home owner coordination, tree and structure protection, structure removal and disposal, shoring, and culvert excavation.

** Cost for utility conflicts includes all utilities that need to be moved including sanitary sewer and potable water lines. Additional survey may be required to locate pressurized utilities.

The Engineer's opinions of probable construction costs are made on the basis of the Engineer's experience and qualifications and represent the Engineer's best judgment as a professional generally familiar with the construction industry. Since the Engineer has no control over the cost of labor, materials, equipment, or services furnished by others; over the contractors methods of determining prices; or over competitive bidding or marketing conditions, the Engineer's cannot and does not guarantee that proposal, bids or actual construction costs will not vary from opinions of probable construction costs prepared by the Engineer.

South Lakeshore Drive/Rolling Road Closed System

Item Number	*Item Description*	*Quantities*	*Unit*	*Unit Price*	*Amount*
1	Mobilization (10%)	1	LS	$ 11,700.00	$ 11,700.00
2	Comprehensive Grading (20%)*	1	LS	$ 19,400.00	$ 19,400.00
3	Construction Staking (0-300000)	1	LS	$ 3,000.00	$ 3,000.00
4	Select Material	128	CY	$ 25.00	$ 3,200.00
5	36" R.C. Pipe Culvert, Class III	74	LF	$ 150.00	$ 11,100.00
6	48" R.C. Pipe Culvert, Class III	49	LF	$ 210.00	$ 10,290.00
7	Drainage Structures, DOT Standard Endwall	4	EA	$ 6,000.00	$ 24,000.00
8	Asphalt Replacement (Surface, Base Course, & Milling)	101	SY	$ 70.00	$ 7,080.00
9	Drainage Structures, Inlet	1	EA	$ 3,500.00	$ 3,500.00
10	Traffic Control (Single 2-lane road)	1	LS	$ 15,000.00	$ 15,000.00
11	Erosion Control (1-2 acre LOD)	1	LS	$ 5,000.00	$ 5,000.00
12	Utility Relocations (Minor Water line adjustments)	1	LS	$ 15,000.00	$ 15,000.00
				Subtotal	$ 128,300.00
				30% Contingency	$38,500.00
				Total	**$ 166,800.00**
				Design, Administration, Fiscal and Legal (30% of Construction Costs)	50,000.00
				Total Opinion of Project Cost	**$ 216,800.00**

* Cost for comprehensive grading includes roadway excavation, saw cutting, compaction of select material, geotechnical recommendations, home owner coordination, tree and structure protection, structure removal and disposal, shoring, and culvert excavation.

** Cost for utility conflicts includes all utilities that need to be moved including sanitary sewer and potable water lines. Additional survey may be required to locate pressurized utilities.

The Engineer's opinions of probable construction costs are made on the basis of the Engineer's experience and qualifications and represent the Engineer's best judgment as a professional generally familiar with the construction industry. Since the Engineer has no control over the cost of labor, materials, equipment, or services furnished by others; over the contractors methods of determining prices; or over competitive bidding or marketing conditions, the Engineer's cannot and does not guarantee that proposal, bids or actual construction costs will not vary from opinions of probable construction costs prepared by the Engineer.

Woodshire Lane/Huntington Drive System

Item Number	*Item Description*	*Quantities*	*Unit*	*Unit Price*	*Amount*
1	Mobilization (10%)	1	LS	$ 20,000.00	$ 20,000.00
2	Comprehensive Grading (20%)*	1	LS	$ 33,400.00	$ 33,400.00
3	Construction Staking (0-300000)	1	LS	$ 3,000.00	$ 3,000.00
4	Select Material	105	CY	$ 25.00	$ 2,610.00
5	30" R.C. Pipe Culvert, Class III	52	LF	$ 130.00	$ 6,760.00
6	4' x 5' Precast R.C. Box Culvert	84	LF	$ 700.00	$ 58,800.00
7	Drainage Structures, Box Culvert Custom Endwall	2	EA	$ 20,000.00	$ 40,000.00
8	Drainage Structures, DOT Standard Endwall	2	EA	$ 6,000.00	$ 12,000.00
9	Asphalt Replacement (Surface, Base Course, & Milling)	75	SY	$ 70.00	$ 5,230.00
10	Drainage Structures, Inlet	1	EA	$ 3,500.00	$ 3,500.00
11	Traffic Control (Single 2-lane road)	1	LS	$ 15,000.00	$ 15,000.00
12	Erosion Control (1-2 acre LOD)	1	LS	$ 5,000.00	$ 5,000.00
13	Utility Relocations (Minor Water line adjustments)	1	LS	$ 15,000.00	$ 15,000.00
				Subtotal	$ 220,300.00
				30% Contingency	$66,100.00
				Total	**$ 286,400.00**
				Design, Administration, Fiscal and Legal (30% of Construction Costs)	85,900.00
				Total Opinion of Project Cost	**$ 372,300.00**

* Cost for comprehensive grading includes roadway excavation, saw cutting, compaction of select material, geotechnical recommendations, home owner coordination, tree and structure protection, structure removal and disposal, shoring, and culvert excavation.

** Cost for utility conflicts includes all utilities that need to be moved including sanitary sewer and potable water lines. Additional survey may be required to locate pressurized utilities.

The Engineer's opinions of probable construction costs are made on the basis of the Engineer's experience and qualifications and represent the Engineer's best judgment as a professional generally familiar with the construction industry. Since the Engineer has no control over the cost of labor, materials, equipment, or services furnished by others; over the contractors methods of determining prices; or over competitive bidding or marketing conditions, the Engineer's cannot and does not guarantee that proposal, bids or actual construction costs will not vary from opinions of probable construction costs prepared by the Engineer.

Piney Mountain Road Improvements (With 3 Storage Areas)

Item Number	*Item Description*	*Quantities*	*Unit*	*Unit Price*	*Amount*
1	Mobilization (10%)	1	LS	$ 19,300.00	$ 19,300.00
2	Comprehensive Grading (20%)*	1	LS	$ 32,200.00	$ 32,200.00
3	Construction Staking (0-300000)	1	LS	$ 3,000.00	$ 3,000.00
4	Select Material	111	CY	$ 25.00	$ 2,780.00
5	7' x 5' Precast R.C. Box Culvert	65	LF	$ 950.00	$ 61,750.00
6	Asphalt Replacement (Surface, Base Course, & Milling)	116	SY	$ 70.00	$ 8,090.00
7	Drainage Structures, Box Culvert Custom Endwall	2	EA	$ 20,000.00	$ 40,000.00
8	Utility Relocations (Minor Water line adjustments)	1	LS	$ 15,000.00	$ 15,000.00
9	Erosion Control (1-2 acre LOD)	1	LS	$ 15,000.00	$ 15,000.00
10	Traffic Control (Single 2-lane road)	1	LS	$ 15,000.00	$ 15,000.00
				Subtotal	$ 197,100.00
				30% Contingency	$59,100.00
				Total	**$ 256,200.00**
				Design, Administration, Fiscal and Legal (30% of Construction Costs)	76,900.00
				Total Opinion of Project Cost	**$ 333,100.00**

* Cost for comprehensive grading includes roadway excavation, saw cutting, compaction of select material, geotechnical recommendations, home owner coordination, tree and structure protection, structure removal and disposal, shoring, and culvert excavation.

** Cost for utility conflicts includes all utilities that need to be moved including sanitary sewer and potable water lines. Additional survey may be required to locate pressurized utilities.

The Engineer's opinions of probable construction costs are made on the basis of the Engineer's experience and qualifications and represent the Engineer's best judgment as a professional generally familiar with the construction industry. Since the Engineer has no control over the cost of labor, materials, equipment, or services furnished by others; over the contractors methods of determining prices; or over competitive bidding or marketing conditions, the Engineer's cannot and does not guarantee that proposal, bids or actual construction costs will not vary from opinions of probable construction costs prepared by the Engineer.

Piney Mountain Road Improvements (Without 3 Storage Areas)

Item Number	*Item Description*	*Quantities*	*Unit*	*Unit Price*	*Amount*
1	Mobilization (10%)	1	LS	$ 24,600.00	$ 24,600.00
2	Comprehensive Grading (20%)*	1	LS	$ 41,000.00	$ 41,000.00
3	Clearing & Grubbing	0.5	AC	$ 20,000.00	$ 10,000.00
4	Construction Staking (300000-800000)	1	LS	$ 6,000.00	$ 6,000.00
5	Select Material	165	CY	$ 25.00	$ 4,130.00
6	10' x 6' Precast R.C. Box Culvert	65	LF	$ 1,300.00	$ 84,500.00
7	Asphalt Replacement (Surface, Base Course, & Milling)	116	SY	$ 70.00	$ 8,090.00
8	Drainage Structures, Box Culvert Custom Endwall	2	EA	$ 20,000.00	$ 40,000.00
9	Utility Relocations (Minor Water line adjustments)	1	LS	$ 15,000.00	$ 15,000.00
10	Erosion Control (1-2 acre LOD)	1	LS	$ 15,000.00	$ 15,000.00
11	Traffic Control (Single 2-lane road)	1	LS	$ 15,000.00	$ 15,000.00
12	Rip Rap Stone, Class 1	100	TN	$ 70.00	$ 7,000.00
				Subtotal	$ 270,300.00
				30% Contingency	$81,100.00
				Total	**$ 351,400.00**
				Design, Administration, Fiscal and Legal (30% of Construction Costs)	105,400.00
				Total Opinion of Project Cost	**$ 456,800.00**

* Cost for comprehensive grading includes roadway excavation, saw cutting, compaction of select material, geotechnical recommendations, home owner coordination, tree and structure protection, structure removal and disposal, shoring, and culvert excavation.

** Cost for utility conflicts includes all utilities that need to be moved including sanitary sewer and potable water lines. Additional survey may be required to locate pressurized utilities.

The Engineer's opinions of probable construction costs are made on the basis of the Engineer's experience and qualifications and represent the Engineer's best judgment as a professional generally familiar with the construction industry. Since the Engineer has no control over the cost of labor, materials, equipment, or services furnished by others; over the contractors methods of determining prices; or over competitive bidding or marketing conditions, the Engineer's cannot and does not guarantee that proposal, bids or actual construction costs will not vary from opinions of probable construction costs prepared by the Engineer.

Appendix H:

Hydraulic & Hydrologic Input and Output Data

List of Contents:

1. HEC-HMS Output (2-,10-,25-,50-, and 100-Year Storms)
    a. Existing Conditions
    b. Future Conditions
    c. Alternative

2. Existing Conditions HEC-RAS Output (2-,10-,25-,50-, and 100-Year Storms)

3. Future Conditions HEC-RAS Output (2-,10-,25-,50-, and 100-Year Storms)

4. Alternative HEC-RAS Output (2-,10-,25-,50-, and 100-Year Storms)

5. Existing Conditions Hydraflow Storm Sewers (10-Year)
    a. Rock Creek Road Closed System

6. Existing Conditions SWMM Output (10-Year)
    a. Shady Lawn Road System
    b. Arlington Street #1 System
    c. Arlington Street #2 System
    d. South Lakeshore Drive/Ridgecrest Drive System
    e. South Lakeshore Drive/Woodhaven Road System
    f. South Lakeshore Drive/Rolling Road System
    g. South Lakeshore Drive System
    h. Allard Road System
    i. Curtis Road System
    j. Woodshire Lane/Huntington Drive System

7. Alternative SWMM Output (10-Year)
    a. Shady Lawn Road System
    b. Arlington Street #1 System
    c. Arlington Street #2 System
    d. South Lakeshore Drive/Ridgecrest Drive System
    e. South Lakeshore Drive/Rolling Road System

EXISTING CONDITIONS:
HEC-HMS OUTPUT

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

2-YEAR EXISTING				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
BH-10	0.139076	29.8	01Jan2015, 12:45	6.9
BH-20	0.07669	29.9	01Jan2015, 12:25	5
ADD-BH-10-20	0.215766	56	01Jan2015, 12:35	11.9
Reach-BH-20	0.215766	55.8	01Jan2015, 12:40	11.9
BH-30	0.165073	49.1	01Jan2015, 12:55	11.4
ADD-BH-30	0.380839	102.6	01Jan2015, 12:45	23.3
BH-40	0.105607	77.4	01Jan2015, 12:10	8
ADD-BH-40	0.486446	126.5	01Jan2015, 12:35	31.4
Reach-BH-40	0.486446	126.3	01Jan2015, 12:40	31.4
BH-60	0.129437	38.7	01Jan2015, 12:50	8.6
BH-50	0.117491	46.8	01Jan2015, 12:20	6.4
Weaver Dairy Rd Ext	0.117491	46.8	01Jan2015, 12:20	6.4
Northern Park	0.246928	73.5	01Jan2015, 12:30	15.1
ADD-BH	0.733374	196.9	01Jan2015, 12:35	46.5
BH-70	0.062883	45.8	01Jan2015, 12:10	5.1
MLK Jr. Blvd	0.796257	225.2	01Jan2015, 12:25	51.6
BH-80	0.10254	48.5	01Jan2015, 12:30	8.1
Stateside Drive	0.10254	48.5	01Jan2015, 12:30	8.1
BH-90	0.094578	21.4	01Jan2015, 13:00	5.2
ADD-BH-90	0.197118	64.2	01Jan2015, 12:35	13.3
BH-100	0.110825	98.8	01Jan2015, 12:05	8
ADD-BH-100	1.1042	315.1	01Jan2015, 12:25	72.9
Reach-BH-100	1.1042	314	01Jan2015, 12:30	72.9
BH-110	0.117356	54.4	01Jan2015, 12:15	7
MLK Jr. - Kings Br	0.117356	54.4	01Jan2015, 12:15	7
BH-120	0.02747	4.7	01Jan2015, 13:10	1.3
ADD-BH-120	1.249026	363.4	01Jan2015, 12:20	81.3
BH-130	0.100527	51.6	01Jan2015, 12:30	8.4
Lake Ellen	1.349553	400.7	01Jan2015, 12:30	89.7
CB-10	0.144686	21.1	01Jan2015, 13:05	5.9
Reach-CB-10	0.144686	21.1	01Jan2015, 13:10	5.9
CB-20	0.112513	10.5	01Jan2015, 12:55	3
ADD-CB-20	0.257199	30.9	01Jan2015, 13:05	8.8
Reach-CB-20	0.257199	30.8	01Jan2015, 13:10	8.8
CB-40	0.051355	59.4	01Jan2015, 12:15	7.7
CB-30	0.026991	2.6	01Jan2015, 12:50	0.7
ADD-CB-30-40	0.335545	44.5	01Jan2015, 13:05	17.2
CB-50	0.072003	32.4	01Jan2015, 12:40	5.8
Municipal Drive	0.072003	32.4	01Jan2015, 12:40	5.8
CB-60	0.031973	34	01Jan2015, 11:55	1.9
ADD-CB-60	0.439521	75.6	01Jan2015, 12:50	24.9
Reach-CB-60	0.439521	75.1	01Jan2015, 12:55	24.9
CB-70	0.149895	40.4	01Jan2015, 13:00	10.1
ADD-CB-70	0.589416	115	01Jan2015, 13:00	35
Reach-CB-70	0.589416	113.5	01Jan2015, 13:15	35
CB-80	0.083068	33	01Jan2015, 12:25	5.1
ADD-CB-80	0.672484	125.1	01Jan2015, 13:10	40.1
Reach-CB-80	0.672484	124.6	01Jan2015, 13:20	40.1
ADD- CB-BH	2.022037	484.5	01Jan2015, 12:35	129.8
EL-20	0.137538	107.1	01Jan2015, 12:05	10.1
ADD-EL-20	2.159575	520.8	01Jan2015, 12:30	139.9
Reach-EL-20	2.159575	518.7	01Jan2015, 12:35	139.9
EL-10	0.138871	137.6	01Jan2015, 12:10	13.7
Piney Mountain Rd	0.138871	137.6	01Jan2015, 12:10	13.7
Piney Mountain Rd -Booker Ck	2.298446	575.8	01Jan2015, 12:30	153.6
EL-30	0.119754	56.2	01Jan2015, 12:10	6.6

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

2-YEAR EXISTING				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Reach- EL-30	2.4182	609.3	01Jan2015, 12:30	160.1
EL-50	0.11573	63.8	01Jan2015, 12:10	6.7
ADD-EL-50	2.53393	640.4	01Jan2015, 12:30	166.9
Reach-EL-50	2.53393	636.5	01Jan2015, 12:40	166.8
EL-40	0.074895	59.2	01Jan2015, 12:10	6
Kensington Drive	0.074895	59.2	01Jan2015, 12:10	6
N Lakeshore Dr - Booker Ck	2.608825	657	01Jan2015, 12:35	172.9
CF-10	0.078889	80.8	01Jan2015, 12:10	8.9
Kingston Drive	0.078889	80.8	01Jan2015, 12:10	8.9
CF-20	0.076885	28.2	01Jan2015, 12:55	6.6
ADD-CF-20	0.155774	89.6	01Jan2015, 12:10	15.6
Weaver Dairy - Cedar Fk	0.155774	89.6	01Jan2015, 12:10	15.6
CF-30	0.044849	10.8	01Jan2015, 12:40	2.2
ADD-CF-30	0.200623	93.6	01Jan2015, 12:10	17.8
Cross Creek Drive	0.200623	93.6	01Jan2015, 12:10	17.8
Reach-CF-50	0.200623	93.6	01Jan2015, 12:10	17.8
CF-40	0.092855	23.1	01Jan2015, 12:45	5
Weaver Dairy Rd - 1	0.092855	23.1	01Jan2015, 12:45	5
CF-50	0.029148	9.5	01Jan2015, 12:15	1.3
ADD-CF-50	0.322626	110.4	01Jan2015, 12:15	24.1
CF-60	0.12336	27.5	01Jan2015, 12:55	6.7
Cedar Hills Circle	0.445986	120.4	01Jan2015, 12:15	30.8
Reach-CF-80	0.445986	118.9	01Jan2015, 12:25	30.8
CF-80	0.176821	63.8	01Jan2015, 12:25	10
CF-70	0.120239	29.9	01Jan2015, 13:05	8.3
Weaver Dairy Rd -2	0.120239	29.9	01Jan2015, 13:05	8.3
Kenmore Road	0.743046	197.5	01Jan2015, 12:25	49.1
Reach-CF-130	0.743046	196.4	01Jan2015, 12:30	49.1
CF-90	0.184752	41.8	01Jan2015, 12:40	8.9
CF-100	0.085353	43.2	01Jan2015, 12:10	4.3
Piney Mountain Rd - Cedar Fk	0.085353	43.2	01Jan2015, 12:10	4.3
CF-110	0.044111	29.4	01Jan2015, 12:00	2.3
ADD-CF-110	0.129464	69.5	01Jan2015, 12:05	6.6
ADD-CF-90-120	0.314216	79.2	01Jan2015, 12:05	15.5
CF-120	0.096092	35.4	01Jan2015, 12:15	4.7
Brookview Drive	1.153354	282.3	01Jan2015, 12:30	69.2
Reach-CF-140	1.153354	282.2	01Jan2015, 12:30	69.2
CF-130	0.151403	43.7	01Jan2015, 12:40	8.5
CF-140	0.042477	13.2	01Jan2015, 12:25	2.1
North Lakeshore Drive	1.347234	335.2	01Jan2015, 12:30	79.9
CF-150	0.050842	22.5	01Jan2015, 12:10	2.5
ADD-CF-150	1.398076	346.4	01Jan2015, 12:30	82.4
EL-60	0.142028	53.5	01Jan2015, 12:20	7.6
EL-90	0.100143	67.3	01Jan2015, 12:10	7.1
EL-70	0.094086	50.4	01Jan2015, 12:20	6.4
EL-80	0.091741	23.4	01Jan2015, 13:05	6
EL-100	0.087147	82.4	01Jan2015, 12:20	10
Eastwood Lake	4.522046	676.7	01Jan2015, 13:35	292.1
LBC-10	0.097332	44	01Jan2015, 12:25	6.5
U/S Limit - Sierra	0.097332	42.6	01Jan2015, 12:30	6.5
LBC-20	0.084519	49	01Jan2015, 12:20	6.6
ADD-LBC-10-20	0.181851	89.5	01Jan2015, 12:25	13.1
Reach-LBC-20	0.181851	88.8	01Jan2015, 12:25	13.1
Honeysuckle Road	0.181851	88.8	01Jan2015, 12:25	13.1
Reach-LBC-30	0.181851	88	01Jan2015, 12:35	13.1
LBC-30	0.159799	66.7	01Jan2015, 13:00	16.2

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

2-YEAR EXISTING				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Booker Creek Road	0.34165	141.2	01Jan2015, 12:40	29.3
Reach-LBC-40	0.34165	135.3	01Jan2015, 12:50	29.2
LBC-40	0.156492	173.4	01Jan2015, 12:10	17.3
LBC-50	0.022218	0.3	01Jan2015, 12:05	0
ADD-LBC-40-50	5.042406	784.4	01Jan2015, 13:25	338.6
LBC-60	0.142061	94.4	01Jan2015, 12:15	10.7
ADD-LBC-60	5.184467	798	01Jan2015, 13:20	349.3
Reach-LBC-60	5.184467	795.8	01Jan2015, 13:30	349.1
LBC-70	0.107956	64.5	01Jan2015, 12:10	7
LBC-130	0.03607	25.7	01Jan2015, 12:30	4.2
ADD-LBC-70-130	5.328493	811.8	01Jan2015, 13:30	360.3
LBC-90	0.115064	65.1	01Jan2015, 12:50	14.3
LBC-80	0.06417	41.5	01Jan2015, 12:35	7
Fordham Blvd - Upstream	0.06417	41.5	01Jan2015, 12:35	7
LBC-100	0.029058	18.2	01Jan2015, 12:45	3.9
Dobbins Drive	0.208292	120.1	01Jan2015, 12:45	25.2
LBC-110	0.0333	17.5	01Jan2015, 12:50	3.7
Summerfield Crossing	0.241592	137.6	01Jan2015, 12:45	28.9
LBC-120	0.049799	25.5	01Jan2015, 12:50	5.6
Foxcroft Drive	0.291391	162.2	01Jan2015, 12:45	34.5
East Franklin Street	5.619884	862.1	01Jan2015, 13:45	394.8
LBC-140	0.088638	84.2	01Jan2015, 12:25	13
ADD-LBC-140	5.708522	875.8	01Jan2015, 13:45	407.8
Reach-LBC-140	5.708522	824.8	01Jan2015, 14:10	406.3
LBC-150	0.107836	65.1	01Jan2015, 12:25	10.2
ADD-LBC-150	5.816358	833.7	01Jan2015, 14:10	416.5
LBC-160	0.077625	67	01Jan2015, 12:20	10.1
Fordham Blvd - Downstream	5.893983	839.3	01Jan2015, 14:15	426.6
LBC-180	0.14221	152.3	01Jan2015, 12:15	17.9
LBC-170	0.027436	31.3	01Jan2015, 12:10	3.1
ADD-LBC-170-180	6.063629	853	01Jan2015, 14:15	447.6
Reach-LBC-190	6.063629	851.5	01Jan2015, 14:20	447.5
LBC-190	0.05069	32.8	01Jan2015, 12:25	4.9
Willow Drive	6.114319	855.9	01Jan2015, 14:20	452.4
Reach-LBC-200	6.114319	829.9	01Jan2015, 14:50	451.5
LBC-200	0.168071	74.7	01Jan2015, 12:45	15
ADD-LBC-200	6.28239	844.3	01Jan2015, 14:50	466.5
OUTLET	6.28239	844.3	01Jan2015, 14:50	466.5

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

10-YEAR EXISTING				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
BH-10	0.139076	74.3	01Jan2015, 12:45	15.1
BH-20	0.07669	65.9	01Jan2015, 12:25	10
ADD-BH-10-20	0.215766	131.8	01Jan2015, 12:35	25.1
Reach-BH-20	0.215766	131	01Jan2015, 12:40	25.1
BH-30	0.165073	105.9	01Jan2015, 12:50	22.8
ADD-BH-30	0.380839	231.5	01Jan2015, 12:45	47.9
BH-40	0.105607	158.7	01Jan2015, 12:10	15.6
ADD-BH-40	0.486446	281.8	01Jan2015, 12:35	63.5
Reach-BH-40	0.486446	281.1	01Jan2015, 12:40	63.5
BH-60	0.129437	84.3	01Jan2015, 12:50	17.4
BH-50	0.117491	112.5	01Jan2015, 12:20	14.1
Weaver Dairy Rd Ext	0.117491	112.5	01Jan2015, 12:20	14.1
Northern Park	0.246928	170.1	01Jan2015, 12:25	31.6
ADD-BH	0.733374	446.3	01Jan2015, 12:30	95.1
BH-70	0.062883	91.9	01Jan2015, 12:10	9.7
MLK Jr. Blvd	0.796257	495.8	01Jan2015, 12:30	104.8
BH-80	0.10254	98.5	01Jan2015, 12:30	15.4
Stateside Drive	0.10254	98.5	01Jan2015, 12:30	15.4
BH-90	0.094578	51.3	01Jan2015, 12:55	11.4
ADD-BH-90	0.197118	138.3	01Jan2015, 12:35	26.8
BH-100	0.110825	203.7	01Jan2015, 12:05	15.9
ADD-BH-100	1.1042	680.2	01Jan2015, 12:25	147.5
Reach-BH-100	1.1042	678.9	01Jan2015, 12:30	147.5
BH-110	0.117356	122.9	01Jan2015, 12:15	14.3
MLK Jr. - Kings Br	0.117356	122.9	01Jan2015, 12:15	14.3
BH-120	0.02747	12.1	01Jan2015, 13:05	3
ADD-BH-120	1.249026	782.8	01Jan2015, 12:20	164.8
BH-130	0.100527	102.6	01Jan2015, 12:30	16.1
Lake Ellen	1.349553	792.7	01Jan2015, 12:45	180.9
CB-10	0.144686	59.5	01Jan2015, 13:00	14.2
Reach-CB-10	0.144686	59.3	01Jan2015, 13:05	14.2
CB-20	0.112513	38.6	01Jan2015, 12:45	8.3
ADD-CB-20	0.257199	95	01Jan2015, 12:55	22.5
Reach-CB-20	0.257199	94.5	01Jan2015, 13:05	22.5
CB-40	0.051355	94.3	01Jan2015, 12:15	12
CB-30	0.026991	9.4	01Jan2015, 12:45	2
ADD-CB-30-40	0.335545	122.5	01Jan2015, 13:00	36.4
CB-50	0.072003	65.1	01Jan2015, 12:40	11.3
Municipal Drive	0.072003	65.1	01Jan2015, 12:40	11.3
CB-60	0.031973	76.1	01Jan2015, 11:55	4.1
ADD-CB-60	0.439521	187.5	01Jan2015, 12:45	51.9
Reach-CB-60	0.439521	186	01Jan2015, 12:55	51.8
CB-70	0.149895	88.1	01Jan2015, 13:00	20.5
ADD-CB-70	0.589416	273.5	01Jan2015, 12:55	72.3
Reach-CB-70	0.589416	268.1	01Jan2015, 13:15	72.2
CB-80	0.083068	74.5	01Jan2015, 12:25	10.5
ADD-CB-80	0.672484	289.5	01Jan2015, 13:15	82.7
Reach-CB-80	0.672484	288.3	01Jan2015, 13:25	82.7
ADD- CB-BH	2.022037	998.4	01Jan2015, 12:50	263.6
EL-20	0.137538	224.3	01Jan2015, 12:05	20
ADD-EL-20	2.159575	1034.8	01Jan2015, 12:50	283.6
Reach-EL-20	2.159575	1032.8	01Jan2015, 12:55	283.5
EL-10	0.138871	254.3	01Jan2015, 12:10	24.7
Piney Mountain Rd	0.138871	254.3	01Jan2015, 12:10	24.7
Piney Mountain Rd -Booker Ck	2.298446	1028	01Jan2015, 13:10	308.2
EL-30	0.119754	135.4	01Jan2015, 12:10	14

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

10-YEAR EXISTING				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Reach- EL-30	2.4182	1048.2	01Jan2015, 13:15	322.1
EL-50	0.11573	147.5	01Jan2015, 12:10	14.3
ADD-EL-50	2.53393	1067.1	01Jan2015, 13:10	336.4
Reach-EL-50	2.53393	1066	01Jan2015, 13:25	336.3
EL-40	0.074895	118.8	01Jan2015, 12:10	11.6
Kensington Drive	0.074895	118.8	01Jan2015, 12:10	11.6
N Lakeshore Dr - Booker Ck	2.608825	1079.3	01Jan2015, 13:20	347.9
CF-10	0.078889	140.4	01Jan2015, 12:10	14.9
Kingston Drive	0.078889	140.4	01Jan2015, 12:10	14.9
CF-20	0.076885	55.2	01Jan2015, 12:55	12.4
ADD-CF-20	0.155774	159.4	01Jan2015, 12:10	27.4
Weaver Dairy - Cedar Fk	0.155774	159.4	01Jan2015, 12:10	27.4
CF-30	0.044849	27.7	01Jan2015, 12:35	4.9
ADD-CF-30	0.200623	172.3	01Jan2015, 12:10	32.3
Cross Creek Drive	0.200623	172.3	01Jan2015, 12:10	32.3
Reach-CF-50	0.200623	172.1	01Jan2015, 12:10	32.3
CF-40	0.092855	55.5	01Jan2015, 12:45	10.8
Weaver Dairy Rd - 1	0.092855	55.5	01Jan2015, 12:45	10.8
CF-50	0.029148	25.4	01Jan2015, 12:15	2.9
ADD-CF-50	0.322626	222.8	01Jan2015, 12:15	46
CF-60	0.12336	65.8	01Jan2015, 12:50	14.5
Cedar Hills Circle	0.445986	250.4	01Jan2015, 12:15	60.5
Reach-CF-80	0.445986	250.1	01Jan2015, 12:25	60.5
CF-80	0.176821	150.8	01Jan2015, 12:25	21.3
CF-70	0.120239	63.9	01Jan2015, 13:05	16.3
Weaver Dairy Rd -2	0.120239	63.9	01Jan2015, 13:05	16.3
Kenmore Road	0.743046	434.4	01Jan2015, 12:25	98.2
Reach-CF-130	0.743046	433.8	01Jan2015, 12:30	98.1
CF-90	0.184752	107.8	01Jan2015, 12:40	20
CF-100	0.085353	106.6	01Jan2015, 12:05	9.6
Piney Mountain Rd - Cedar Fk	0.085353	106.6	01Jan2015, 12:05	9.6
CF-110	0.044111	71.8	01Jan2015, 12:00	5
ADD-CF-110	0.129464	170.1	01Jan2015, 12:05	14.6
ADD-CF-90-120	0.314216	202.4	01Jan2015, 12:05	34.6
CF-120	0.096092	90.5	01Jan2015, 12:15	10.4
Brookview Drive	1.153354	648.7	01Jan2015, 12:25	143.1
Reach-CF-140	1.153354	648.3	01Jan2015, 12:30	143.1
CF-130	0.151403	103.7	01Jan2015, 12:40	18.5
CF-140	0.042477	33.2	01Jan2015, 12:20	4.6
North Lakeshore Drive	1.347234	778.3	01Jan2015, 12:30	166.3
CF-150	0.050842	57.1	01Jan2015, 12:10	5.6
ADD-CF-150	1.398076	803.9	01Jan2015, 12:30	171.8
EL-60	0.142028	129.1	01Jan2015, 12:20	16.3
EL-90	0.100143	143.2	01Jan2015, 12:10	14.3
EL-70	0.094086	109.1	01Jan2015, 12:15	13
EL-80	0.091741	51.8	01Jan2015, 13:00	12.3
EL-100	0.087147	144.2	01Jan2015, 12:15	17.5
Eastwood Lake	4.522046	1683.7	01Jan2015, 13:20	593.1
LBC-10	0.097332	95.6	01Jan2015, 12:25	13.2
U/S Limit - Sierra	0.097332	86.3	01Jan2015, 12:30	13.2
LBC-20	0.084519	99.9	01Jan2015, 12:20	12.8
ADD-LBC-10-20	0.181851	178.3	01Jan2015, 12:25	26
Reach-LBC-20	0.181851	177.1	01Jan2015, 12:25	26
Honeysuckle Road	0.181851	177.1	01Jan2015, 12:25	26
Reach-LBC-30	0.181851	175.2	01Jan2015, 12:35	26
LBC-30	0.159799	123.5	01Jan2015, 13:00	29.2

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

10-YEAR EXISTING				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Booker Creek Road	0.34165	274.6	01Jan2015, 12:40	55.3
Reach-LBC-40	0.34165	260	01Jan2015, 12:50	55
LBC-40	0.156492	308.4	01Jan2015, 12:10	30.4
LBC-50	0.022218	0.5	01Jan2015, 12:05	0.1
ADD-LBC-40-50	5.042406	1938.2	01Jan2015, 13:10	678.5
LBC-60	0.142061	193.6	01Jan2015, 12:10	20.9
ADD-LBC-60	5.184467	1969.9	01Jan2015, 13:10	699.5
Reach-LBC-60	5.184467	1961.8	01Jan2015, 13:20	699.1
LBC-70	0.107956	142.6	01Jan2015, 12:10	14.3
LBC-130	0.03607	45.1	01Jan2015, 12:30	7.3
ADD-LBC-70-130	5.328493	1995.8	01Jan2015, 13:20	720.7
LBC-90	0.115064	111.7	01Jan2015, 12:50	24.3
LBC-80	0.06417	74.5	01Jan2015, 12:30	12.3
Fordham Blvd - Upstream	0.06417	74.5	01Jan2015, 12:30	12.3
LBC-100	0.029058	30.4	01Jan2015, 12:45	6.4
Dobbins Drive	0.208292	208.4	01Jan2015, 12:40	43.1
LBC-110	0.0333	31.3	01Jan2015, 12:50	6.5
Summerfield Crossing	0.241592	239.2	01Jan2015, 12:45	49.6
LBC-120	0.049799	45.5	01Jan2015, 12:50	9.8
Foxcroft Drive	0.291391	281.6	01Jan2015, 12:50	59.3
East Franklin Street	5.619884	2180.8	01Jan2015, 13:25	780
LBC-140	0.088638	136.8	01Jan2015, 12:25	20.9
ADD-LBC-140	5.708522	2216	01Jan2015, 13:20	800.8
Reach-LBC-140	5.708522	1954.4	01Jan2015, 13:45	797.5
LBC-150	0.107836	122.6	01Jan2015, 12:25	18.3
ADD-LBC-150	5.816358	1975.9	01Jan2015, 13:45	815.8
LBC-160	0.077625	113.2	01Jan2015, 12:20	16.6
Fordham Blvd - Downstream	5.893983	1987.8	01Jan2015, 13:50	832.4
LBC-180	0.14221	259.3	01Jan2015, 12:15	30.1
LBC-170	0.027436	54.9	01Jan2015, 12:10	5.5
ADD-LBC-170-180	6.063629	2015.1	01Jan2015, 13:50	868
Reach-LBC-190	6.063629	2004.8	01Jan2015, 14:00	868
LBC-190	0.05069	61.7	01Jan2015, 12:25	9
Willow Drive	6.114319	2014.2	01Jan2015, 14:00	877
Reach-LBC-200	6.114319	1873.1	01Jan2015, 14:30	875.4
LBC-200	0.168071	144.9	01Jan2015, 12:45	28.3
ADD-LBC-200	6.28239	1904.5	01Jan2015, 14:30	903.6
OUTLET	6.28239	1904.5	01Jan2015, 14:30	903.6

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

25-YEAR EXISTING				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
BH-10	0.139076	104.5	01Jan2015, 12:45	20.6
BH-20	0.07669	89.3	01Jan2015, 12:25	13.3
ADD-BH-10-20	0.215766	182.6	01Jan2015, 12:35	33.8
Reach-BH-20	0.215766	181.4	01Jan2015, 12:35	33.8
BH-30	0.165073	142.2	01Jan2015, 12:50	30.1
ADD-BH-30	0.380839	316.7	01Jan2015, 12:40	64
BH-40	0.105607	209.7	01Jan2015, 12:10	20.4
ADD-BH-40	0.486446	382.8	01Jan2015, 12:35	84.3
Reach-BH-40	0.486446	382.2	01Jan2015, 12:40	84.3
BH-60	0.129437	113.8	01Jan2015, 12:45	23.1
BH-50	0.117491	154.9	01Jan2015, 12:20	19.1
Weaver Dairy Rd Ext	0.117491	154.9	01Jan2015, 12:20	19.1
Northern Park	0.246928	233	01Jan2015, 12:25	42.2
ADD-BH	0.733374	607.8	01Jan2015, 12:30	126.6
BH-70	0.062883	120.8	01Jan2015, 12:10	12.6
MLK Jr. Blvd	0.796257	660.2	01Jan2015, 12:35	139.1
BH-80	0.10254	129.9	01Jan2015, 12:30	20.1
Stateside Drive	0.10254	129.9	01Jan2015, 12:30	20.1
BH-90	0.094578	70.8	01Jan2015, 12:55	15.4
ADD-BH-90	0.197118	185.7	01Jan2015, 12:35	35.5
BH-100	0.110825	269.3	01Jan2015, 12:05	20.9
ADD-BH-100	1.1042	903.6	01Jan2015, 12:30	195.5
Reach-BH-100	1.1042	899.8	01Jan2015, 12:35	195.5
BH-110	0.117356	168.2	01Jan2015, 12:15	19
MLK Jr. - Kings Br	0.117356	168.2	01Jan2015, 12:15	19
BH-120	0.02747	17	01Jan2015, 13:05	4.2
ADD-BH-120	1.249026	1012.9	01Jan2015, 12:25	218.6
BH-130	0.100527	134	01Jan2015, 12:30	20.9
Lake Ellen	1.349553	1008.4	01Jan2015, 12:50	239.5
CB-10	0.144686	85.9	01Jan2015, 13:00	19.8
Reach-CB-10	0.144686	85.7	01Jan2015, 13:05	19.8
CB-20	0.112513	60	01Jan2015, 12:45	12.1
ADD-CB-20	0.257199	140.6	01Jan2015, 12:55	31.9
Reach-CB-20	0.257199	139.3	01Jan2015, 13:05	31.9
CB-40	0.051355	115.2	01Jan2015, 12:15	14.5
CB-30	0.026991	14.6	01Jan2015, 12:45	2.9
ADD-CB-30-40	0.335545	172.7	01Jan2015, 13:05	49.3
CB-50	0.072003	85.3	01Jan2015, 12:35	14.8
Municipal Drive	0.072003	85.3	01Jan2015, 12:35	14.8
CB-60	0.031973	102.7	01Jan2015, 11:55	5.5
ADD-CB-60	0.439521	252.5	01Jan2015, 12:45	69.6
Reach-CB-60	0.439521	251.2	01Jan2015, 12:55	69.5
CB-70	0.149895	118.5	01Jan2015, 13:00	27.2
ADD-CB-70	0.589416	369.2	01Jan2015, 12:55	96.8
Reach-CB-70	0.589416	363.4	01Jan2015, 13:15	96.7
CB-80	0.083068	101.6	01Jan2015, 12:20	14
ADD-CB-80	0.672484	391.7	01Jan2015, 13:15	110.7
Reach-CB-80	0.672484	390.6	01Jan2015, 13:25	110.7
ADD- CB-BH	2.022037	1306.1	01Jan2015, 13:05	350.2
EL-20	0.137538	297.9	01Jan2015, 12:05	26.3
ADD-EL-20	2.159575	1341.3	01Jan2015, 13:00	376.5
Reach-EL-20	2.159575	1338.8	01Jan2015, 13:10	376.3
EL-10	0.138871	325	01Jan2015, 12:10	31.5
Piney Mountain Rd	0.138871	325	01Jan2015, 12:10	31.5
Piney Mountain Rd -Booker Ck	2.298446	1368.7	01Jan2015, 13:15	407.8
EL-30	0.119754	187.6	01Jan2015, 12:10	18.8

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

25-YEAR EXISTING				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Reach- EL-30	2.4182	1393.1	01Jan2015, 13:20	426.5
EL-50	0.11573	201.5	01Jan2015, 12:10	19.2
ADD-EL-50	2.53393	1417.6	01Jan2015, 13:15	445.7
Reach-EL-50	2.53393	1416	01Jan2015, 13:25	445.6
EL-40	0.074895	155.6	01Jan2015, 12:10	15.1
Kensington Drive	0.074895	155.6	01Jan2015, 12:10	15.1
N Lakeshore Dr - Booker Ck	2.608825	1431.9	01Jan2015, 13:25	460.7
CF-10	0.078889	177.3	01Jan2015, 12:10	18.6
Kingston Drive	0.078889	177.3	01Jan2015, 12:10	18.6
CF-20	0.076885	72	01Jan2015, 12:55	16
ADD-CF-20	0.155774	202.9	01Jan2015, 12:10	34.7
Weaver Dairy - Cedar Fk	0.155774	202.9	01Jan2015, 12:10	34.7
CF-30	0.044849	39	01Jan2015, 12:35	6.7
ADD-CF-30	0.200623	222.1	01Jan2015, 12:10	41.4
Cross Creek Drive	0.200623	222.1	01Jan2015, 12:10	41.4
Reach-CF-50	0.200623	221.9	01Jan2015, 12:10	41.4
CF-40	0.092855	77.1	01Jan2015, 12:40	14.7
Weaver Dairy Rd - 1	0.092855	77.1	01Jan2015, 12:40	14.7
CF-50	0.029148	36.2	01Jan2015, 12:15	4.1
ADD-CF-50	0.322626	295.9	01Jan2015, 12:15	60.1
CF-60	0.12336	91.4	01Jan2015, 12:50	19.6
Cedar Hills Circle	0.445986	337.6	01Jan2015, 12:20	79.7
Reach-CF-80	0.445986	337.2	01Jan2015, 12:25	79.7
CF-80	0.176821	207.5	01Jan2015, 12:25	28.7
CF-70	0.120239	85.9	01Jan2015, 13:05	21.5
Weaver Dairy Rd -2	0.120239	85.9	01Jan2015, 13:05	21.5
Kenmore Road	0.743046	590.2	01Jan2015, 12:25	129.9
Reach-CF-130	0.743046	589.6	01Jan2015, 12:30	129.9
CF-90	0.184752	152	01Jan2015, 12:40	27.4
CF-100	0.085353	149	01Jan2015, 12:05	13.1
Piney Mountain Rd - Cedar Fk	0.085353	149	01Jan2015, 12:05	13.1
CF-110	0.044111	99.5	01Jan2015, 12:00	6.8
ADD-CF-110	0.129464	235.8	01Jan2015, 12:05	19.9
ADD-CF-90-120	0.314216	285.5	01Jan2015, 12:05	47.3
CF-120	0.096092	127.2	01Jan2015, 12:15	14.2
Brookview Drive	1.153354	888.2	01Jan2015, 12:25	191.4
Reach-CF-140	1.153354	887.4	01Jan2015, 12:30	191.4
CF-130	0.151403	142.4	01Jan2015, 12:40	25
CF-140	0.042477	46.8	01Jan2015, 12:20	6.3
North Lakeshore Drive	1.347234	1067.8	01Jan2015, 12:30	222.7
CF-150	0.050842	80	01Jan2015, 12:10	7.6
ADD-CF-150	1.398076	1102.7	01Jan2015, 12:30	230.3
EL-60	0.142028	178.9	01Jan2015, 12:20	22.1
EL-90	0.100143	190.7	01Jan2015, 12:10	18.9
EL-70	0.094086	146.5	01Jan2015, 12:15	17.3
EL-80	0.091741	70	01Jan2015, 13:00	16.4
EL-100	0.087147	180.7	01Jan2015, 12:15	22.1
Eastwood Lake	4.522046	2285.7	01Jan2015, 13:15	787.4
LBC-10	0.097332	128.6	01Jan2015, 12:20	17.5
U/S Limit - Sierra	0.097332	114.4	01Jan2015, 12:35	17.5
LBC-20	0.084519	131.6	01Jan2015, 12:20	16.7
ADD-LBC-10-20	0.181851	234.2	01Jan2015, 12:25	34.2
Reach-LBC-20	0.181851	232.2	01Jan2015, 12:25	34.2
Honeysuckle Road	0.181851	232.2	01Jan2015, 12:25	34.2
Reach-LBC-30	0.181851	229.6	01Jan2015, 12:35	34.2
LBC-30	0.159799	157.7	01Jan2015, 13:00	37.2

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

25-YEAR EXISTING				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Booker Creek Road	0.34165	356.8	01Jan2015, 12:40	71.4
Reach-LBC-40	0.34165	339.5	01Jan2015, 12:50	71.2
LBC-40	0.156492	388.5	01Jan2015, 12:10	38.3
LBC-50	0.022218	0.6	01Jan2015, 12:05	0.1
ADD-LBC-40-50	5.042406	2630.1	01Jan2015, 13:05	897
LBC-60	0.142061	257	01Jan2015, 12:10	27.4
ADD-LBC-60	5.184467	2675	01Jan2015, 13:05	924.4
Reach-LBC-60	5.184467	2666.6	01Jan2015, 13:15	923.9
LBC-70	0.107956	192.6	01Jan2015, 12:10	19
LBC-130	0.03607	56.5	01Jan2015, 12:30	9.1
ADD-LBC-70-130	5.328493	2713.7	01Jan2015, 13:15	952
LBC-90	0.115064	139.2	01Jan2015, 12:50	30.3
LBC-80	0.06417	94.3	01Jan2015, 12:30	15.6
Fordham Blvd - Upstream	0.06417	94.3	01Jan2015, 12:30	15.6
LBC-100	0.029058	37.7	01Jan2015, 12:45	7.9
Dobbins Drive	0.208292	260.9	01Jan2015, 12:40	53.8
LBC-110	0.0333	39.5	01Jan2015, 12:50	8.2
Summerfield Crossing	0.241592	299.5	01Jan2015, 12:40	62
LBC-120	0.049799	57.4	01Jan2015, 12:50	12.3
Foxcroft Drive	0.291391	358.8	01Jan2015, 12:45	74.3
East Franklin Street	5.619884	2980.9	01Jan2015, 13:15	1026.2
LBC-140	0.088638	167.6	01Jan2015, 12:25	25.5
ADD-LBC-140	5.708522	3029.2	01Jan2015, 13:15	1051.8
Reach-LBC-140	5.708522	2668.9	01Jan2015, 13:40	1046.8
LBC-150	0.107836	158.3	01Jan2015, 12:25	23.4
ADD-LBC-150	5.816358	2699.1	01Jan2015, 13:35	1070.2
LBC-160	0.077625	141	01Jan2015, 12:20	20.5
Fordham Blvd - Downstream	5.893983	2719	01Jan2015, 13:40	1090.7
LBC-180	0.14221	322.7	01Jan2015, 12:15	37.4
LBC-170	0.027436	68.8	01Jan2015, 12:10	6.9
ADD-LBC-170-180	6.063629	2756.5	01Jan2015, 13:40	1135
Reach-LBC-190	6.063629	2747.6	01Jan2015, 13:50	1134.8
LBC-190	0.05069	79	01Jan2015, 12:25	11.5
Willow Drive	6.114319	2761.8	01Jan2015, 13:45	1146.4
Reach-LBC-200	6.114319	2590.1	01Jan2015, 14:20	1143.8
LBC-200	0.168071	187.6	01Jan2015, 12:45	36.4
ADD-LBC-200	6.28239	2634.8	01Jan2015, 14:20	1180.3
OUTLET	6.28239	2634.8	01Jan2015, 14:20	1180.3

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

50-YEAR EXISTING				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
BH-10	0.139076	129.4	01Jan2015, 12:45	25.1
BH-20	0.07669	108.4	01Jan2015, 12:25	15.9
ADD-BH-10-20	0.215766	224.1	01Jan2015, 12:35	41
Reach-BH-20	0.215766	223.3	01Jan2015, 12:35	41
BH-30	0.165073	171.5	01Jan2015, 12:50	36
ADD-BH-30	0.380839	386.1	01Jan2015, 12:40	77
BH-40	0.105607	250.5	01Jan2015, 12:10	24.2
ADD-BH-40	0.486446	465.2	01Jan2015, 12:30	101.3
Reach-BH-40	0.486446	464.3	01Jan2015, 12:40	101.2
BH-60	0.129437	137.6	01Jan2015, 12:45	27.7
BH-50	0.117491	189.2	01Jan2015, 12:20	23.2
Weaver Dairy Rd Ext	0.117491	189.2	01Jan2015, 12:20	23.2
Northern Park	0.246928	284	01Jan2015, 12:25	50.9
ADD-BH	0.733374	739.2	01Jan2015, 12:30	152.1
BH-70	0.062883	143.8	01Jan2015, 12:10	14.9
MLK Jr. Blvd	0.796257	777.2	01Jan2015, 12:35	167
BH-80	0.10254	155.1	01Jan2015, 12:30	23.9
Stateside Drive	0.10254	155.1	01Jan2015, 12:30	23.9
BH-90	0.094578	86.6	01Jan2015, 12:55	18.6
ADD-BH-90	0.197118	223.9	01Jan2015, 12:35	42.5
BH-100	0.110825	321.7	01Jan2015, 12:05	24.9
ADD-BH-100	1.1042	1063.8	01Jan2015, 12:30	234.4
Reach-BH-100	1.1042	1061.8	01Jan2015, 12:35	234.3
BH-110	0.117356	205.2	01Jan2015, 12:15	22.9
MLK Jr. - Kings Br	0.117356	205.2	01Jan2015, 12:15	22.9
BH-120	0.02747	21.1	01Jan2015, 13:05	5.1
ADD-BH-120	1.249026	1201.6	01Jan2015, 12:25	262.3
BH-130	0.100527	158.9	01Jan2015, 12:30	24.7
Lake Ellen	1.349553	1191.8	01Jan2015, 12:50	287
CB-10	0.144686	107.7	01Jan2015, 13:00	24.4
Reach-CB-10	0.144686	107.4	01Jan2015, 13:05	24.4
CB-20	0.112513	78.2	01Jan2015, 12:45	15.3
ADD-CB-20	0.257199	178.6	01Jan2015, 12:55	39.8
Reach-CB-20	0.257199	176.8	01Jan2015, 13:05	39.7
CB-40	0.051355	131.8	01Jan2015, 12:15	16.5
CB-30	0.026991	19	01Jan2015, 12:45	3.7
ADD-CB-30-40	0.335545	215.7	01Jan2015, 13:05	60
CB-50	0.072003	101.4	01Jan2015, 12:35	17.5
Municipal Drive	0.072003	101.4	01Jan2015, 12:35	17.5
CB-60	0.031973	124	01Jan2015, 11:55	6.7
ADD-CB-60	0.439521	306.9	01Jan2015, 12:45	84.1
Reach-CB-60	0.439521	305.5	01Jan2015, 12:55	84.1
CB-70	0.149895	143	01Jan2015, 13:00	32.6
ADD-CB-70	0.589416	448.1	01Jan2015, 12:55	116.7
Reach-CB-70	0.589416	442.1	01Jan2015, 13:15	116.6
CB-80	0.083068	123.8	01Jan2015, 12:20	16.9
ADD-CB-80	0.672484	475.8	01Jan2015, 13:15	133.5
Reach-CB-80	0.672484	474.6	01Jan2015, 13:25	133.5
ADD- CB-BH	2.022037	1571.3	01Jan2015, 13:05	420.5
EL-20	0.137538	356.7	01Jan2015, 12:05	31.3
ADD-EL-20	2.159575	1611.2	01Jan2015, 13:05	451.8
Reach-EL-20	2.159575	1607.9	01Jan2015, 13:10	451.6
EL-10	0.138871	380.8	01Jan2015, 12:10	36.9
Piney Mountain Rd	0.138871	380.8	01Jan2015, 12:10	36.9
Piney Mountain Rd -Booker Ck	2.298446	1641.9	01Jan2015, 13:15	488.5
EL-30	0.119754	230.1	01Jan2015, 12:10	22.8

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

50-YEAR EXISTING				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Reach- EL-30	2.4182	1670.8	01Jan2015, 13:20	511.3
EL-50	0.11573	245.2	01Jan2015, 12:10	23.2
ADD-EL-50	2.53393	1698.5	01Jan2015, 13:15	534.5
Reach-EL-50	2.53393	1696.2	01Jan2015, 13:25	534.3
EL-40	0.074895	184.8	01Jan2015, 12:10	17.9
Kensington Drive	0.074895	184.8	01Jan2015, 12:10	17.9
N Lakeshore Dr - Booker Ck	2.608825	1714.7	01Jan2015, 13:25	552.2
CF-10	0.078889	206.8	01Jan2015, 12:10	21.6
Kingston Drive	0.078889	206.8	01Jan2015, 12:10	21.6
CF-20	0.076885	85.4	01Jan2015, 12:55	18.9
ADD-CF-20	0.155774	237.7	01Jan2015, 12:10	40.5
Weaver Dairy - Cedar Fk	0.155774	237.7	01Jan2015, 12:10	40.5
CF-30	0.044849	48.3	01Jan2015, 12:35	8.2
ADD-CF-30	0.200623	262.2	01Jan2015, 12:10	48.7
Cross Creek Drive	0.200623	262.2	01Jan2015, 12:10	48.7
Reach-CF-50	0.200623	261.9	01Jan2015, 12:10	48.7
CF-40	0.092855	94.8	01Jan2015, 12:40	17.8
Weaver Dairy Rd - 1	0.092855	94.8	01Jan2015, 12:40	17.8
CF-50	0.029148	45.1	01Jan2015, 12:15	5
ADD-CF-50	0.322626	355.3	01Jan2015, 12:15	71.5
CF-60	0.12336	112.3	01Jan2015, 12:50	23.7
Cedar Hills Circle	0.445986	408.8	01Jan2015, 12:20	95.2
Reach-CF-80	0.445986	408.5	01Jan2015, 12:25	95.2
CF-80	0.176821	253.5	01Jan2015, 12:25	34.7
CF-70	0.120239	103.8	01Jan2015, 13:05	25.7
Weaver Dairy Rd -2	0.120239	103.8	01Jan2015, 13:05	25.7
Kenmore Road	0.743046	717.4	01Jan2015, 12:25	155.7
Reach-CF-130	0.743046	716.8	01Jan2015, 12:30	155.7
CF-90	0.184752	188.2	01Jan2015, 12:40	33.5
CF-100	0.085353	183.6	01Jan2015, 12:05	16
Piney Mountain Rd - Cedar Fk	0.085353	183.6	01Jan2015, 12:05	16
CF-110	0.044111	122.1	01Jan2015, 12:00	8.2
ADD-CF-110	0.129464	289.2	01Jan2015, 12:05	24.2
ADD-CF-90-120	0.314216	353.6	01Jan2015, 12:05	57.7
CF-120	0.096092	157.3	01Jan2015, 12:15	17.3
Brookview Drive	1.153354	1086.5	01Jan2015, 12:25	230.7
Reach-CF-140	1.153354	1082.2	01Jan2015, 12:30	230.7
CF-130	0.151403	174	01Jan2015, 12:35	30.2
CF-140	0.042477	58	01Jan2015, 12:20	7.7
North Lakeshore Drive	1.347234	1303.7	01Jan2015, 12:30	268.7
CF-150	0.050842	98.6	01Jan2015, 12:10	9.3
ADD-CF-150	1.398076	1348.1	01Jan2015, 12:25	278
EL-60	0.142028	220.3	01Jan2015, 12:15	26.9
EL-90	0.100143	228.6	01Jan2015, 12:10	22.5
EL-70	0.094086	176.5	01Jan2015, 12:15	20.7
EL-80	0.091741	84.6	01Jan2015, 13:00	19.7
EL-100	0.087147	209	01Jan2015, 12:15	25.6
Eastwood Lake	4.522046	2645.3	01Jan2015, 13:20	945.4
LBC-10	0.097332	155.4	01Jan2015, 12:20	21
U/S Limit - Sierra	0.097332	137.4	01Jan2015, 12:35	21
LBC-20	0.084519	156.9	01Jan2015, 12:20	19.8
ADD-LBC-10-20	0.181851	279.7	01Jan2015, 12:25	40.8
Reach-LBC-20	0.181851	277.3	01Jan2015, 12:25	40.8
Honeysuckle Road	0.181851	277.3	01Jan2015, 12:25	40.8
Reach-LBC-30	0.181851	273.8	01Jan2015, 12:35	40.8
LBC-30	0.159799	184.5	01Jan2015, 13:00	43.5

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

50-YEAR EXISTING				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Booker Creek Road	0.34165	422.5	01Jan2015, 12:40	84.4
Reach-LBC-40	0.34165	401.9	01Jan2015, 12:50	84.1
LBC-40	0.156492	451.1	01Jan2015, 12:10	44.6
LBC-50	0.022218	0.6	01Jan2015, 12:05	0.1
ADD-LBC-40-50	5.042406	3069	01Jan2015, 12:55	1074.1
LBC-60	0.142061	307.7	01Jan2015, 12:10	32.6
ADD-LBC-60	5.184467	3143.7	01Jan2015, 12:50	1106.8
Reach-LBC-60	5.184467	3127.5	01Jan2015, 13:05	1106.1
LBC-70	0.107956	232.9	01Jan2015, 12:10	22.8
LBC-130	0.03607	65.5	01Jan2015, 12:30	10.6
ADD-LBC-70-130	5.328493	3202.7	01Jan2015, 13:00	1139.5
LBC-90	0.115064	160.6	01Jan2015, 12:50	35
LBC-80	0.06417	109.8	01Jan2015, 12:30	18.2
Fordham Blvd - Upstream	0.06417	109.8	01Jan2015, 12:30	18.2
LBC-100	0.029058	43.3	01Jan2015, 12:45	9.1
Dobbins Drive	0.208292	301.9	01Jan2015, 12:40	62.2
LBC-110	0.0333	45.9	01Jan2015, 12:45	9.5
Summerfield Crossing	0.241592	346.6	01Jan2015, 12:45	71.7
LBC-120	0.049799	66.7	01Jan2015, 12:50	14.3
Foxcroft Drive	0.291391	415.2	01Jan2015, 12:45	86
East Franklin Street	5.619884	3525.5	01Jan2015, 13:10	1225.5
LBC-140	0.088638	191.7	01Jan2015, 12:25	29.2
ADD-LBC-140	5.708522	3590.1	01Jan2015, 13:05	1254.7
Reach-LBC-140	5.708522	3167.6	01Jan2015, 13:35	1248.2
LBC-150	0.107836	186.7	01Jan2015, 12:25	27.4
ADD-LBC-150	5.816358	3204.6	01Jan2015, 13:35	1275.6
LBC-160	0.077625	162.7	01Jan2015, 12:20	23.7
Fordham Blvd - Downstream	5.893983	3228.5	01Jan2015, 13:40	1299.2
LBC-180	0.14221	372.2	01Jan2015, 12:15	43.1
LBC-170	0.027436	79.6	01Jan2015, 12:10	8
ADD-LBC-170-180	6.063629	3273.3	01Jan2015, 13:35	1350.4
Reach-LBC-190	6.063629	3267	01Jan2015, 13:45	1350.3
LBC-190	0.05069	92.6	01Jan2015, 12:25	13.5
Willow Drive	6.114319	3283.8	01Jan2015, 13:45	1363.9
Reach-LBC-200	6.114319	3131.1	01Jan2015, 14:20	1360.5
LBC-200	0.168071	221.3	01Jan2015, 12:45	42.9
ADD-LBC-200	6.28239	3185.1	01Jan2015, 14:15	1403.5
OUTLET	6.28239	3185.1	01Jan2015, 14:15	1403.5

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

100-YEAR EXISTING				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
BH-10	0.139076	154.8	01Jan2015, 12:45	29.7
BH-20	0.07669	127.7	01Jan2015, 12:25	18.6
ADD-BH-10-20	0.215766	266.6	01Jan2015, 12:35	48.3
Reach-BH-20	0.215766	266	01Jan2015, 12:35	48.3
BH-30	0.165073	201	01Jan2015, 12:50	42
ADD-BH-30	0.380839	456.9	01Jan2015, 12:40	90.4
BH-40	0.105607	291.4	01Jan2015, 12:10	28.1
ADD-BH-40	0.486446	548.6	01Jan2015, 12:35	118.5
Reach-BH-40	0.486446	547.5	01Jan2015, 12:40	118.4
BH-60	0.129437	161.8	01Jan2015, 12:45	32.3
BH-50	0.117491	223.8	01Jan2015, 12:20	27.4
Weaver Dairy Rd Ext	0.117491	223.8	01Jan2015, 12:20	27.4
Northern Park	0.246928	335.6	01Jan2015, 12:25	59.7
ADD-BH	0.733374	871.6	01Jan2015, 12:30	178.1
BH-70	0.062883	167	01Jan2015, 12:10	17.2
MLK Jr. Blvd	0.796257	886.1	01Jan2015, 12:40	195.3
BH-80	0.10254	180.3	01Jan2015, 12:30	27.7
Stateside Drive	0.10254	180.3	01Jan2015, 12:30	27.7
BH-90	0.094578	102.7	01Jan2015, 12:55	21.9
ADD-BH-90	0.197118	262.5	01Jan2015, 12:35	49.6
BH-100	0.110825	374.2	01Jan2015, 12:05	29
ADD-BH-100	1.1042	1202.9	01Jan2015, 12:35	273.9
Reach-BH-100	1.1042	1200.8	01Jan2015, 12:40	273.9
BH-110	0.117356	242.8	01Jan2015, 12:15	26.9
MLK Jr. - Kings Br	0.117356	242.8	01Jan2015, 12:15	26.9
BH-120	0.02747	25.2	01Jan2015, 13:05	6
ADD-BH-120	1.249026	1363.4	01Jan2015, 12:20	306.8
BH-130	0.100527	183.7	01Jan2015, 12:30	28.6
Lake Ellen	1.349553	1274.6	01Jan2015, 13:00	335.3
CB-10	0.144686	130	01Jan2015, 13:00	29.2
Reach-CB-10	0.144686	129.5	01Jan2015, 13:05	29.2
CB-20	0.112513	97.2	01Jan2015, 12:45	18.7
ADD-CB-20	0.257199	218.1	01Jan2015, 12:55	47.9
Reach-CB-20	0.257199	216	01Jan2015, 13:05	47.9
CB-40	0.051355	148.3	01Jan2015, 12:15	18.6
CB-30	0.026991	23.6	01Jan2015, 12:45	4.5
ADD-CB-30-40	0.335545	261.2	01Jan2015, 13:05	70.9
CB-50	0.072003	117.4	01Jan2015, 12:35	20.3
Municipal Drive	0.072003	117.4	01Jan2015, 12:35	20.3
CB-60	0.031973	145.4	01Jan2015, 11:55	7.8
ADD-CB-60	0.439521	363.9	01Jan2015, 12:50	99
Reach-CB-60	0.439521	362.2	01Jan2015, 12:55	98.9
CB-70	0.149895	167.6	01Jan2015, 13:00	38.1
ADD-CB-70	0.589416	529.7	01Jan2015, 13:00	137
Reach-CB-70	0.589416	523.3	01Jan2015, 13:15	136.9
CB-80	0.083068	146.3	01Jan2015, 12:20	19.8
ADD-CB-80	0.672484	562.4	01Jan2015, 13:15	156.7
Reach-CB-80	0.672484	561.2	01Jan2015, 13:25	156.7
ADD- CB-BH	2.022037	1828.8	01Jan2015, 13:20	492
EL-20	0.137538	415.7	01Jan2015, 12:05	36.4
ADD-EL-20	2.159575	1865.7	01Jan2015, 13:20	528.4
Reach-EL-20	2.159575	1858.7	01Jan2015, 13:25	528.2
EL-10	0.138871	436.3	01Jan2015, 12:10	42.3
Piney Mountain Rd	0.138871	436.3	01Jan2015, 12:10	42.3
Piney Mountain Rd -Booker Ck	2.298446	1888.9	01Jan2015, 13:25	570.5
EL-30	0.119754	273.3	01Jan2015, 12:10	26.9

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

100-YEAR EXISTING				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Reach- EL-30	2.4182	1916	01Jan2015, 13:30	597.5
EL-50	0.11573	289.3	01Jan2015, 12:10	27.3
ADD-EL-50	2.53393	1943.6	01Jan2015, 13:30	624.8
Reach-EL-50	2.53393	1940.3	01Jan2015, 13:40	624.6
EL-40	0.074895	214.1	01Jan2015, 12:10	20.8
Kensington Drive	0.074895	214.1	01Jan2015, 12:10	20.8
N Lakeshore Dr - Booker Ck	2.608825	1958.2	01Jan2015, 13:40	645.4
CF-10	0.078889	236.3	01Jan2015, 12:10	24.6
Kingston Drive	0.078889	236.3	01Jan2015, 12:10	24.6
CF-20	0.076885	98.8	01Jan2015, 12:55	21.8
ADD-CF-20	0.155774	272.8	01Jan2015, 12:10	46.4
Weaver Dairy - Cedar Fk	0.155774	272.8	01Jan2015, 12:10	46.4
CF-30	0.044849	57.8	01Jan2015, 12:35	9.8
ADD-CF-30	0.200623	302.6	01Jan2015, 12:10	56.1
Cross Creek Drive	0.200623	302.6	01Jan2015, 12:10	56.1
Reach-CF-50	0.200623	302.4	01Jan2015, 12:10	56.1
CF-40	0.092855	112.9	01Jan2015, 12:40	21
Weaver Dairy Rd - 1	0.092855	112.9	01Jan2015, 12:40	21
CF-50	0.029148	54.3	01Jan2015, 12:15	5.9
ADD-CF-50	0.322626	415.5	01Jan2015, 12:15	83
CF-60	0.12336	133.5	01Jan2015, 12:50	28
Cedar Hills Circle	0.445986	481.2	01Jan2015, 12:20	111
Reach-CF-80	0.445986	481	01Jan2015, 12:35	111
CF-80	0.176821	300.2	01Jan2015, 12:25	40.9
CF-70	0.120239	121.9	01Jan2015, 13:05	30
Weaver Dairy Rd -2	0.120239	121.9	01Jan2015, 13:05	30
Kenmore Road	0.743046	846.8	01Jan2015, 12:30	181.9
Reach-CF-130	0.743046	844.6	01Jan2015, 12:35	181.9
CF-90	0.184752	225.2	01Jan2015, 12:40	39.7
CF-100	0.085353	218.8	01Jan2015, 12:05	18.9
Piney Mountain Rd - Cedar Fk	0.085353	218.8	01Jan2015, 12:05	18.9
CF-110	0.044111	145.1	01Jan2015, 12:00	9.7
ADD-CF-110	0.129464	343.5	01Jan2015, 12:05	28.6
ADD-CF-90-120	0.314216	423.2	01Jan2015, 12:05	68.4
CF-120	0.096092	188	01Jan2015, 12:15	20.5
Brookview Drive	1.153354	1279.1	01Jan2015, 12:25	270.8
Reach-CF-140	1.153354	1275.8	01Jan2015, 12:30	270.9
CF-130	0.151403	206.2	01Jan2015, 12:35	35.6
CF-140	0.042477	69.4	01Jan2015, 12:20	9.1
North Lakeshore Drive	1.347234	1538.9	01Jan2015, 12:30	315.6
CF-150	0.050842	117.5	01Jan2015, 12:10	11
ADD-CF-150	1.398076	1590.2	01Jan2015, 12:25	326.6
EL-60	0.142028	262.6	01Jan2015, 12:15	31.7
EL-90	0.100143	266.6	01Jan2015, 12:10	26.3
EL-70	0.094086	206.7	01Jan2015, 12:15	24.1
EL-80	0.091741	99.4	01Jan2015, 13:00	23
EL-100	0.087147	236.9	01Jan2015, 12:15	29.1
Eastwood Lake	4.522046	2892.2	01Jan2015, 13:30	1106
LBC-10	0.097332	182.5	01Jan2015, 12:20	24.5
U/S Limit - Sierra	0.097332	154.8	01Jan2015, 12:35	24.5
LBC-20	0.084519	182.2	01Jan2015, 12:20	23
ADD-LBC-10-20	0.181851	322.5	01Jan2015, 12:25	47.5
Reach-LBC-20	0.181851	320.1	01Jan2015, 12:25	47.5
Honeysuckle Road	0.181851	320.1	01Jan2015, 12:25	47.5
Reach-LBC-30	0.181851	315.9	01Jan2015, 12:30	47.5
LBC-30	0.159799	211.2	01Jan2015, 13:00	49.9

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

100-YEAR EXISTING				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Booker Creek Road	0.34165	484.1	01Jan2015, 12:40	97.4
Reach-LBC-40	0.34165	462.3	01Jan2015, 12:50	97.1
LBC-40	0.156492	513.1	01Jan2015, 12:10	50.8
LBC-50	0.022218	0.7	01Jan2015, 12:05	0.1
ADD-LBC-40-50	5.042406	3337	01Jan2015, 13:05	1254
LBC-60	0.142061	358.6	01Jan2015, 12:10	37.9
ADD-LBC-60	5.184467	3404.3	01Jan2015, 12:55	1291.9
Reach-LBC-60	5.184467	3401.3	01Jan2015, 13:05	1291.3
LBC-70	0.107956	273.5	01Jan2015, 12:10	26.6
LBC-130	0.03607	74.4	01Jan2015, 12:30	12
ADD-LBC-70-130	5.328493	3485.1	01Jan2015, 12:55	1330
LBC-90	0.115064	181.8	01Jan2015, 12:50	39.6
LBC-80	0.06417	125.2	01Jan2015, 12:30	20.7
Fordham Blvd - Upstream	0.06417	125.2	01Jan2015, 12:30	20.7
LBC-100	0.029058	48.9	01Jan2015, 12:45	10.3
Dobbins Drive	0.208292	342.5	01Jan2015, 12:40	70.6
LBC-110	0.0333	52.3	01Jan2015, 12:45	10.8
Summerfield Crossing	0.241592	393.5	01Jan2015, 12:45	81.5
LBC-120	0.049799	75.9	01Jan2015, 12:50	16.3
Foxcroft Drive	0.291391	467.3	01Jan2015, 12:45	97.8
East Franklin Street	5.619884	3888.6	01Jan2015, 13:05	1427.8
LBC-140	0.088638	215.5	01Jan2015, 12:25	32.8
ADD-LBC-140	5.708522	3973.7	01Jan2015, 13:00	1460.6
Reach-LBC-140	5.708522	3531.1	01Jan2015, 13:35	1453.7
LBC-150	0.107836	215.3	01Jan2015, 12:25	31.5
ADD-LBC-150	5.816358	3573.2	01Jan2015, 13:35	1485.2
LBC-160	0.077625	184.4	01Jan2015, 12:20	26.8
Fordham Blvd - Downstream	5.893983	3603.5	01Jan2015, 13:35	1511.9
LBC-180	0.14221	421.3	01Jan2015, 12:15	48.9
LBC-170	0.027436	90.3	01Jan2015, 12:10	9.1
ADD-LBC-170-180	6.063629	3654.7	01Jan2015, 13:35	1569.9
Reach-LBC-190	6.063629	3648.2	01Jan2015, 13:40	1569.8
LBC-190	0.05069	106.1	01Jan2015, 12:25	15.5
Willow Drive	6.114319	3668.8	01Jan2015, 13:40	1585.4
Reach-LBC-200	6.114319	3518.2	01Jan2015, 14:15	1581.4
LBC-200	0.168071	254.9	01Jan2015, 12:45	49.5
ADD-LBC-200	6.28239	3581.8	01Jan2015, 14:10	1630.9
OUTLET	6.28239	3581.8	01Jan2015, 14:10	1630.9

FUTURE CONDITIONS:
HEC-HMS OUTPUT

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

2-YEAR FUTURE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
BH-10	0.139076	56.7	01Jan2015, 12:40	12.4
BH-20	0.07669	32.5	01Jan2015, 12:25	5.4
ADD-BH-10-20	0.215766	85.9	01Jan2015, 12:35	17.8
Reach-BH-20	0.215766	85.5	01Jan2015, 12:40	17.8
BH-30	0.165073	61.1	01Jan2015, 12:50	13.9
ADD-BH-30	0.380839	114.6	01Jan2015, 13:10	31.7
BH-40	0.105607	84.9	01Jan2015, 12:10	8.8
ADD-BH-40	0.486446	126.6	01Jan2015, 13:10	40.5
Reach-BH-40	0.486446	125.9	01Jan2015, 13:15	40.5
BH-60	0.129437	47.3	01Jan2015, 12:50	10.4
BH-50	0.117491	60.1	01Jan2015, 12:20	8.1
Weaver Dairy Rd Ext	0.117491	53.3	01Jan2015, 12:30	8.1
Northern Park	0.246928	95.1	01Jan2015, 12:35	18.5
ADD-BH	0.733374	188.2	01Jan2015, 12:45	59
BH-70	0.062883	45.8	01Jan2015, 12:10	5.1
MLK Jr. Blvd	0.796257	216.7	01Jan2015, 12:25	64.1
BH-80	0.10254	54.4	01Jan2015, 12:30	9
Stateside Drive	0.10254	54.4	01Jan2015, 12:30	9
BH-90	0.094578	28.2	01Jan2015, 12:55	6.7
ADD-BH-90	0.197118	76.2	01Jan2015, 12:35	15.7
BH-100	0.110825	49.9	01Jan2015, 12:30	8.3
ADD-BH-100	1.1042	337.9	01Jan2015, 12:30	88.1
Reach-BH-100	1.1042	336.9	01Jan2015, 12:30	88.1
BH-110	0.117356	108.7	01Jan2015, 12:15	13.3
MLK Jr. - Kings Br	0.117356	81	01Jan2015, 12:25	13.3
BH-120	0.02747	19.5	01Jan2015, 12:10	2.1
ADD-BH-120	1.249026	425.6	01Jan2015, 12:30	103.5
BH-130	0.100527	56.2	01Jan2015, 12:30	9.1
Lake Ellen	1.349553	464.3	01Jan2015, 12:40	112.7
CB-10	0.144686	57.9	01Jan2015, 12:55	14.1
Reach-CB-10	0.144686	57.9	01Jan2015, 13:00	14.1
CB-20	0.112513	43.7	01Jan2015, 12:45	9.4
ADD-CB-20	0.257199	98.2	01Jan2015, 12:50	23.5
Reach-CB-20	0.257199	97.5	01Jan2015, 13:00	23.5
CB-30	0.026991	17.8	01Jan2015, 12:40	3.6
CB-40	0.051355	61.5	01Jan2015, 12:15	7.6
ADD-CB-30-40	0.335545	126.2	01Jan2015, 13:00	34.7
CB-50	0.072003	59.8	01Jan2015, 12:35	11.3
Municipal Drive	0.072003	59.8	01Jan2015, 12:35	11.3
CB-60	0.031973	33.7	01Jan2015, 12:20	4.8
RT CB-50-60	0.103976	70	01Jan2015, 12:50	16.1
ADD-CB-60	0.439521	195.1	01Jan2015, 12:55	50.8
Reach-CB-60	0.439521	193.6	01Jan2015, 13:05	50.7
CB-70	0.149895	69.7	01Jan2015, 13:00	16.8
RT CB-70	0.149895	55.1	01Jan2015, 13:30	16.8
ADD-CB-70	0.589416	243	01Jan2015, 13:10	67.6
Reach-CB-70	0.589416	239.3	01Jan2015, 13:30	67.5
CB-80	0.083068	37.8	01Jan2015, 12:25	5.8
ADD-CB-80	0.672484	248.1	01Jan2015, 13:25	73.3
Reach-CB-80	0.672484	247.6	01Jan2015, 13:40	73.2
ADD- CB-BH	2.022037	599.1	01Jan2015, 12:45	185.9
EL-20	0.137538	110	01Jan2015, 12:05	10.4
ADD-EL-20	2.159575	621.6	01Jan2015, 12:45	196.4
Reach-EL-20	2.159575	618.7	01Jan2015, 12:50	196.3
EL-10	0.138871	140.4	01Jan2015, 12:10	14.1
Piney Mountain Rd	0.138871	140.4	01Jan2015, 12:10	14.1

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

2-YEAR FUTURE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Piney Mountain Rd -Booker Ck	2.298446	638.6	01Jan2015, 12:55	210.4
EL-30	0.119754	60	01Jan2015, 12:10	6.8
Reach- EL-30	2.4182	655.9	01Jan2015, 12:45	217.2
EL-50	0.11573	74.8	01Jan2015, 12:10	7.8
ADD-EL-50	2.53393	679	01Jan2015, 12:40	225
Reach-EL-50	2.53393	675.7	01Jan2015, 12:50	225
EL-40	0.074895	63.5	01Jan2015, 12:10	6.4
Kensington Drive	0.074895	63.5	01Jan2015, 12:10	6.4
N Lakeshore Dr - Booker Ck	2.608825	690	01Jan2015, 12:50	231.4
CF-10	0.078889	86.1	01Jan2015, 12:10	9.4
Kingston Drive	0.078889	86.1	01Jan2015, 12:10	9.4
CF-20	0.076885	38.8	01Jan2015, 12:55	9.1
ADD-CF-20	0.155774	100.4	01Jan2015, 12:10	18.6
Weaver Dairy - Cedar Fk	0.155774	100.4	01Jan2015, 12:10	18.6
CF-30	0.044849	14.8	01Jan2015, 12:40	2.9
ADD-CF-30	0.200623	107	01Jan2015, 12:10	21.4
Cross Creek Drive	0.200623	107	01Jan2015, 12:10	21.4
Reach-CF-50	0.200623	105.7	01Jan2015, 12:15	21.4
CF-40	0.092855	35.5	01Jan2015, 12:45	7.3
Weaver Dairy Rd - 1	0.092855	29.1	01Jan2015, 13:05	7.3
CF-50	0.029148	11.2	01Jan2015, 12:15	1.5
ADD-CF-50	0.322626	125	01Jan2015, 12:15	30.3
CF-60	0.12336	34.8	01Jan2015, 12:55	8.3
Cedar Hills Circle	0.445986	140.2	01Jan2015, 12:20	38.5
Reach-CF-80	0.445986	139.7	01Jan2015, 12:25	38.5
CF-80	0.176821	73.1	01Jan2015, 12:25	11.2
CF-70	0.120239	34.5	01Jan2015, 13:05	9.4
Weaver Dairy Rd -2	0.120239	34.5	01Jan2015, 13:05	9.4
Kenmore Road	0.743046	230.8	01Jan2015, 12:30	59.2
Reach-CF-130	0.743046	230.4	01Jan2015, 12:35	59.2
CF-90	0.184752	47.9	01Jan2015, 12:40	9.9
CF-100	0.085353	44.9	01Jan2015, 12:10	4.5
Piney Mountain Rd - Cedar Fk	0.085353	44.9	01Jan2015, 12:10	4.5
CF-110	0.044111	18.5	01Jan2015, 12:20	2.5
ADD-CF-110	0.129464	61.1	01Jan2015, 12:10	7
ADD-CF-90-120	0.314216	81.1	01Jan2015, 12:15	17
CF-120	0.096092	41.2	01Jan2015, 12:15	5.3
Brookview Drive	1.153354	334.2	01Jan2015, 12:30	81.4
Reach-CF-140	1.153354	333.1	01Jan2015, 12:30	81.5
CF-130	0.151403	45.1	01Jan2015, 12:40	8.6
CF-140	0.042477	15.9	01Jan2015, 12:25	2.5
North Lakeshore Drive	1.347234	389.9	01Jan2015, 12:30	92.6
CF-150	0.050842	26.8	01Jan2015, 12:10	2.9
ADD-CF-150	1.398076	402.6	01Jan2015, 12:30	95.5
EL-60	0.142028	55.7	01Jan2015, 12:20	7.9
EL-90	0.100143	74.5	01Jan2015, 12:10	7.8
EL-70	0.094086	55.6	01Jan2015, 12:20	7
EL-80	0.091741	61.2	01Jan2015, 12:10	6.3
EL-100	0.087147	83.6	01Jan2015, 12:20	10.2
Eastwood Lake	4.522046	833.4	01Jan2015, 13:40	366
LBC-10	0.097332	45.3	01Jan2015, 12:25	6.7
U/S Limit - Sierra	0.097332	43.7	01Jan2015, 12:30	6.7
LBC-20	0.084519	50.5	01Jan2015, 12:20	6.8
ADD-LBC-10-20	0.181851	91.8	01Jan2015, 12:25	13.6
Reach-LBC-20	0.181851	91.4	01Jan2015, 12:25	13.6
Honeysuckle Road	0.181851	91.4	01Jan2015, 12:25	13.6

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

2-YEAR FUTURE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Reach-LBC-30	0.181851	91.1	01Jan2015, 12:25	13.6
LBC-30	0.159799	71.5	01Jan2015, 13:00	17.3
Booker Creek Road	0.34165	140.1	01Jan2015, 12:35	30.9
Reach-LBC-40	0.34165	135.3	01Jan2015, 12:45	30.8
LBC-40	0.156492	178.4	01Jan2015, 12:10	17.9
LBC-50	0.022218	14	01Jan2015, 12:10	1.4
ADD-LBC-40-50	5.042406	931.6	01Jan2015, 13:30	416.2
LBC-60	0.142061	102.1	01Jan2015, 12:15	11.5
ADD-LBC-60	5.184467	944.8	01Jan2015, 13:30	427.7
Reach-LBC-60	5.184467	942.7	01Jan2015, 13:40	427.6
LBC-70	0.107956	72.2	01Jan2015, 12:10	7.7
LBC-130	0.03607	27.1	01Jan2015, 12:30	4.5
ADD-LBC-70-130	5.328493	957.3	01Jan2015, 13:40	439.8
LBC-90	0.115064	66.9	01Jan2015, 12:50	14.8
LBC-80	0.06417	46.4	01Jan2015, 12:30	7.9
Fordham Blvd - Upstream	0.06417	46.4	01Jan2015, 12:30	7.9
LBC-100	0.029058	19	01Jan2015, 12:45	4.1
Dobbins Drive	0.208292	127.1	01Jan2015, 12:40	26.9
LBC-110	0.0333	20.8	01Jan2015, 12:50	4.5
Summerfield Crossing	0.241592	147.7	01Jan2015, 12:45	31.4
LBC-120	0.049799	27.4	01Jan2015, 12:50	6
Foxcroft Drive	0.291391	174.4	01Jan2015, 12:45	37.4
East Franklin Street	5.619884	968.4	01Jan2015, 14:05	477.2
LBC-140	0.088638	84.4	01Jan2015, 12:25	13
ADD-LBC-140	5.708522	978.9	01Jan2015, 14:05	490.2
Reach-LBC-140	5.708522	946.1	01Jan2015, 14:30	488.7
LBC-150	0.107836	70.1	01Jan2015, 12:25	10.9
ADD-LBC-150	5.816358	953.8	01Jan2015, 14:30	499.6
LBC-160	0.077625	73	01Jan2015, 12:20	11
Fordham Blvd - Downstream	5.893983	958.9	01Jan2015, 14:35	510.7
LBC-180	0.14221	168.5	01Jan2015, 12:15	20
LBC-170	0.027436	38.5	01Jan2015, 12:10	4.1
ADD-LBC-170-180	6.063629	971.8	01Jan2015, 14:35	534.8
Reach-LBC-190	6.063629	970.8	01Jan2015, 14:45	534.7
LBC-190	0.05069	33.2	01Jan2015, 12:25	5
Willow Drive	6.114319	974.5	01Jan2015, 14:40	539.7
Reach-LBC-200	6.114319	955.4	01Jan2015, 15:15	538.9
LBC-200	0.168071	74.7	01Jan2015, 12:45	15
ADD-LBC-200	6.28239	967.6	01Jan2015, 15:10	553.9
OUTLET	6.28239	967.6	01Jan2015, 15:10	553.9

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

10-YEAR FUTURE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
BH-10	0.139076	107.1	01Jan2015, 12:40	22.1
BH-20	0.07669	69.5	01Jan2015, 12:25	10.5
ADD-BH-10-20	0.215766	168.6	01Jan2015, 12:35	32.6
Reach-BH-20	0.215766	167.7	01Jan2015, 12:40	32.6
BH-30	0.165073	121	01Jan2015, 12:50	26.1
ADD-BH-30	0.380839	263.2	01Jan2015, 12:55	58.7
BH-40	0.105607	167.9	01Jan2015, 12:10	16.6
ADD-BH-40	0.486446	292.8	01Jan2015, 12:55	75.3
Reach-BH-40	0.486446	291.8	01Jan2015, 13:00	75.3
BH-60	0.129437	95.5	01Jan2015, 12:45	19.7
BH-50	0.117491	129.2	01Jan2015, 12:20	16.3
Weaver Dairy Rd Ext	0.117491	114.5	01Jan2015, 12:30	16.3
Northern Park	0.246928	198.7	01Jan2015, 12:35	36.1
ADD-BH	0.733374	457.5	01Jan2015, 12:50	111.3
BH-70	0.062883	91.9	01Jan2015, 12:10	9.7
MLK Jr. Blvd	0.796257	473.6	01Jan2015, 12:55	121
BH-80	0.10254	105.6	01Jan2015, 12:30	16.6
Stateside Drive	0.10254	105.6	01Jan2015, 12:30	16.6
BH-90	0.094578	60	01Jan2015, 12:55	13.3
ADD-BH-90	0.197118	153.3	01Jan2015, 12:35	29.9
BH-100	0.110825	103.6	01Jan2015, 12:30	16.2
ADD-BH-100	1.1042	696.5	01Jan2015, 12:40	167.1
Reach-BH-100	1.1042	694.7	01Jan2015, 12:45	167.1
BH-110	0.117356	190.2	01Jan2015, 12:10	22.4
MLK Jr. - Kings Br	0.117356	141.8	01Jan2015, 12:25	22.4
BH-120	0.02747	39.6	01Jan2015, 12:10	4.1
ADD-BH-120	1.249026	844.6	01Jan2015, 12:30	193.6
BH-130	0.100527	108.1	01Jan2015, 12:30	17
Lake Ellen	1.349553	854.5	01Jan2015, 12:50	210.6
CB-10	0.144686	108.2	01Jan2015, 12:55	25.3
Reach-CB-10	0.144686	107.8	01Jan2015, 13:00	25.3
CB-20	0.112513	86.2	01Jan2015, 12:40	17.3
ADD-CB-20	0.257199	186.4	01Jan2015, 12:50	42.6
Reach-CB-20	0.257199	184.3	01Jan2015, 13:00	42.5
CB-30	0.026991	29.6	01Jan2015, 12:40	5.9
CB-40	0.051355	99.5	01Jan2015, 12:15	12.1
ADD-CB-30-40	0.335545	226	01Jan2015, 13:05	60.5
CB-50	0.072003	95	01Jan2015, 12:35	17.9
Municipal Drive	0.072003	95	01Jan2015, 12:35	17.9
CB-60	0.031973	54.3	01Jan2015, 12:20	7.7
RT CB-50-60	0.103976	111.7	01Jan2015, 12:50	25.5
ADD-CB-60	0.439521	332.7	01Jan2015, 13:00	86
Reach-CB-60	0.439521	331.1	01Jan2015, 13:05	86
CB-70	0.149895	124	01Jan2015, 12:55	29.2
RT CB-70	0.149895	98.1	01Jan2015, 13:25	29.2
ADD-CB-70	0.589416	422.1	01Jan2015, 13:10	115.2
Reach-CB-70	0.589416	416.3	01Jan2015, 13:30	115.1
CB-80	0.083068	80.7	01Jan2015, 12:25	11.4
ADD-CB-80	0.672484	433.2	01Jan2015, 13:30	126.5
Reach-CB-80	0.672484	432.1	01Jan2015, 13:40	126.5
ADD- CB-BH	2.022037	1156.2	01Jan2015, 13:10	337.1
EL-20	0.137538	227.5	01Jan2015, 12:05	20.4
ADD-EL-20	2.159575	1182.1	01Jan2015, 13:05	357.5
Reach-EL-20	2.159575	1179.6	01Jan2015, 13:15	357.4
EL-10	0.138871	257.2	01Jan2015, 12:10	25.1
Piney Mountain Rd	0.138871	257.2	01Jan2015, 12:10	25.1

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

10-YEAR FUTURE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Piney Mountain Rd -Booker Ck	2.298446	1168.7	01Jan2015, 13:30	382.5
EL-30	0.119754	141.1	01Jan2015, 12:10	14.4
Reach- EL-30	2.4182	1184.1	01Jan2015, 13:35	396.9
EL-50	0.11573	161.1	01Jan2015, 12:10	15.7
ADD-EL-50	2.53393	1199.8	01Jan2015, 13:35	412.7
Reach-EL-50	2.53393	1196.9	01Jan2015, 13:45	412.6
EL-40	0.074895	124	01Jan2015, 12:10	12.2
Kensington Drive	0.074895	124	01Jan2015, 12:10	12.2
N Lakeshore Dr - Booker Ck	2.608825	1207.5	01Jan2015, 13:45	424.7
CF-10	0.078889	147.5	01Jan2015, 12:10	15.6
Kingston Drive	0.078889	147.5	01Jan2015, 12:10	15.6
CF-20	0.076885	67.4	01Jan2015, 12:55	15.5
ADD-CF-20	0.155774	173.3	01Jan2015, 12:10	31.1
Weaver Dairy - Cedar Fk	0.155774	173.3	01Jan2015, 12:10	31.1
CF-30	0.044849	33	01Jan2015, 12:35	5.8
ADD-CF-30	0.200623	189.8	01Jan2015, 12:10	37
Cross Creek Drive	0.200623	189.8	01Jan2015, 12:10	37
Reach-CF-50	0.200623	187.8	01Jan2015, 12:15	37
CF-40	0.092855	72.2	01Jan2015, 12:40	14
Weaver Dairy Rd - 1	0.092855	59	01Jan2015, 13:00	14
CF-50	0.029148	27.7	01Jan2015, 12:15	3.2
ADD-CF-50	0.322626	233.6	01Jan2015, 12:15	54.1
CF-60	0.12336	75.8	01Jan2015, 12:50	16.6
Cedar Hills Circle	0.445986	271.7	01Jan2015, 12:40	70.7
Reach-CF-80	0.445986	271.3	01Jan2015, 12:45	70.7
CF-80	0.176821	162.8	01Jan2015, 12:25	23
CF-70	0.120239	69.7	01Jan2015, 13:05	17.8
Weaver Dairy Rd -2	0.120239	69.7	01Jan2015, 13:05	17.8
Kenmore Road	0.743046	470.8	01Jan2015, 12:25	111.5
Reach-CF-130	0.743046	470.5	01Jan2015, 12:30	111.5
CF-90	0.184752	116.2	01Jan2015, 12:40	21.5
CF-100	0.085353	108.8	01Jan2015, 12:05	9.8
Piney Mountain Rd - Cedar Fk	0.085353	108.8	01Jan2015, 12:05	9.8
CF-110	0.044111	43.6	01Jan2015, 12:15	5.3
ADD-CF-110	0.129464	146.1	01Jan2015, 12:10	15.2
ADD-CF-90-120	0.314216	198.8	01Jan2015, 12:15	36.6
CF-120	0.096092	98.2	01Jan2015, 12:15	11.2
Brookview Drive	1.153354	719.4	01Jan2015, 12:30	159.3
Reach-CF-140	1.153354	718.9	01Jan2015, 12:30	159.4
CF-130	0.151403	106.2	01Jan2015, 12:40	18.8
CF-140	0.042477	36.9	01Jan2015, 12:20	5.1
North Lakeshore Drive	1.347234	854.6	01Jan2015, 12:30	183.3
CF-150	0.050842	62.6	01Jan2015, 12:10	6.1
ADD-CF-150	1.398076	882.1	01Jan2015, 12:30	189.4
EL-60	0.142028	131.6	01Jan2015, 12:20	16.7
EL-90	0.100143	151.9	01Jan2015, 12:10	15.2
EL-70	0.094086	116	01Jan2015, 12:15	13.9
EL-80	0.091741	131	01Jan2015, 12:10	12.8
EL-100	0.087147	145.4	01Jan2015, 12:15	17.8
Eastwood Lake	4.522046	1777.9	01Jan2015, 13:20	690.2
LBC-10	0.097332	97	01Jan2015, 12:25	13.5
U/S Limit - Sierra	0.097332	87.5	01Jan2015, 12:30	13.5
LBC-20	0.084519	101.6	01Jan2015, 12:20	13.1
ADD-LBC-10-20	0.181851	181	01Jan2015, 12:25	26.5
Reach-LBC-20	0.181851	179.8	01Jan2015, 12:25	26.5
Honeysuckle Road	0.181851	179.8	01Jan2015, 12:25	26.5

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

10-YEAR FUTURE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Reach-LBC-30	0.181851	179.4	01Jan2015, 12:25	26.5
LBC-30	0.159799	129	01Jan2015, 13:00	30.7
Booker Creek Road	0.34165	270.5	01Jan2015, 12:35	57.2
Reach-LBC-40	0.34165	257.2	01Jan2015, 12:45	57
LBC-40	0.156492	313.3	01Jan2015, 12:10	31.1
LBC-50	0.022218	30.7	01Jan2015, 12:10	2.9
ADD-LBC-40-50	5.042406	2033.1	01Jan2015, 13:05	781.3
LBC-60	0.142061	203.7	01Jan2015, 12:10	22
ADD-LBC-60	5.184467	2069.3	01Jan2015, 13:05	803.3
Reach-LBC-60	5.184467	2063.3	01Jan2015, 13:15	803
LBC-70	0.107956	152.4	01Jan2015, 12:10	15.3
LBC-130	0.03607	46.4	01Jan2015, 12:30	7.6
ADD-LBC-70-130	5.328493	2103	01Jan2015, 13:10	825.8
LBC-90	0.115064	113.5	01Jan2015, 12:50	24.9
LBC-80	0.06417	79.9	01Jan2015, 12:30	13.5
Fordham Blvd - Upstream	0.06417	79.9	01Jan2015, 12:30	13.5
LBC-100	0.029058	31.3	01Jan2015, 12:45	6.7
Dobbins Drive	0.208292	215.9	01Jan2015, 12:40	45
LBC-110	0.0333	34.7	01Jan2015, 12:45	7.4
Summerfield Crossing	0.241592	249.9	01Jan2015, 12:40	52.4
LBC-120	0.049799	47.5	01Jan2015, 12:50	10.3
Foxcroft Drive	0.291391	293.9	01Jan2015, 12:50	62.7
East Franklin Street	5.619884	2324.1	01Jan2015, 13:15	888.5
LBC-140	0.088638	136.9	01Jan2015, 12:25	20.9
ADD-LBC-140	5.708522	2363.8	01Jan2015, 13:15	909.4
Reach-LBC-140	5.708522	2090.3	01Jan2015, 13:45	905.9
LBC-150	0.107836	128.7	01Jan2015, 12:25	19.3
ADD-LBC-150	5.816358	2113.4	01Jan2015, 13:40	925.1
LBC-160	0.077625	119.5	01Jan2015, 12:20	17.7
Fordham Blvd - Downstream	5.893983	2129.4	01Jan2015, 13:45	942.9
LBC-180	0.14221	276.6	01Jan2015, 12:15	32.6
LBC-170	0.027436	61.9	01Jan2015, 12:10	6.6
ADD-LBC-170-180	6.063629	2159.4	01Jan2015, 13:45	982.1
Reach-LBC-190	6.063629	2153.1	01Jan2015, 13:55	982
LBC-190	0.05069	62.1	01Jan2015, 12:25	9.1
Willow Drive	6.114319	2163.2	01Jan2015, 13:55	991.2
Reach-LBC-200	6.114319	2043.2	01Jan2015, 14:30	989.4
LBC-200	0.168071	144.9	01Jan2015, 12:45	28.3
ADD-LBC-200	6.28239	2074.5	01Jan2015, 14:30	1017.7
OUTLET	6.28239	2074.5	01Jan2015, 14:30	1017.7

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

25-YEAR FUTURE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
BH-10	0.139076	139.5	01Jan2015, 12:40	28.2
BH-20	0.07669	93.3	01Jan2015, 12:25	13.8
ADD-BH-10-20	0.215766	221.9	01Jan2015, 12:35	42
Reach-BH-20	0.215766	220.8	01Jan2015, 12:35	42
BH-30	0.165073	158.4	01Jan2015, 12:50	33.8
ADD-BH-30	0.380839	349.6	01Jan2015, 12:55	75.8
BH-40	0.105607	219.5	01Jan2015, 12:10	21.4
ADD-BH-40	0.486446	391.1	01Jan2015, 12:50	97.2
Reach-BH-40	0.486446	389.9	01Jan2015, 12:55	97.2
BH-60	0.129437	126	01Jan2015, 12:45	25.6
BH-50	0.117491	172.9	01Jan2015, 12:20	21.6
Weaver Dairy Rd Ext	0.117491	152.4	01Jan2015, 12:30	21.6
Northern Park	0.246928	264.7	01Jan2015, 12:35	47.2
ADD-BH	0.733374	615	01Jan2015, 12:45	144.4
BH-70	0.062883	120.8	01Jan2015, 12:10	12.6
MLK Jr. Blvd	0.796257	638.6	01Jan2015, 12:50	157
BH-80	0.10254	137.4	01Jan2015, 12:30	21.4
Stateside Drive	0.10254	137.4	01Jan2015, 12:30	21.4
BH-90	0.094578	80.2	01Jan2015, 12:55	17.5
ADD-BH-90	0.197118	201.9	01Jan2015, 12:35	38.9
BH-100	0.110825	137.4	01Jan2015, 12:30	21.2
ADD-BH-100	1.1042	943.1	01Jan2015, 12:40	217.1
Reach-BH-100	1.1042	940.3	01Jan2015, 12:45	217.2
BH-110	0.117356	240.6	01Jan2015, 12:10	28
MLK Jr. - Kings Br	0.117356	179.3	01Jan2015, 12:25	28
BH-120	0.02747	52.3	01Jan2015, 12:10	5.3
ADD-BH-120	1.249026	1106.9	01Jan2015, 12:35	250.4
BH-130	0.100527	139.7	01Jan2015, 12:30	21.9
Lake Ellen	1.349553	1084.8	01Jan2015, 12:55	272.4
CB-10	0.144686	139.2	01Jan2015, 12:55	32.2
Reach-CB-10	0.144686	138.6	01Jan2015, 13:00	32.2
CB-20	0.112513	113.2	01Jan2015, 12:40	22.3
ADD-CB-20	0.257199	242.1	01Jan2015, 12:50	54.5
Reach-CB-20	0.257199	239.4	01Jan2015, 13:00	54.4
CB-30	0.026991	36.7	01Jan2015, 12:40	7.2
CB-40	0.051355	121.9	01Jan2015, 12:15	14.8
ADD-CB-30-40	0.335545	288	01Jan2015, 13:05	76.4
CB-50	0.072003	115.5	01Jan2015, 12:35	21.7
Municipal Drive	0.072003	115.5	01Jan2015, 12:35	21.7
CB-60	0.031973	66.4	01Jan2015, 12:20	9.4
RT CB-50-60	0.103976	136.1	01Jan2015, 12:50	31.1
ADD-CB-60	0.439521	417.8	01Jan2015, 12:55	107.5
Reach-CB-60	0.439521	415.5	01Jan2015, 13:05	107.5
CB-70	0.149895	156.8	01Jan2015, 12:55	36.7
RT CB-70	0.149895	120.9	01Jan2015, 13:30	36.7
ADD-CB-70	0.589416	528.4	01Jan2015, 13:10	144.2
Reach-CB-70	0.589416	522.2	01Jan2015, 13:30	144.1
CB-80	0.083068	108.5	01Jan2015, 12:20	15
ADD-CB-80	0.672484	544.1	01Jan2015, 13:25	159.1
Reach-CB-80	0.672484	543.2	01Jan2015, 13:40	159.1
ADD- CB-BH	2.022037	1500.8	01Jan2015, 13:15	431.4
EL-20	0.137538	301.1	01Jan2015, 12:05	26.7
ADD-EL-20	2.159575	1530.3	01Jan2015, 13:15	458.1
Reach-EL-20	2.159575	1527.1	01Jan2015, 13:20	458
EL-10	0.138871	327.9	01Jan2015, 12:10	31.9
Piney Mountain Rd	0.138871	327.9	01Jan2015, 12:10	31.9

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

25-YEAR FUTURE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Piney Mountain Rd -Booker Ck	2.298446	1543.1	01Jan2015, 13:30	489.9
EL-30	0.119754	194	01Jan2015, 12:10	19.4
Reach- EL-30	2.4182	1562.8	01Jan2015, 13:35	509.3
EL-50	0.11573	216	01Jan2015, 12:10	20.8
ADD-EL-50	2.53393	1582.9	01Jan2015, 13:35	530.1
Reach-EL-50	2.53393	1580.3	01Jan2015, 13:45	530
EL-40	0.074895	161.1	01Jan2015, 12:10	15.7
Kensington Drive	0.074895	161.1	01Jan2015, 12:10	15.7
N Lakeshore Dr - Booker Ck	2.608825	1593.6	01Jan2015, 13:45	545.7
CF-10	0.078889	185.1	01Jan2015, 12:10	19.4
Kingston Drive	0.078889	185.1	01Jan2015, 12:10	19.4
CF-20	0.076885	84.7	01Jan2015, 12:50	19.3
ADD-CF-20	0.155774	218	01Jan2015, 12:10	38.8
Weaver Dairy - Cedar Fk	0.155774	218	01Jan2015, 12:10	38.8
CF-30	0.044849	44.9	01Jan2015, 12:35	7.8
ADD-CF-30	0.200623	241.2	01Jan2015, 12:10	46.5
Cross Creek Drive	0.200623	241.2	01Jan2015, 12:10	46.5
Reach-CF-50	0.200623	238.6	01Jan2015, 12:15	46.5
CF-40	0.092855	95.5	01Jan2015, 12:40	18.1
Weaver Dairy Rd - 1	0.092855	78	01Jan2015, 13:00	18.1
CF-50	0.029148	38.8	01Jan2015, 12:15	4.4
ADD-CF-50	0.322626	302.3	01Jan2015, 12:15	69
CF-60	0.12336	102.4	01Jan2015, 12:50	21.9
Cedar Hills Circle	0.445986	356.7	01Jan2015, 12:40	90.9
Reach-CF-80	0.445986	356.3	01Jan2015, 12:45	90.9
CF-80	0.176821	220.5	01Jan2015, 12:25	30.6
CF-70	0.120239	92.2	01Jan2015, 13:05	23.1
Weaver Dairy Rd -2	0.120239	92.2	01Jan2015, 13:05	23.1
Kenmore Road	0.743046	624.5	01Jan2015, 12:30	144.7
Reach-CF-130	0.743046	623.5	01Jan2015, 12:30	144.7
CF-90	0.184752	161.3	01Jan2015, 12:40	29.1
CF-100	0.085353	151.3	01Jan2015, 12:05	13.3
Piney Mountain Rd - Cedar Fk	0.085353	151.3	01Jan2015, 12:05	13.3
CF-110	0.044111	60.1	01Jan2015, 12:15	7.2
ADD-CF-110	0.129464	201.5	01Jan2015, 12:10	20.5
ADD-CF-90-120	0.314216	277.1	01Jan2015, 12:15	49.6
CF-120	0.096092	135.7	01Jan2015, 12:15	15.2
Brookview Drive	1.153354	966.5	01Jan2015, 12:30	209.4
Reach-CF-140	1.153354	966.1	01Jan2015, 12:30	209.4
CF-130	0.151403	145.5	01Jan2015, 12:40	25.3
CF-140	0.042477	50.9	01Jan2015, 12:20	6.9
North Lakeshore Drive	1.347234	1153	01Jan2015, 12:30	241.6
CF-150	0.050842	85.9	01Jan2015, 12:10	8.2
ADD-CF-150	1.398076	1190	01Jan2015, 12:30	249.9
EL-60	0.142028	181.6	01Jan2015, 12:15	22.5
EL-90	0.100143	200	01Jan2015, 12:10	19.9
EL-70	0.094086	153.9	01Jan2015, 12:15	18.2
EL-80	0.091741	175.1	01Jan2015, 12:10	16.9
EL-100	0.087147	181.8	01Jan2015, 12:15	22.3
Eastwood Lake	4.522046	2358.8	01Jan2015, 13:15	895.1
LBC-10	0.097332	130.2	01Jan2015, 12:20	17.8
U/S Limit - Sierra	0.097332	115.7	01Jan2015, 12:35	17.8
LBC-20	0.084519	133.3	01Jan2015, 12:20	17
ADD-LBC-10-20	0.181851	237.1	01Jan2015, 12:25	34.8
Reach-LBC-20	0.181851	235.1	01Jan2015, 12:25	34.8
Honeysuckle Road	0.181851	235.1	01Jan2015, 12:25	34.8

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

25-YEAR FUTURE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Reach-LBC-30	0.181851	234.5	01Jan2015, 12:25	34.8
LBC-30	0.159799	163.3	01Jan2015, 13:00	38.8
Booker Creek Road	0.34165	350.9	01Jan2015, 12:35	73.6
Reach-LBC-40	0.34165	334.9	01Jan2015, 12:45	73.3
LBC-40	0.156492	393.3	01Jan2015, 12:10	39.1
LBC-50	0.022218	41.3	01Jan2015, 12:10	3.9
ADD-LBC-40-50	5.042406	2714.2	01Jan2015, 13:00	1011.4
LBC-60	0.142061	267.8	01Jan2015, 12:10	28.6
ADD-LBC-60	5.184467	2770.8	01Jan2015, 12:55	1040
Reach-LBC-60	5.184467	2762.3	01Jan2015, 13:05	1039.4
LBC-70	0.107956	203.1	01Jan2015, 12:10	20.1
LBC-130	0.03607	57.9	01Jan2015, 12:30	9.5
ADD-LBC-70-130	5.328493	2821.8	01Jan2015, 13:05	1069
LBC-90	0.115064	140.9	01Jan2015, 12:50	30.9
LBC-80	0.06417	99.6	01Jan2015, 12:30	16.8
Fordham Blvd - Upstream	0.06417	99.6	01Jan2015, 12:30	16.8
LBC-100	0.029058	38.5	01Jan2015, 12:45	8.2
Dobbins Drive	0.208292	268.2	01Jan2015, 12:40	55.8
LBC-110	0.0333	43	01Jan2015, 12:45	9.1
Summerfield Crossing	0.241592	310.2	01Jan2015, 12:45	65
LBC-120	0.049799	59.4	01Jan2015, 12:50	12.8
Foxcroft Drive	0.291391	369.8	01Jan2015, 12:45	77.8
East Franklin Street	5.619884	3122.4	01Jan2015, 13:10	1146.8
LBC-140	0.088638	167.8	01Jan2015, 12:25	25.6
ADD-LBC-140	5.708522	3177.4	01Jan2015, 13:10	1172.3
Reach-LBC-140	5.708522	2801.8	01Jan2015, 13:35	1167
LBC-150	0.107836	164.8	01Jan2015, 12:25	24.4
ADD-LBC-150	5.816358	2834.4	01Jan2015, 13:35	1191.4
LBC-160	0.077625	147.3	01Jan2015, 12:20	21.7
Fordham Blvd - Downstream	5.893983	2856.5	01Jan2015, 13:35	1213.1
LBC-180	0.14221	340.1	01Jan2015, 12:15	40
LBC-170	0.027436	75.5	01Jan2015, 12:10	8.1
ADD-LBC-170-180	6.063629	2897.7	01Jan2015, 13:35	1261.3
Reach-LBC-190	6.063629	2891.2	01Jan2015, 13:45	1261.2
LBC-190	0.05069	79.4	01Jan2015, 12:25	11.6
Willow Drive	6.114319	2905.8	01Jan2015, 13:45	1272.8
Reach-LBC-200	6.114319	2758.8	01Jan2015, 14:20	1270
LBC-200	0.168071	187.6	01Jan2015, 12:45	36.4
ADD-LBC-200	6.28239	2805.2	01Jan2015, 14:15	1306.5
OUTLET	6.28239	2805.2	01Jan2015, 14:15	1306.5

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

50-YEAR FUTURE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
BH-10	0.139076	165.8	01Jan2015, 12:40	33.1
BH-20	0.07669	112.6	01Jan2015, 12:25	16.5
ADD-BH-10-20	0.215766	264.9	01Jan2015, 12:35	49.6
Reach-BH-20	0.215766	263.2	01Jan2015, 12:35	49.6
BH-30	0.165073	188.3	01Jan2015, 12:50	39.9
ADD-BH-30	0.380839	439.5	01Jan2015, 12:45	89.6
BH-40	0.105607	260.5	01Jan2015, 12:10	25.4
ADD-BH-40	0.486446	500	01Jan2015, 12:45	114.9
Reach-BH-40	0.486446	495.5	01Jan2015, 12:50	114.9
BH-60	0.129437	150.4	01Jan2015, 12:45	30.4
BH-50	0.117491	208	01Jan2015, 12:20	25.8
Weaver Dairy Rd Ext	0.117491	178.5	01Jan2015, 12:30	25.8
Northern Park	0.246928	315.2	01Jan2015, 12:35	56.2
ADD-BH	0.733374	776.8	01Jan2015, 12:45	171.1
BH-70	0.062883	143.8	01Jan2015, 12:10	14.9
MLK Jr. Blvd	0.796257	774.8	01Jan2015, 12:55	186
BH-80	0.10254	162.8	01Jan2015, 12:30	25.2
Stateside Drive	0.10254	162.8	01Jan2015, 12:30	25.2
BH-90	0.094578	96.4	01Jan2015, 12:55	20.9
ADD-BH-90	0.197118	240.7	01Jan2015, 12:35	46.2
BH-100	0.110825	164.5	01Jan2015, 12:30	25.2
ADD-BH-100	1.1042	1134.3	01Jan2015, 12:40	257.4
Reach-BH-100	1.1042	1129.7	01Jan2015, 12:40	257.4
BH-110	0.117356	280.8	01Jan2015, 12:10	32.5
MLK Jr. - Kings Br	0.117356	209.1	01Jan2015, 12:25	32.5
BH-120	0.02747	62.6	01Jan2015, 12:10	6.3
ADD-BH-120	1.249026	1323.3	01Jan2015, 12:35	296.1
BH-130	0.100527	164.7	01Jan2015, 12:30	25.8
Lake Ellen	1.349553	1270.8	01Jan2015, 13:00	321.9
CB-10	0.144686	163.8	01Jan2015, 12:55	37.7
Reach-CB-10	0.144686	163	01Jan2015, 13:00	37.7
CB-20	0.112513	135.1	01Jan2015, 12:40	26.3
ADD-CB-20	0.257199	284.7	01Jan2015, 12:50	64
Reach-CB-20	0.257199	281.6	01Jan2015, 13:00	64
CB-30	0.026991	42.3	01Jan2015, 12:40	8.3
CB-40	0.051355	139.5	01Jan2015, 12:15	16.9
ADD-CB-30-40	0.335545	331.3	01Jan2015, 13:10	89.2
CB-50	0.072003	131.5	01Jan2015, 12:35	24.7
Municipal Drive	0.072003	131.5	01Jan2015, 12:35	24.7
CB-60	0.031973	75.8	01Jan2015, 12:20	10.7
RT CB-50-60	0.103976	153.7	01Jan2015, 12:50	35.4
ADD-CB-60	0.439521	477.2	01Jan2015, 13:00	124.5
Reach-CB-60	0.439521	473.9	01Jan2015, 13:10	124.5
CB-70	0.149895	182.6	01Jan2015, 12:55	42.6
RT CB-70	0.149895	139.4	01Jan2015, 13:30	42.6
ADD-CB-70	0.589416	604.9	01Jan2015, 13:10	167.2
Reach-CB-70	0.589416	598.5	01Jan2015, 13:30	167.1
CB-80	0.083068	131	01Jan2015, 12:20	17.9
ADD-CB-80	0.672484	624.3	01Jan2015, 13:30	185
Reach-CB-80	0.672484	623.1	01Jan2015, 13:40	185
ADD- CB-BH	2.022037	1785	01Jan2015, 13:15	506.9
EL-20	0.137538	359.9	01Jan2015, 12:05	31.7
ADD-EL-20	2.159575	1821.1	01Jan2015, 13:10	538.6
Reach-EL-20	2.159575	1815.4	01Jan2015, 13:20	538.5
EL-10	0.138871	383.6	01Jan2015, 12:10	37.3
Piney Mountain Rd	0.138871	383.6	01Jan2015, 12:10	37.3

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

50-YEAR FUTURE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Piney Mountain Rd -Booker Ck	2.298446	1836.2	01Jan2015, 13:25	575.8
EL-30	0.119754	237.1	01Jan2015, 12:10	23.5
Reach- EL-30	2.4182	1858.9	01Jan2015, 13:30	599.2
EL-50	0.11573	260.2	01Jan2015, 12:10	24.9
ADD-EL-50	2.53393	1883.7	01Jan2015, 13:30	624.1
Reach-EL-50	2.53393	1878.2	01Jan2015, 13:40	623.9
EL-40	0.074895	190.6	01Jan2015, 12:10	18.6
Kensington Drive	0.074895	190.6	01Jan2015, 12:10	18.6
N Lakeshore Dr - Booker Ck	2.608825	1894.3	01Jan2015, 13:40	642.5
CF-10	0.078889	215	01Jan2015, 12:10	22.4
Kingston Drive	0.078889	215	01Jan2015, 12:10	22.4
CF-20	0.076885	98.4	01Jan2015, 12:50	22.4
ADD-CF-20	0.155774	253.5	01Jan2015, 12:10	44.8
Weaver Dairy - Cedar Fk	0.155774	253.5	01Jan2015, 12:10	44.8
CF-30	0.044849	54.4	01Jan2015, 12:35	9.3
ADD-CF-30	0.200623	282.2	01Jan2015, 12:10	54.1
Cross Creek Drive	0.200623	282.2	01Jan2015, 12:10	54.1
Reach-CF-50	0.200623	279.4	01Jan2015, 12:15	54.1
CF-40	0.092855	114.1	01Jan2015, 12:40	21.5
Weaver Dairy Rd - 1	0.092855	93.3	01Jan2015, 13:00	21.5
CF-50	0.029148	47.9	01Jan2015, 12:15	5.3
ADD-CF-50	0.322626	357.7	01Jan2015, 12:15	81
CF-60	0.12336	123.8	01Jan2015, 12:50	26.2
Cedar Hills Circle	0.445986	425	01Jan2015, 12:40	107.2
Reach-CF-80	0.445986	424.6	01Jan2015, 12:45	107.2
CF-80	0.176821	267.1	01Jan2015, 12:25	36.8
CF-70	0.120239	110.3	01Jan2015, 13:05	27.5
Weaver Dairy Rd -2	0.120239	110.3	01Jan2015, 13:05	27.5
Kenmore Road	0.743046	748.9	01Jan2015, 12:25	171.5
Reach-CF-130	0.743046	748.3	01Jan2015, 12:30	171.5
CF-90	0.184752	198.1	01Jan2015, 12:40	35.3
CF-100	0.085353	186	01Jan2015, 12:05	16.2
Piney Mountain Rd - Cedar Fk	0.085353	186	01Jan2015, 12:05	16.2
CF-110	0.044111	73.6	01Jan2015, 12:15	8.7
ADD-CF-110	0.129464	246.6	01Jan2015, 12:10	24.9
ADD-CF-90-120	0.314216	341.8	01Jan2015, 12:10	60.2
CF-120	0.096092	166.2	01Jan2015, 12:15	18.4
Brookview Drive	1.153354	1169.8	01Jan2015, 12:25	250
Reach-CF-140	1.153354	1167.2	01Jan2015, 12:30	250
CF-130	0.151403	177.5	01Jan2015, 12:35	30.6
CF-140	0.042477	62.2	01Jan2015, 12:20	8.3
North Lakeshore Drive	1.347234	1395.6	01Jan2015, 12:30	289
CF-150	0.050842	104.8	01Jan2015, 12:10	9.9
ADD-CF-150	1.398076	1440.1	01Jan2015, 12:30	298.9
EL-60	0.142028	223.1	01Jan2015, 12:15	27.3
EL-90	0.100143	238.1	01Jan2015, 12:10	23.7
EL-70	0.094086	184.1	01Jan2015, 12:15	21.7
EL-80	0.091741	210.3	01Jan2015, 12:10	20.2
EL-100	0.087147	210.1	01Jan2015, 12:15	25.9
Eastwood Lake	4.522046	2688	01Jan2015, 13:35	1059.8
LBC-10	0.097332	157	01Jan2015, 12:20	21.3
U/S Limit - Sierra	0.097332	138.8	01Jan2015, 12:35	21.3
LBC-20	0.084519	158.6	01Jan2015, 12:20	20.1
ADD-LBC-10-20	0.181851	282.6	01Jan2015, 12:25	41.4
Reach-LBC-20	0.181851	280.1	01Jan2015, 12:25	41.4
Honeysuckle Road	0.181851	280.1	01Jan2015, 12:25	41.4

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

50-YEAR FUTURE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Reach-LBC-30	0.181851	279.4	01Jan2015, 12:25	41.4
LBC-30	0.159799	190.1	01Jan2015, 13:00	45.2
Booker Creek Road	0.34165	415.1	01Jan2015, 12:35	86.6
Reach-LBC-40	0.34165	396	01Jan2015, 12:45	86.4
LBC-40	0.156492	455.8	01Jan2015, 12:10	45.4
LBC-50	0.022218	49.8	01Jan2015, 12:10	4.7
ADD-LBC-40-50	5.042406	3109.4	01Jan2015, 12:45	1196.2
LBC-60	0.142061	318.9	01Jan2015, 12:10	33.9
ADD-LBC-60	5.184467	3220.7	01Jan2015, 12:40	1230.1
Reach-LBC-60	5.184467	3193.4	01Jan2015, 12:55	1229.6
LBC-70	0.107956	243.8	01Jan2015, 12:10	24
LBC-130	0.03607	66.8	01Jan2015, 12:30	10.9
ADD-LBC-70-130	5.328493	3294.6	01Jan2015, 12:50	1264.5
LBC-90	0.115064	162.3	01Jan2015, 12:50	35.6
LBC-80	0.06417	115.1	01Jan2015, 12:30	19.4
Fordham Blvd - Upstream	0.06417	115.1	01Jan2015, 12:30	19.4
LBC-100	0.029058	44.2	01Jan2015, 12:45	9.4
Dobbins Drive	0.208292	309.1	01Jan2015, 12:40	64.3
LBC-110	0.0333	49.4	01Jan2015, 12:45	10.5
Summerfield Crossing	0.241592	357.8	01Jan2015, 12:40	74.8
LBC-120	0.049799	68.7	01Jan2015, 12:50	14.9
Foxcroft Drive	0.291391	428.1	01Jan2015, 12:45	89.7
East Franklin Street	5.619884	3638	01Jan2015, 13:00	1354.2
LBC-140	0.088638	191.9	01Jan2015, 12:25	29.2
ADD-LBC-140	5.708522	3720	01Jan2015, 13:00	1383.4
Reach-LBC-140	5.708522	3258.9	01Jan2015, 13:30	1377.1
LBC-150	0.107836	193.4	01Jan2015, 12:25	28.5
ADD-LBC-150	5.816358	3300.4	01Jan2015, 13:30	1405.6
LBC-160	0.077625	169	01Jan2015, 12:20	24.9
Fordham Blvd - Downstream	5.893983	3327.8	01Jan2015, 13:35	1430.5
LBC-180	0.14221	389.5	01Jan2015, 12:15	45.9
LBC-170	0.027436	86.1	01Jan2015, 12:10	9.2
ADD-LBC-170-180	6.063629	3377.3	01Jan2015, 13:30	1485.6
Reach-LBC-190	6.063629	3370.9	01Jan2015, 13:40	1485.5
LBC-190	0.05069	93	01Jan2015, 12:25	13.6
Willow Drive	6.114319	3389.9	01Jan2015, 13:35	1499.1
Reach-LBC-200	6.114319	3248.3	01Jan2015, 14:15	1495.7
LBC-200	0.168071	221.3	01Jan2015, 12:45	42.9
ADD-LBC-200	6.28239	3303.9	01Jan2015, 14:15	1538.6
OUTLET	6.28239	3303.9	01Jan2015, 14:15	1538.6

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

100-YEAR FUTURE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
BH-10	0.139076	192.3	01Jan2015, 12:40	38.1
BH-20	0.07669	132.1	01Jan2015, 12:25	19.3
ADD-BH-10-20	0.215766	308.5	01Jan2015, 12:35	57.4
Reach-BH-20	0.215766	307	01Jan2015, 12:35	57.4
BH-30	0.165073	218.2	01Jan2015, 12:50	46.1
ADD-BH-30	0.380839	513.4	01Jan2015, 12:45	103.5
BH-40	0.105607	301.7	01Jan2015, 12:10	29.3
ADD-BH-40	0.486446	591.3	01Jan2015, 12:40	132.8
Reach-BH-40	0.486446	583.9	01Jan2015, 12:50	132.7
BH-60	0.129437	174.9	01Jan2015, 12:45	35.2
BH-50	0.117491	243.2	01Jan2015, 12:20	30.1
Weaver Dairy Rd Ext	0.117491	206.1	01Jan2015, 12:30	30.1
Northern Park	0.246928	366	01Jan2015, 12:35	65.3
ADD-BH	0.733374	929.7	01Jan2015, 12:45	198.1
BH-70	0.062883	167	01Jan2015, 12:10	17.2
MLK Jr. Blvd	0.796257	903.2	01Jan2015, 12:55	215.3
BH-80	0.10254	188.2	01Jan2015, 12:30	29.1
Stateside Drive	0.10254	188.2	01Jan2015, 12:30	29.1
BH-90	0.094578	112.9	01Jan2015, 12:50	24.4
ADD-BH-90	0.197118	279.8	01Jan2015, 12:35	53.5
BH-100	0.110825	191.7	01Jan2015, 12:30	29.3
ADD-BH-100	1.1042	1282.9	01Jan2015, 12:40	298.1
Reach-BH-100	1.1042	1281.7	01Jan2015, 12:45	298.1
BH-110	0.117356	321	01Jan2015, 12:10	36.9
MLK Jr. - Kings Br	0.117356	224.8	01Jan2015, 12:25	36.9
BH-120	0.02747	72.9	01Jan2015, 12:10	7.3
ADD-BH-120	1.249026	1503.1	01Jan2015, 12:35	342.3
BH-130	0.100527	189.6	01Jan2015, 12:30	29.7
Lake Ellen	1.349553	1282.2	01Jan2015, 13:15	372
CB-10	0.144686	188.5	01Jan2015, 12:55	43.2
Reach-CB-10	0.144686	187.7	01Jan2015, 13:05	43.2
CB-20	0.112513	157.1	01Jan2015, 12:40	30.4
ADD-CB-20	0.257199	326.6	01Jan2015, 12:50	73.6
Reach-CB-20	0.257199	323.4	01Jan2015, 13:00	73.6
CB-30	0.026991	47.8	01Jan2015, 12:40	9.4
CB-40	0.051355	156.8	01Jan2015, 12:15	19
ADD-CB-30-40	0.335545	377.4	01Jan2015, 13:10	101.9
CB-50	0.072003	147.3	01Jan2015, 12:35	27.7
Municipal Drive	0.072003	147.3	01Jan2015, 12:35	27.7
CB-60	0.031973	85.1	01Jan2015, 12:20	12
RT CB-50-60	0.103976	168.3	01Jan2015, 12:50	39.7
ADD-CB-60	0.439521	536.3	01Jan2015, 13:05	141.6
Reach-CB-60	0.439521	534.3	01Jan2015, 13:10	141.6
CB-70	0.149895	208.2	01Jan2015, 12:55	48.6
RT CB-70	0.149895	157.9	01Jan2015, 13:30	48.6
ADD-CB-70	0.589416	684.5	01Jan2015, 13:15	190.2
Reach-CB-70	0.589416	676.7	01Jan2015, 13:30	190.2
CB-80	0.083068	153.8	01Jan2015, 12:20	20.9
ADD-CB-80	0.672484	706.5	01Jan2015, 13:30	211.1
Reach-CB-80	0.672484	704.2	01Jan2015, 13:40	211
ADD- CB-BH	2.022037	1978.8	01Jan2015, 13:40	583
EL-20	0.137538	418.9	01Jan2015, 12:05	36.8
ADD-EL-20	2.159575	2009.6	01Jan2015, 13:40	619.8
Reach-EL-20	2.159575	2007	01Jan2015, 13:45	619.7
EL-10	0.138871	439.1	01Jan2015, 12:10	42.7
Piney Mountain Rd	0.138871	439.1	01Jan2015, 12:10	42.7

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

100-YEAR FUTURE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Piney Mountain Rd -Booker Ck	2.298446	2035	01Jan2015, 13:45	662.4
EL-30	0.119754	280.8	01Jan2015, 12:10	27.6
Reach- EL-30	2.4182	2057.2	01Jan2015, 13:50	689.9
EL-50	0.11573	304.7	01Jan2015, 12:10	29.1
ADD-EL-50	2.53393	2080.9	01Jan2015, 13:50	719
Reach-EL-50	2.53393	2077.2	01Jan2015, 14:00	718.9
EL-40	0.074895	219.9	01Jan2015, 12:10	21.4
Kensington Drive	0.074895	219.9	01Jan2015, 12:10	21.4
N Lakeshore Dr - Booker Ck	2.608825	2092.6	01Jan2015, 14:00	740.3
CF-10	0.078889	244.9	01Jan2015, 12:10	25.5
Kingston Drive	0.078889	244.9	01Jan2015, 12:10	25.5
CF-20	0.076885	112	01Jan2015, 12:50	25.4
ADD-CF-20	0.155774	289.1	01Jan2015, 12:10	50.9
Weaver Dairy - Cedar Fk	0.155774	289.1	01Jan2015, 12:10	50.9
CF-30	0.044849	64.1	01Jan2015, 12:35	10.9
ADD-CF-30	0.200623	323.4	01Jan2015, 12:10	61.8
Cross Creek Drive	0.200623	323.4	01Jan2015, 12:10	61.8
Reach-CF-50	0.200623	320.1	01Jan2015, 12:15	61.8
CF-40	0.092855	132.9	01Jan2015, 12:40	24.9
Weaver Dairy Rd - 1	0.092855	108.7	01Jan2015, 13:00	24.9
CF-50	0.029148	57.2	01Jan2015, 12:15	6.3
ADD-CF-50	0.322626	413.4	01Jan2015, 12:15	93
CF-60	0.12336	145.6	01Jan2015, 12:50	30.6
Cedar Hills Circle	0.445986	493.8	01Jan2015, 12:40	123.6
Reach-CF-80	0.445986	493.2	01Jan2015, 12:45	123.6
CF-80	0.176821	314.2	01Jan2015, 12:25	43.1
CF-70	0.120239	128.6	01Jan2015, 13:05	31.8
Weaver Dairy Rd -2	0.120239	128.6	01Jan2015, 13:05	31.8
Kenmore Road	0.743046	873.8	01Jan2015, 12:30	198.5
Reach-CF-130	0.743046	871.5	01Jan2015, 12:35	198.5
CF-90	0.184752	235.5	01Jan2015, 12:40	41.7
CF-100	0.085353	221.2	01Jan2015, 12:05	19.2
Piney Mountain Rd - Cedar Fk	0.085353	221.2	01Jan2015, 12:05	19.2
CF-110	0.044111	87.3	01Jan2015, 12:15	10.2
ADD-CF-110	0.129464	292.3	01Jan2015, 12:10	29.3
ADD-CF-90-120	0.314216	408	01Jan2015, 12:10	71
CF-120	0.096092	197.3	01Jan2015, 12:15	21.7
Brookview Drive	1.153354	1364.2	01Jan2015, 12:25	291.2
Reach-CF-140	1.153354	1360.4	01Jan2015, 12:30	291.2
CF-130	0.151403	209.9	01Jan2015, 12:35	36.1
CF-140	0.042477	73.8	01Jan2015, 12:20	9.8
North Lakeshore Drive	1.347234	1630.9	01Jan2015, 12:30	337
CF-150	0.050842	124	01Jan2015, 12:10	11.7
ADD-CF-150	1.398076	1683.4	01Jan2015, 12:25	348.7
EL-60	0.142028	265.5	01Jan2015, 12:15	32.1
EL-90	0.100143	276.3	01Jan2015, 12:10	27.4
EL-70	0.094086	214.4	01Jan2015, 12:15	25.2
EL-80	0.091741	245.8	01Jan2015, 12:10	23.5
EL-100	0.087147	238	01Jan2015, 12:15	29.4
Eastwood Lake	4.522046	2929.3	01Jan2015, 13:35	1226.4
LBC-10	0.097332	184.1	01Jan2015, 12:20	24.8
U/S Limit - Sierra	0.097332	155.7	01Jan2015, 12:35	24.8
LBC-20	0.084519	183.9	01Jan2015, 12:20	23.3
ADD-LBC-10-20	0.181851	324.6	01Jan2015, 12:25	48.1
Reach-LBC-20	0.181851	322.6	01Jan2015, 12:25	48.1
Honeysuckle Road	0.181851	322.6	01Jan2015, 12:25	48.1

Town of Chapel Hill - Eastwood Lake Subwatershed Study - HMS Output

100-YEAR FUTURE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Reach-LBC-30	0.181851	321.5	01Jan2015, 12:25	48.1
LBC-30	0.159799	216.8	01Jan2015, 13:00	51.5
Booker Creek Road	0.34165	474.8	01Jan2015, 12:35	99.7
Reach-LBC-40	0.34165	454.8	01Jan2015, 12:45	99.4
LBC-40	0.156492	517.6	01Jan2015, 12:10	51.7
LBC-50	0.022218	58.5	01Jan2015, 12:10	5.5
ADD-LBC-40-50	5.042406	3371.1	01Jan2015, 13:00	1382.9
LBC-60	0.142061	370.1	01Jan2015, 12:10	39.2
ADD-LBC-60	5.184467	3462.7	01Jan2015, 12:40	1422.2
Reach-LBC-60	5.184467	3459.1	01Jan2015, 12:50	1421.5
LBC-70	0.107956	284.7	01Jan2015, 12:10	27.9
LBC-130	0.03607	75.6	01Jan2015, 12:30	12.4
ADD-LBC-70-130	5.328493	3587.6	01Jan2015, 12:45	1461.8
LBC-90	0.115064	183.5	01Jan2015, 12:50	40.2
LBC-80	0.06417	130.4	01Jan2015, 12:30	22
Fordham Blvd - Upstream	0.06417	130.4	01Jan2015, 12:30	22
LBC-100	0.029058	49.7	01Jan2015, 12:45	10.6
Dobbins Drive	0.208292	349.5	01Jan2015, 12:40	72.8
LBC-110	0.0333	55.7	01Jan2015, 12:45	11.9
Summerfield Crossing	0.241592	404	01Jan2015, 12:45	84.7
LBC-120	0.049799	77.9	01Jan2015, 12:50	16.9
Foxcroft Drive	0.291391	479.8	01Jan2015, 12:40	101.5
East Franklin Street	5.619884	3997.7	01Jan2015, 13:00	1563.3
LBC-140	0.088638	215.7	01Jan2015, 12:25	32.8
ADD-LBC-140	5.708522	4103	01Jan2015, 12:55	1596.1
Reach-LBC-140	5.708522	3614.8	01Jan2015, 13:30	1589.4
LBC-150	0.107836	222.1	01Jan2015, 12:25	32.6
ADD-LBC-150	5.816358	3662	01Jan2015, 13:30	1622
LBC-160	0.077625	190.6	01Jan2015, 12:20	28
Fordham Blvd - Downstream	5.893983	3697.1	01Jan2015, 13:30	1650.1
LBC-180	0.14221	438.4	01Jan2015, 12:15	51.7
LBC-170	0.027436	96.5	01Jan2015, 12:10	10.3
ADD-LBC-170-180	6.063629	3753.6	01Jan2015, 13:25	1712.1
Reach-LBC-190	6.063629	3748.9	01Jan2015, 13:35	1712
LBC-190	0.05069	106.5	01Jan2015, 12:25	15.6
Willow Drive	6.114319	3771.5	01Jan2015, 13:35	1727.6
Reach-LBC-200	6.114319	3619.2	01Jan2015, 14:10	1723.6
LBC-200	0.168071	254.9	01Jan2015, 12:45	49.5
ADD-LBC-200	6.28239	3688.4	01Jan2015, 14:05	1773
OUTLET	6.28239	3688.4	01Jan2015, 14:05	1773

ALTERNATIVE CONDITIONS: HEC-HMS OUTPUT

Town of Chapel Hill -Eastwood Lake Subwatershed Study - HMS Output

2-YEAR ALTERNATIVE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
BH-10	0.139076	33.9	01Jan2015, 12:45	7.7
BH-20	0.07669	32.5	01Jan2015, 12:25	5.4
ADD-BH-10-20	0.215766	62.4	01Jan2015, 12:35	13.1
Parkside Storage	0.215766	8	01Jan2015, 16:00	12
Reach-BH-20	0.215766	8	01Jan2015, 16:10	11.9
BH-30	0.165073	61.1	01Jan2015, 12:50	13.9
ADD-BH-30	0.380839	49.4	01Jan2015, 13:25	25.8
BH-40	0.105607	84.9	01Jan2015, 12:10	8.8
ADD-BH-40	0.486446	92.9	01Jan2015, 12:10	34.6
Reach-BH-40	0.486446	90.9	01Jan2015, 12:15	34.6
BH-60	0.129437	47.3	01Jan2015, 12:50	10.4
BH-50	0.117491	60.1	01Jan2015, 12:20	8.1
Weaver Dairy Rd Ext	0.117491	53.3	01Jan2015, 12:30	8.1
Northern Park	0.246928	95.1	01Jan2015, 12:35	18.5
ADD-BH	0.733374	165.2	01Jan2015, 12:25	53.1
BH-70	0.062883	45.8	01Jan2015, 12:10	5.1
MLK Jr. Blvd	0.796257	203.1	01Jan2015, 12:20	58.2
BH-80	0.10254	54.4	01Jan2015, 12:30	9
Stateside Drive	0.10254	54.4	01Jan2015, 12:30	9
BH-90	0.094578	28.2	01Jan2015, 12:55	6.7
ADD-BH-90	0.197118	76.2	01Jan2015, 12:35	15.7
BH-100	0.110825	49.9	01Jan2015, 12:30	8.3
ADD-BH-100	1.1042	317	01Jan2015, 12:25	82.2
MLK - Storage	1.1042	291.7	01Jan2015, 12:40	82.1
Reach-BH-100	1.1042	291.7	01Jan2015, 12:40	82.1
Lake Ellen	1.349553	360	01Jan2015, 12:55	106.7
BH-110	0.117356	108.7	01Jan2015, 12:15	13.3
MLK Jr. - Kings Br	0.117356	81	01Jan2015, 12:25	13.3
BH-120	0.02747	19.5	01Jan2015, 12:10	2.1
ADD-BH-120	1.249026	370.8	01Jan2015, 12:35	97.6
BH-130	0.100527	56.2	01Jan2015, 12:30	9.1
CB-10	0.144686	57.9	01Jan2015, 12:55	14.1
Reach-CB-10	0.144686	57.9	01Jan2015, 12:55	14.1
CB-20	0.112513	25.1	01Jan2015, 12:45	5.5
ADD-CB-20	0.257199	82.4	01Jan2015, 12:55	19.6
Reach-CB-20	0.257199	81.9	01Jan2015, 13:00	19.6
CB-40	0.051355	61.5	01Jan2015, 12:15	7.6
CB-30	0.026991	17.8	01Jan2015, 12:40	3.6
ADD-CB-30-40	0.335545	110.7	01Jan2015, 13:00	30.8
CB-50	0.072003	59.8	01Jan2015, 12:35	11.3
Municipal Drive	0.072003	59.8	01Jan2015, 12:35	11.3
CB-60	0.031973	33.7	01Jan2015, 12:20	4.8
RT CB-50-60	0.103976	70	01Jan2015, 12:50	16.1
ADD-CB-60	0.439521	179.8	01Jan2015, 12:55	46.9
Reach-CB-60	0.439521	178.4	01Jan2015, 13:05	46.9
CB-70	0.149895	69.7	01Jan2015, 13:00	16.8
RT CB-70	0.149895	55.1	01Jan2015, 13:30	16.8
ADD-CB-70	0.589416	227.7	01Jan2015, 13:10	63.7
Reach-CB-70	0.589416	224.3	01Jan2015, 13:30	63.6
CB-80	0.083068	37.8	01Jan2015, 12:25	5.8
ADD-CB-80	0.672484	233	01Jan2015, 13:30	69.4
Reach-CB-80	0.672484	232.5	01Jan2015, 13:40	69.4
ADD- CB-BH	2.022037	535	01Jan2015, 13:05	176.1
EL-20	0.137538	110	01Jan2015, 12:05	10.4
ADD-EL-20	2.159575	549.6	01Jan2015, 13:05	186.5
Reach-EL-20	2.159575	549.6	01Jan2015, 13:05	186.5

Town of Chapel Hill -Eastwood Lake Subwatershed Study - HMS Output

2-YEAR ALTERNATIVE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
EL-10	0.138871	140.4	01Jan2015, 12:10	14.1
Piney Mountain Rd	0.138871	140.4	01Jan2015, 12:10	14.1
Piney Mountain Rd -Booker Ck	2.298446	513.2	01Jan2015, 13:35	200.6
EL-30	0.119754	60	01Jan2015, 12:10	6.8
Reach- EL-30	2.4182	520.7	01Jan2015, 13:40	207.4
EL-50	0.11573	74.8	01Jan2015, 12:10	7.8
ADD-EL-50	2.53393	528.7	01Jan2015, 13:40	215.3
Reach-EL-50	2.53393	528.2	01Jan2015, 13:50	215.2
EL-40	0.074895	63.5	01Jan2015, 12:10	6.4
Kensington Drive	0.074895	63.5	01Jan2015, 12:10	6.4
N Lakeshore Dr - Booker Ck	2.608825	533.9	01Jan2015, 13:50	221.7
CF-10	0.078889	86.1	01Jan2015, 12:10	9.4
Kingston Drive	0.078889	86.1	01Jan2015, 12:10	9.4
CF-20	0.076885	38.8	01Jan2015, 12:55	9.1
ADD-CF-20	0.155774	100.4	01Jan2015, 12:10	18.6
Weaver Dairy - Cedar Fk	0.155774	100.4	01Jan2015, 12:10	18.6
CF-30	0.044849	10.6	01Jan2015, 13:05	2.9
ADD-CF-30	0.200623	102.8	01Jan2015, 12:10	21.4
Cross Creek Drive	0.200623	102.8	01Jan2015, 12:10	21.4
Reach-CF-50	0.200623	100.8	01Jan2015, 12:15	21.4
CF-40	0.092855	35.5	01Jan2015, 12:45	7.3
Weaver Dairy Rd - 1	0.092855	29.1	01Jan2015, 13:05	7.3
CF-50	0.029148	11.2	01Jan2015, 12:15	1.5
ADD-CF-50	0.322626	120.1	01Jan2015, 12:15	30.3
CF-60	0.12336	34.8	01Jan2015, 12:55	8.3
Cedar Hills Circle	0.445986	134.2	01Jan2015, 12:15	38.5
Reach-CF-80	0.445986	134	01Jan2015, 12:25	38.5
CF-80	0.176821	73.1	01Jan2015, 12:25	11.2
CF-70	0.120239	34.5	01Jan2015, 13:05	9.4
Weaver Dairy Rd -2	0.120239	34.5	01Jan2015, 13:05	9.4
Kenmore Road	0.743046	224.9	01Jan2015, 12:25	59.2
Reach-CF-130	0.743046	223.9	01Jan2015, 12:30	59.2
CF-90	0.184752	47.9	01Jan2015, 12:40	9.9
CF-100	0.085353	44.9	01Jan2015, 12:10	4.5
Piney Mountain Rd - Cedar Fk	0.085353	44.9	01Jan2015, 12:10	4.5
CF-110	0.044111	18.5	01Jan2015, 12:20	2.5
ADD-CF-110	0.129464	61.1	01Jan2015, 12:10	7
ADD-CF-90-120	0.314216	81.1	01Jan2015, 12:15	17
CF-120	0.096092	67.9	01Jan2015, 12:00	5.3
Brookview Drive	1.153354	313.2	01Jan2015, 12:30	81.4
Reach-CF-140	1.153354	311.9	01Jan2015, 12:30	81.4
CF-130	0.151403	48	01Jan2015, 12:40	9.2
CF-140	0.042477	15.9	01Jan2015, 12:25	2.5
North Lakeshore Drive	1.347234	371.6	01Jan2015, 12:30	93.1
CF-150	0.050842	26.8	01Jan2015, 12:10	2.9
ADD-CF-150	1.398076	384.3	01Jan2015, 12:30	96
EL-60	0.142028	55.7	01Jan2015, 12:20	7.9
EL-90	0.100143	74.5	01Jan2015, 12:10	7.8
EL-70	0.094086	97.4	01Jan2015, 12:00	7
EL-80	0.091741	61.2	01Jan2015, 12:10	6.3
EL-100	0.087147	83.6	01Jan2015, 12:20	10.2
Eastwood Lake	4.522046	701.4	01Jan2015, 14:05	356.3
LBC-10	0.097332	45.3	01Jan2015, 12:25	6.7
U/S Limit - Sierra	0.097332	43.7	01Jan2015, 12:30	6.7
LBC-20	0.084519	50.5	01Jan2015, 12:20	6.8
ADD-LBC-10-20	0.181851	91.8	01Jan2015, 12:25	13.6

Town of Chapel Hill -Eastwood Lake Subwatershed Study - HMS Output

2-YEAR ALTERNATIVE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Reach-LBC-20	0.181851	91.4	01Jan2015, 12:25	13.6
Honeysuckle Road	0.181851	91.4	01Jan2015, 12:25	13.6
Reach-LBC-30	0.181851	90.5	01Jan2015, 12:35	13.6
LBC-30	0.159799	71.5	01Jan2015, 13:00	17.3
Booker Creek Road	0.34165	147.9	01Jan2015, 12:40	30.9
Reach-LBC-40	0.34165	141.9	01Jan2015, 12:50	30.8
LBC-40	0.156492	115.3	01Jan2015, 12:30	17.9
LBC-50	0.022218	14	01Jan2015, 12:10	1.4
ADD-LBC-40-50	5.042406	782.4	01Jan2015, 13:45	406.5
LBC-60	0.142061	102.1	01Jan2015, 12:15	11.5
ADD-LBC-60	5.184467	793.7	01Jan2015, 13:45	418
Reach-LBC-60	5.184467	793.3	01Jan2015, 13:50	417.8
LBC-70	0.107956	72.2	01Jan2015, 12:10	7.7
LBC-130	0.03607	27.1	01Jan2015, 12:30	4.5
ADD-LBC-70-130	5.328493	806.4	01Jan2015, 13:45	430.1
LBC-90	0.115064	66.9	01Jan2015, 12:50	14.8
LBC-80	0.06417	46.4	01Jan2015, 12:30	7.9
Fordham Blvd - Upstream	0.06417	46.4	01Jan2015, 12:30	7.9
LBC-100	0.029058	19	01Jan2015, 12:45	4.1
Dobbins Drive	0.208292	127.1	01Jan2015, 12:40	26.9
LBC-110	0.0333	20.8	01Jan2015, 12:50	4.5
Summerfield Crossing	0.241592	147.7	01Jan2015, 12:45	31.4
LBC-120	0.049799	27.4	01Jan2015, 12:50	6
Foxcroft Drive	0.291391	174.4	01Jan2015, 12:45	37.4
East Franklin Street	5.619884	871	01Jan2015, 13:55	467.4
LBC-140	0.088638	93.7	01Jan2015, 12:20	13
ADD-LBC-140	5.708522	881.8	01Jan2015, 13:50	480.5
Reach-LBC-140	5.708522	853.7	01Jan2015, 14:25	479.1
LBC-150	0.107836	70.1	01Jan2015, 12:25	10.9
ADD-LBC-150	5.816358	861.9	01Jan2015, 14:20	490
LBC-160	0.077625	73	01Jan2015, 12:20	11
Fordham Blvd - Downstream	5.893983	867.6	01Jan2015, 14:30	501
LBC-180	0.14221	168.5	01Jan2015, 12:15	20
LBC-170	0.027436	38.5	01Jan2015, 12:10	4.1
ADD-LBC-170-180	6.063629	880.9	01Jan2015, 14:25	525.2
Reach-LBC-190	6.063629	880.2	01Jan2015, 14:35	525
LBC-190	0.05069	33.2	01Jan2015, 12:25	5
Willow Drive	6.114319	884	01Jan2015, 14:35	530
Reach-LBC-200	6.114319	869	01Jan2015, 15:10	529.2
LBC-200	0.168071	74.7	01Jan2015, 12:45	15
ADD-LBC-200	6.28239	881.6	01Jan2015, 15:05	544.2
OUTLET	6.28239	881.6	01Jan2015, 15:05	544.2

Town of Chapel Hill -Eastwood Lake Subwatershed Study - HMS Output

10-YEAR ALTERNATIVE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
BH-10	0.139076	80.1	01Jan2015, 12:45	16.2
BH-20	0.07669	69.5	01Jan2015, 12:25	10.5
ADD-BH-10-20	0.215766	140.8	01Jan2015, 12:35	26.7
Parkside Storage	0.215766	18.5	01Jan2015, 15:20	25
Reach-BH-20	0.215766	18.5	01Jan2015, 15:25	25
BH-30	0.165073	121	01Jan2015, 12:50	26.1
ADD-BH-30	0.380839	102.2	01Jan2015, 13:20	51
BH-40	0.105607	167.9	01Jan2015, 12:10	16.6
ADD-BH-40	0.486446	185.6	01Jan2015, 12:10	67.6
Reach-BH-40	0.486446	181.4	01Jan2015, 12:15	67.6
BH-60	0.129437	95.5	01Jan2015, 12:45	19.7
BH-50	0.117491	129.2	01Jan2015, 12:20	16.3
Weaver Dairy Rd Ext	0.117491	114.5	01Jan2015, 12:30	16.3
Northern Park	0.246928	198.7	01Jan2015, 12:35	36.1
ADD-BH	0.733374	336.9	01Jan2015, 12:25	103.6
BH-70	0.062883	91.9	01Jan2015, 12:10	9.7
MLK Jr. Blvd	0.796257	412.3	01Jan2015, 12:20	113.3
BH-80	0.10254	105.6	01Jan2015, 12:30	16.6
Stateside Drive	0.10254	105.6	01Jan2015, 12:30	16.6
BH-90	0.094578	60	01Jan2015, 12:55	13.3
ADD-BH-90	0.197118	153.3	01Jan2015, 12:35	29.9
BH-100	0.110825	103.6	01Jan2015, 12:30	16.2
ADD-BH-100	1.1042	651.6	01Jan2015, 12:25	159.4
MLK - Storage	1.1042	620	01Jan2015, 12:35	159.4
Reach-BH-100	1.1042	619.3	01Jan2015, 12:35	159.4
Lake Ellen	1.349553	683.6	01Jan2015, 12:55	202.8
BH-110	0.117356	190.2	01Jan2015, 12:10	22.4
MLK Jr. - Kings Br	0.117356	141.8	01Jan2015, 12:25	22.4
BH-120	0.02747	39.6	01Jan2015, 12:10	4.1
ADD-BH-120	1.249026	763.1	01Jan2015, 12:35	185.8
BH-130	0.100527	108.1	01Jan2015, 12:30	17
CB-10	0.144686	108.2	01Jan2015, 12:55	25.3
Reach-CB-10	0.144686	108.1	01Jan2015, 12:55	25.3
CB-20	0.112513	64.6	01Jan2015, 12:45	12.5
ADD-CB-20	0.257199	170.2	01Jan2015, 12:50	37.8
Reach-CB-20	0.257199	168.5	01Jan2015, 13:00	37.7
CB-40	0.051355	99.5	01Jan2015, 12:15	12.1
CB-30	0.026991	29.6	01Jan2015, 12:40	5.9
ADD-CB-30-40	0.335545	211.4	01Jan2015, 13:00	55.7
CB-50	0.072003	95	01Jan2015, 12:35	17.9
Municipal Drive	0.072003	95	01Jan2015, 12:35	17.9
CB-60	0.031973	54.3	01Jan2015, 12:20	7.7
RT CB-50-60	0.103976	111.7	01Jan2015, 12:50	25.5
ADD-CB-60	0.439521	319.5	01Jan2015, 12:55	81.2
Reach-CB-60	0.439521	317.6	01Jan2015, 13:05	81.2
CB-70	0.149895	124	01Jan2015, 12:55	29.2
RT CB-70	0.149895	98.1	01Jan2015, 13:25	29.2
ADD-CB-70	0.589416	408.1	01Jan2015, 13:10	110.4
Reach-CB-70	0.589416	402.1	01Jan2015, 13:30	110.3
CB-80	0.083068	80.7	01Jan2015, 12:25	11.4
ADD-CB-80	0.672484	419	01Jan2015, 13:30	121.6
Reach-CB-80	0.672484	418.2	01Jan2015, 13:40	121.6
ADD- CB-BH	2.022037	987.9	01Jan2015, 13:15	324.5
EL-20	0.137538	227.5	01Jan2015, 12:05	20.4
ADD-EL-20	2.159575	1011.1	01Jan2015, 13:15	344.9
Reach-EL-20	2.159575	1011.1	01Jan2015, 13:15	344.9

Town of Chapel Hill -Eastwood Lake Subwatershed Study - HMS Output

10-YEAR ALTERNATIVE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
EL-10	0.138871	257.2	01Jan2015, 12:10	25.1
Piney Mountain Rd	0.138871	257.2	01Jan2015, 12:10	25.1
Piney Mountain Rd -Booker Ck	2.298446	1018	01Jan2015, 13:25	370
EL-30	0.119754	141.1	01Jan2015, 12:10	14.4
Reach- EL-30	2.4182	1034.3	01Jan2015, 13:30	384.4
EL-50	0.11573	161.1	01Jan2015, 12:10	15.7
ADD-EL-50	2.53393	1050.7	01Jan2015, 13:30	400.1
Reach-EL-50	2.53393	1048.9	01Jan2015, 13:40	400
EL-40	0.074895	124	01Jan2015, 12:10	12.2
Kensington Drive	0.074895	124	01Jan2015, 12:10	12.2
N Lakeshore Dr - Booker Ck	2.608825	1060	01Jan2015, 13:40	412.2
CF-10	0.078889	147.5	01Jan2015, 12:10	15.6
Kingston Drive	0.078889	147.5	01Jan2015, 12:10	15.6
CF-20	0.076885	67.4	01Jan2015, 12:55	15.5
ADD-CF-20	0.155774	173.3	01Jan2015, 12:10	31.1
Weaver Dairy - Cedar Fk	0.155774	173.3	01Jan2015, 12:10	31.1
CF-30	0.044849	23.6	01Jan2015, 13:05	5.8
ADD-CF-30	0.200623	179.5	01Jan2015, 12:10	37
Cross Creek Drive	0.200623	179.5	01Jan2015, 12:10	37
Reach-CF-50	0.200623	176	01Jan2015, 12:15	37
CF-40	0.092855	72.2	01Jan2015, 12:40	14
Weaver Dairy Rd - 1	0.092855	59	01Jan2015, 13:00	14
CF-50	0.029148	27.7	01Jan2015, 12:15	3.2
ADD-CF-50	0.322626	221.8	01Jan2015, 12:15	54.1
CF-60	0.12336	75.8	01Jan2015, 12:50	16.6
Cedar Hills Circle	0.445986	259.7	01Jan2015, 12:50	70.7
Reach-CF-80	0.445986	259.5	01Jan2015, 12:55	70.7
CF-80	0.176821	162.8	01Jan2015, 12:25	23
CF-70	0.120239	69.7	01Jan2015, 13:05	17.8
Weaver Dairy Rd -2	0.120239	69.7	01Jan2015, 13:05	17.8
Kenmore Road	0.743046	456.8	01Jan2015, 12:25	111.5
Reach-CF-130	0.743046	456.8	01Jan2015, 12:30	111.5
CF-90	0.184752	116.2	01Jan2015, 12:40	21.5
CF-100	0.085353	108.8	01Jan2015, 12:05	9.8
Piney Mountain Rd - Cedar Fk	0.085353	108.8	01Jan2015, 12:05	9.8
CF-110	0.044111	43.6	01Jan2015, 12:15	5.3
ADD-CF-110	0.129464	146.1	01Jan2015, 12:10	15.2
ADD-CF-90-120	0.314216	198.8	01Jan2015, 12:15	36.6
CF-120	0.096092	160.7	01Jan2015, 12:00	11.2
Brookview Drive	1.153354	666.9	01Jan2015, 12:30	159.4
Reach-CF-140	1.153354	665.8	01Jan2015, 12:30	159.4
CF-130	0.151403	109.4	01Jan2015, 12:40	19.4
CF-140	0.042477	36.9	01Jan2015, 12:20	5.1
North Lakeshore Drive	1.347234	804.8	01Jan2015, 12:30	184
CF-150	0.050842	62.6	01Jan2015, 12:10	6.1
ADD-CF-150	1.398076	832.3	01Jan2015, 12:30	190.1
EL-60	0.142028	131.6	01Jan2015, 12:20	16.7
EL-90	0.100143	151.9	01Jan2015, 12:10	15.2
EL-70	0.094086	200.7	01Jan2015, 12:00	13.9
EL-80	0.091741	131	01Jan2015, 12:10	12.8
EL-100	0.087147	145.4	01Jan2015, 12:15	17.8
Eastwood Lake	4.522046	1588.4	01Jan2015, 13:30	677.5
LBC-10	0.097332	97	01Jan2015, 12:25	13.5
U/S Limit - Sierra	0.097332	87.5	01Jan2015, 12:30	13.5
LBC-20	0.084519	101.6	01Jan2015, 12:20	13.1
ADD-LBC-10-20	0.181851	181	01Jan2015, 12:25	26.5

Town of Chapel Hill -Eastwood Lake Subwatershed Study - HMS Output

10-YEAR ALTERNATIVE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Reach-LBC-20	0.181851	179.8	01Jan2015, 12:25	26.5
Honeysuckle Road	0.181851	179.8	01Jan2015, 12:25	26.5
Reach-LBC-30	0.181851	177.8	01Jan2015, 12:35	26.5
LBC-30	0.159799	129	01Jan2015, 13:00	30.7
Booker Creek Road	0.34165	282.3	01Jan2015, 12:40	57.2
Reach-LBC-40	0.34165	267.4	01Jan2015, 12:50	57
LBC-40	0.156492	203.8	01Jan2015, 12:25	31.1
LBC-50	0.022218	30.7	01Jan2015, 12:10	2.9
ADD-LBC-40-50	5.042406	1860.9	01Jan2015, 13:15	768.6
LBC-60	0.142061	203.7	01Jan2015, 12:10	22
ADD-LBC-60	5.184467	1893	01Jan2015, 13:10	790.6
Reach-LBC-60	5.184467	1889.4	01Jan2015, 13:20	790.3
LBC-70	0.107956	152.4	01Jan2015, 12:10	15.3
LBC-130	0.03607	46.4	01Jan2015, 12:30	7.6
ADD-LBC-70-130	5.328493	1925.2	01Jan2015, 13:15	813.2
LBC-90	0.115064	113.5	01Jan2015, 12:50	24.9
LBC-80	0.06417	79.9	01Jan2015, 12:30	13.5
Fordham Blvd - Upstream	0.06417	79.9	01Jan2015, 12:30	13.5
LBC-100	0.029058	31.3	01Jan2015, 12:45	6.7
Dobbins Drive	0.208292	215.9	01Jan2015, 12:40	45
LBC-110	0.0333	34.7	01Jan2015, 12:45	7.4
Summerfield Crossing	0.241592	249.9	01Jan2015, 12:40	52.4
LBC-120	0.049799	47.5	01Jan2015, 12:50	10.3
Foxcroft Drive	0.291391	293.9	01Jan2015, 12:50	62.7
East Franklin Street	5.619884	2141.4	01Jan2015, 13:15	875.8
LBC-140	0.088638	152	01Jan2015, 12:20	20.9
ADD-LBC-140	5.708522	2173.8	01Jan2015, 13:15	896.7
Reach-LBC-140	5.708522	1933.6	01Jan2015, 13:45	893.5
LBC-150	0.107836	128.7	01Jan2015, 12:25	19.3
ADD-LBC-150	5.816358	1955.7	01Jan2015, 13:45	912.8
LBC-160	0.077625	119.5	01Jan2015, 12:20	17.7
Fordham Blvd - Downstream	5.893983	1969.7	01Jan2015, 13:50	930.5
LBC-180	0.14221	276.6	01Jan2015, 12:15	32.6
LBC-170	0.027436	61.9	01Jan2015, 12:10	6.6
ADD-LBC-170-180	6.063629	1998.1	01Jan2015, 13:50	969.7
Reach-LBC-190	6.063629	1990.8	01Jan2015, 14:00	969.5
LBC-190	0.05069	62.1	01Jan2015, 12:25	9.1
Willow Drive	6.114319	2000.2	01Jan2015, 14:00	978.6
Reach-LBC-200	6.114319	1884.3	01Jan2015, 14:35	977
LBC-200	0.168071	144.9	01Jan2015, 12:45	28.3
ADD-LBC-200	6.28239	1915.2	01Jan2015, 14:30	1005.2
OUTLET	6.28239	1915.2	01Jan2015, 14:30	1005.2

Town of Chapel Hill -Eastwood Lake Subwatershed Study - HMS Output

25-YEAR ALTERNATIVE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
BH-10	0.139076	111	01Jan2015, 12:45	21.8
BH-20	0.07669	93.3	01Jan2015, 12:25	13.8
ADD-BH-10-20	0.215766	192.7	01Jan2015, 12:35	35.6
Parkside Storage	0.215766	23.5	01Jan2015, 15:20	33.5
Reach-BH-20	0.215766	23.5	01Jan2015, 15:30	33.5
BH-30	0.165073	158.4	01Jan2015, 12:50	33.8
ADD-BH-30	0.380839	156.1	01Jan2015, 13:10	67.2
BH-40	0.105607	219.5	01Jan2015, 12:10	21.4
ADD-BH-40	0.486446	244.1	01Jan2015, 12:10	88.6
Reach-BH-40	0.486446	238.8	01Jan2015, 12:15	88.6
BH-60	0.129437	126	01Jan2015, 12:45	25.6
BH-50	0.117491	172.9	01Jan2015, 12:20	21.6
Weaver Dairy Rd Ext	0.117491	152.4	01Jan2015, 12:30	21.6
Northern Park	0.246928	264.7	01Jan2015, 12:35	47.2
ADD-BH	0.733374	446.6	01Jan2015, 12:20	135.8
BH-70	0.062883	120.8	01Jan2015, 12:10	12.6
MLK Jr. Blvd	0.796257	524.8	01Jan2015, 12:25	148.4
BH-80	0.10254	137.4	01Jan2015, 12:30	21.4
Stateside Drive	0.10254	137.4	01Jan2015, 12:30	21.4
BH-90	0.094578	80.2	01Jan2015, 12:55	17.5
ADD-BH-90	0.197118	201.9	01Jan2015, 12:35	38.9
BH-100	0.110825	137.4	01Jan2015, 12:30	21.2
ADD-BH-100	1.1042	854.9	01Jan2015, 12:30	208.5
MLK - Storage	1.1042	840.7	01Jan2015, 12:35	208.4
Reach-BH-100	1.1042	840.4	01Jan2015, 12:35	208.4
Lake Ellen	1.349553	931.3	01Jan2015, 12:55	263.6
BH-110	0.117356	240.6	01Jan2015, 12:10	28
MLK Jr. - Kings Br	0.117356	179.3	01Jan2015, 12:25	28
BH-120	0.02747	52.3	01Jan2015, 12:10	5.3
ADD-BH-120	1.249026	1030	01Jan2015, 12:30	241.7
BH-130	0.100527	139.7	01Jan2015, 12:30	21.9
CB-10	0.144686	139.2	01Jan2015, 12:55	32.2
Reach-CB-10	0.144686	139.1	01Jan2015, 12:55	32.2
CB-20	0.112513	90.6	01Jan2015, 12:45	17.1
ADD-CB-20	0.257199	226.2	01Jan2015, 12:50	49.3
Reach-CB-20	0.257199	223.8	01Jan2015, 13:00	49.3
CB-40	0.051355	121.9	01Jan2015, 12:15	14.8
CB-30	0.026991	36.7	01Jan2015, 12:40	7.2
ADD-CB-30-40	0.335545	276.1	01Jan2015, 13:00	71.3
CB-50	0.072003	115.5	01Jan2015, 12:35	21.7
Municipal Drive	0.072003	115.5	01Jan2015, 12:35	21.7
CB-60	0.031973	66.4	01Jan2015, 12:20	9.4
RT CB-50-60	0.103976	136.1	01Jan2015, 12:50	31.1
ADD-CB-60	0.439521	407.3	01Jan2015, 12:55	102.3
Reach-CB-60	0.439521	404.7	01Jan2015, 13:05	102.3
CB-70	0.149895	156.8	01Jan2015, 12:55	36.7
RT CB-70	0.149895	120.9	01Jan2015, 13:30	36.7
ADD-CB-70	0.589416	516.8	01Jan2015, 13:10	139
Reach-CB-70	0.589416	509.4	01Jan2015, 13:30	138.9
CB-80	0.083068	108.5	01Jan2015, 12:20	15
ADD-CB-80	0.672484	532.5	01Jan2015, 13:25	153.9
Reach-CB-80	0.672484	530.8	01Jan2015, 13:40	153.9
ADD- CB-BH	2.022037	1289.9	01Jan2015, 13:10	417.5
EL-20	0.137538	301.1	01Jan2015, 12:05	26.7
ADD-EL-20	2.159575	1322.4	01Jan2015, 13:05	444.1
Reach-EL-20	2.159575	1322.4	01Jan2015, 13:05	444.1

Town of Chapel Hill -Eastwood Lake Subwatershed Study - HMS Output

25-YEAR ALTERNATIVE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
EL-10	0.138871	327.9	01Jan2015, 12:10	31.9
Piney Mountain Rd	0.138871	327.9	01Jan2015, 12:10	31.9
Piney Mountain Rd -Booker Ck	2.298446	1355.9	01Jan2015, 13:10	476
EL-30	0.119754	194	01Jan2015, 12:10	19.4
Reach- EL-30	2.4182	1379.5	01Jan2015, 13:20	495.4
EL-50	0.11573	216	01Jan2015, 12:10	20.8
ADD-EL-50	2.53393	1403.3	01Jan2015, 13:20	516.2
Reach-EL-50	2.53393	1399.7	01Jan2015, 13:30	516
EL-40	0.074895	161.1	01Jan2015, 12:10	15.7
Kensington Drive	0.074895	161.1	01Jan2015, 12:10	15.7
N Lakeshore Dr - Booker Ck	2.608825	1415	01Jan2015, 13:30	531.8
CF-10	0.078889	185.1	01Jan2015, 12:10	19.4
Kingston Drive	0.078889	185.1	01Jan2015, 12:10	19.4
CF-20	0.076885	84.7	01Jan2015, 12:50	19.3
ADD-CF-20	0.155774	218	01Jan2015, 12:10	38.8
Weaver Dairy - Cedar Fk	0.155774	218	01Jan2015, 12:10	38.8
CF-30	0.044849	32	01Jan2015, 13:05	7.8
ADD-CF-30	0.200623	227	01Jan2015, 12:10	46.5
Cross Creek Drive	0.200623	227	01Jan2015, 12:10	46.5
Reach-CF-50	0.200623	222.6	01Jan2015, 12:15	46.5
CF-40	0.092855	95.5	01Jan2015, 12:40	18.1
Weaver Dairy Rd - 1	0.092855	78	01Jan2015, 13:00	18.1
CF-50	0.029148	38.8	01Jan2015, 12:15	4.4
ADD-CF-50	0.322626	286.2	01Jan2015, 12:15	69
CF-60	0.12336	102.4	01Jan2015, 12:50	21.9
Cedar Hills Circle	0.445986	340.4	01Jan2015, 12:45	90.9
Reach-CF-80	0.445986	340.1	01Jan2015, 12:55	90.9
CF-80	0.176821	220.5	01Jan2015, 12:25	30.6
CF-70	0.120239	92.2	01Jan2015, 13:05	23.1
Weaver Dairy Rd -2	0.120239	92.2	01Jan2015, 13:05	23.1
Kenmore Road	0.743046	605.8	01Jan2015, 12:25	144.7
Reach-CF-130	0.743046	603.9	01Jan2015, 12:30	144.7
CF-90	0.184752	161.3	01Jan2015, 12:40	29.1
CF-100	0.085353	151.3	01Jan2015, 12:05	13.3
Piney Mountain Rd - Cedar Fk	0.085353	151.3	01Jan2015, 12:05	13.3
CF-110	0.044111	60.1	01Jan2015, 12:15	7.2
ADD-CF-110	0.129464	201.5	01Jan2015, 12:10	20.5
ADD-CF-90-120	0.314216	277.1	01Jan2015, 12:15	49.6
CF-120	0.096092	221.3	01Jan2015, 12:00	15.2
Brookview Drive	1.153354	892.2	01Jan2015, 12:30	209.4
Reach-CF-140	1.153354	890.8	01Jan2015, 12:30	209.4
CF-130	0.151403	148.8	01Jan2015, 12:35	26
CF-140	0.042477	50.9	01Jan2015, 12:20	6.9
North Lakeshore Drive	1.347234	1081.1	01Jan2015, 12:30	242.4
CF-150	0.050842	85.9	01Jan2015, 12:10	8.2
ADD-CF-150	1.398076	1118	01Jan2015, 12:30	250.6
EL-60	0.142028	181.6	01Jan2015, 12:15	22.5
EL-90	0.100143	200	01Jan2015, 12:10	19.9
EL-70	0.094086	264.9	01Jan2015, 12:00	18.2
EL-80	0.091741	175.1	01Jan2015, 12:10	16.9
EL-100	0.087147	181.8	01Jan2015, 12:15	22.3
Eastwood Lake	4.522046	2187.2	01Jan2015, 13:25	880.8
LBC-10	0.097332	130.2	01Jan2015, 12:20	17.8
U/S Limit - Sierra	0.097332	115.7	01Jan2015, 12:35	17.8
LBC-20	0.084519	133.3	01Jan2015, 12:20	17
ADD-LBC-10-20	0.181851	237.1	01Jan2015, 12:25	34.8

Town of Chapel Hill -Eastwood Lake Subwatershed Study - HMS Output

25-YEAR ALTERNATIVE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Reach-LBC-20	0.181851	235.1	01Jan2015, 12:25	34.8
Honeysuckle Road	0.181851	235.1	01Jan2015, 12:25	34.8
Reach-LBC-30	0.181851	232.5	01Jan2015, 12:35	34.8
LBC-30	0.159799	163.3	01Jan2015, 13:00	38.8
Booker Creek Road	0.34165	364.8	01Jan2015, 12:40	73.6
Reach-LBC-40	0.34165	347.2	01Jan2015, 12:50	73.3
LBC-40	0.156492	256.5	01Jan2015, 12:25	39.1
LBC-50	0.022218	41.3	01Jan2015, 12:10	3.9
ADD-LBC-40-50	5.042406	2588.9	01Jan2015, 13:05	997.1
LBC-60	0.142061	267.8	01Jan2015, 12:10	28.6
ADD-LBC-60	5.184467	2640.1	01Jan2015, 13:00	1025.7
Reach-LBC-60	5.184467	2633	01Jan2015, 13:10	1025.1
LBC-70	0.107956	203.1	01Jan2015, 12:10	20.1
LBC-130	0.03607	57.9	01Jan2015, 12:30	9.5
ADD-LBC-70-130	5.328493	2690.5	01Jan2015, 13:05	1054.7
LBC-90	0.115064	140.9	01Jan2015, 12:50	30.9
LBC-80	0.06417	99.6	01Jan2015, 12:30	16.8
Fordham Blvd - Upstream	0.06417	99.6	01Jan2015, 12:30	16.8
LBC-100	0.029058	38.5	01Jan2015, 12:45	8.2
Dobbins Drive	0.208292	268.2	01Jan2015, 12:40	55.8
LBC-110	0.0333	43	01Jan2015, 12:45	9.1
Summerfield Crossing	0.241592	310.2	01Jan2015, 12:45	65
LBC-120	0.049799	59.4	01Jan2015, 12:50	12.8
Foxcroft Drive	0.291391	369.8	01Jan2015, 12:45	77.8
East Franklin Street	5.619884	2987.6	01Jan2015, 13:10	1132.5
LBC-140	0.088638	186.3	01Jan2015, 12:20	25.6
ADD-LBC-140	5.708522	3032.2	01Jan2015, 13:10	1158
Reach-LBC-140	5.708522	2670.1	01Jan2015, 13:35	1153.2
LBC-150	0.107836	164.8	01Jan2015, 12:25	24.4
ADD-LBC-150	5.816358	2702.8	01Jan2015, 13:35	1177.6
LBC-160	0.077625	147.3	01Jan2015, 12:20	21.7
Fordham Blvd - Downstream	5.893983	2723.9	01Jan2015, 13:40	1199.3
LBC-180	0.14221	340.1	01Jan2015, 12:15	40
LBC-170	0.027436	75.5	01Jan2015, 12:10	8.1
ADD-LBC-170-180	6.063629	2763.1	01Jan2015, 13:35	1247.4
Reach-LBC-190	6.063629	2757.3	01Jan2015, 13:45	1247.3
LBC-190	0.05069	79.4	01Jan2015, 12:25	11.6
Willow Drive	6.114319	2771.9	01Jan2015, 13:45	1259
Reach-LBC-200	6.114319	2613.7	01Jan2015, 14:20	1256.4
LBC-200	0.168071	187.6	01Jan2015, 12:45	36.4
ADD-LBC-200	6.28239	2660.6	01Jan2015, 14:15	1292.8
OUTLET	6.28239	2660.6	01Jan2015, 14:15	1292.8

Town of Chapel Hill -Eastwood Lake Subwatershed Study - HMS Output

50-YEAR ALTERNATIVE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
BH-10	0.139076	136.3	01Jan2015, 12:45	26.4
BH-20	0.07669	112.6	01Jan2015, 12:25	16.5
ADD-BH-10-20	0.215766	234.9	01Jan2015, 12:35	42.9
Parkside Storage	0.215766	27	01Jan2015, 15:25	40.4
Reach-BH-20	0.215766	27	01Jan2015, 15:35	40.4
BH-30	0.165073	188.3	01Jan2015, 12:50	39.9
ADD-BH-30	0.380839	190.7	01Jan2015, 13:05	80.2
BH-40	0.105607	260.5	01Jan2015, 12:10	25.4
ADD-BH-40	0.486446	291	01Jan2015, 12:10	105.5
Reach-BH-40	0.486446	284.7	01Jan2015, 12:15	105.5
BH-60	0.129437	150.4	01Jan2015, 12:45	30.4
BH-50	0.117491	208	01Jan2015, 12:20	25.8
Weaver Dairy Rd Ext	0.117491	178.5	01Jan2015, 12:30	25.8
Northern Park	0.246928	315.2	01Jan2015, 12:35	56.2
ADD-BH	0.733374	529.7	01Jan2015, 12:20	161.7
BH-70	0.062883	143.8	01Jan2015, 12:10	14.9
MLK Jr. Blvd	0.796257	599.5	01Jan2015, 12:30	176.6
BH-80	0.10254	162.8	01Jan2015, 12:30	25.2
Stateside Drive	0.10254	162.8	01Jan2015, 12:30	25.2
BH-90	0.094578	96.4	01Jan2015, 12:55	20.9
ADD-BH-90	0.197118	240.7	01Jan2015, 12:35	46.2
BH-100	0.110825	164.5	01Jan2015, 12:30	25.2
ADD-BH-100	1.1042	1002.8	01Jan2015, 12:30	248
MLK - Storage	1.1042	979	01Jan2015, 12:35	247.9
Reach-BH-100	1.1042	978.4	01Jan2015, 12:35	247.9
Lake Ellen	1.349553	1036.1	01Jan2015, 13:00	312.4
BH-110	0.117356	280.8	01Jan2015, 12:10	32.5
MLK Jr. - Kings Br	0.117356	209.1	01Jan2015, 12:25	32.5
BH-120	0.02747	62.6	01Jan2015, 12:10	6.3
ADD-BH-120	1.249026	1191.6	01Jan2015, 12:30	286.6
BH-130	0.100527	164.7	01Jan2015, 12:30	25.8
CB-10	0.144686	163.8	01Jan2015, 12:55	37.7
Reach-CB-10	0.144686	163.8	01Jan2015, 12:55	37.7
CB-20	0.112513	111.8	01Jan2015, 12:45	20.9
ADD-CB-20	0.257199	271.2	01Jan2015, 12:50	58.6
Reach-CB-20	0.257199	268.2	01Jan2015, 13:00	58.5
CB-40	0.051355	139.5	01Jan2015, 12:15	16.9
CB-30	0.026991	42.3	01Jan2015, 12:40	8.3
ADD-CB-30-40	0.335545	322.2	01Jan2015, 13:05	83.7
CB-50	0.072003	131.5	01Jan2015, 12:35	24.7
Municipal Drive	0.072003	131.5	01Jan2015, 12:35	24.7
CB-60	0.031973	75.8	01Jan2015, 12:20	10.7
RT CB-50-60	0.103976	153.7	01Jan2015, 12:50	35.4
ADD-CB-60	0.439521	469.9	01Jan2015, 13:00	119.1
Reach-CB-60	0.439521	466.8	01Jan2015, 13:05	119.1
CB-70	0.149895	182.6	01Jan2015, 12:55	42.6
RT CB-70	0.149895	139.4	01Jan2015, 13:30	42.6
ADD-CB-70	0.589416	597.1	01Jan2015, 13:10	161.8
Reach-CB-70	0.589416	589.4	01Jan2015, 13:30	161.7
CB-80	0.083068	131	01Jan2015, 12:20	17.9
ADD-CB-80	0.672484	615.6	01Jan2015, 13:25	179.6
Reach-CB-80	0.672484	614.5	01Jan2015, 13:40	179.6
ADD- CB-BH	2.022037	1575.8	01Jan2015, 13:15	492
EL-20	0.137538	359.9	01Jan2015, 12:05	31.7
ADD-EL-20	2.159575	1610.2	01Jan2015, 13:15	523.7
Reach-EL-20	2.159575	1610	01Jan2015, 13:15	523.7

Town of Chapel Hill -Eastwood Lake Subwatershed Study - HMS Output

50-YEAR ALTERNATIVE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
EL-10	0.138871	383.6	01Jan2015, 12:10	37.3
Piney Mountain Rd	0.138871	383.6	01Jan2015, 12:10	37.3
Piney Mountain Rd -Booker Ck	2.298446	1643.3	01Jan2015, 13:20	561
EL-30	0.119754	237.1	01Jan2015, 12:10	23.5
Reach- EL-30	2.4182	1668.1	01Jan2015, 13:25	584.3
EL-50	0.11573	260.2	01Jan2015, 12:10	24.9
ADD-EL-50	2.53393	1694.2	01Jan2015, 13:25	609.2
Reach-EL-50	2.53393	1688.6	01Jan2015, 13:35	609
EL-40	0.074895	190.6	01Jan2015, 12:10	18.6
Kensington Drive	0.074895	190.6	01Jan2015, 12:10	18.6
N Lakeshore Dr - Booker Ck	2.608825	1705.4	01Jan2015, 13:35	627.6
CF-10	0.078889	215	01Jan2015, 12:10	22.4
Kingston Drive	0.078889	215	01Jan2015, 12:10	22.4
CF-20	0.076885	98.4	01Jan2015, 12:50	22.4
ADD-CF-20	0.155774	253.5	01Jan2015, 12:10	44.8
Weaver Dairy - Cedar Fk	0.155774	253.5	01Jan2015, 12:10	44.8
CF-30	0.044849	38.9	01Jan2015, 13:00	9.3
ADD-CF-30	0.200623	264.9	01Jan2015, 12:10	54.1
Cross Creek Drive	0.200623	264.9	01Jan2015, 12:10	54.1
Reach-CF-50	0.200623	259.6	01Jan2015, 12:15	54.1
CF-40	0.092855	114.1	01Jan2015, 12:40	21.5
Weaver Dairy Rd - 1	0.092855	93.3	01Jan2015, 13:00	21.5
CF-50	0.029148	47.9	01Jan2015, 12:15	5.3
ADD-CF-50	0.322626	338	01Jan2015, 12:15	81
CF-60	0.12336	123.8	01Jan2015, 12:50	26.2
Cedar Hills Circle	0.445986	405.3	01Jan2015, 12:45	107.2
Reach-CF-80	0.445986	404.9	01Jan2015, 12:50	107.2
CF-80	0.176821	267.1	01Jan2015, 12:25	36.8
CF-70	0.120239	110.3	01Jan2015, 13:05	27.5
Weaver Dairy Rd -2	0.120239	110.3	01Jan2015, 13:05	27.5
Kenmore Road	0.743046	727	01Jan2015, 12:25	171.4
Reach-CF-130	0.743046	725.5	01Jan2015, 12:30	171.5
CF-90	0.184752	198.1	01Jan2015, 12:40	35.3
CF-100	0.085353	186	01Jan2015, 12:05	16.2
Piney Mountain Rd - Cedar Fk	0.085353	186	01Jan2015, 12:05	16.2
CF-110	0.044111	73.6	01Jan2015, 12:15	8.7
ADD-CF-110	0.129464	246.6	01Jan2015, 12:10	24.9
ADD-CF-90-120	0.314216	341.8	01Jan2015, 12:10	60.2
CF-120	0.096092	270.7	01Jan2015, 12:00	18.4
Brookview Drive	1.153354	1075.7	01Jan2015, 12:30	250
Reach-CF-140	1.153354	1074	01Jan2015, 12:30	250
CF-130	0.151403	180.9	01Jan2015, 12:35	31.4
CF-140	0.042477	62.2	01Jan2015, 12:20	8.3
North Lakeshore Drive	1.347234	1305.9	01Jan2015, 12:30	289.7
CF-150	0.050842	104.8	01Jan2015, 12:10	9.9
ADD-CF-150	1.398076	1350.4	01Jan2015, 12:30	299.7
EL-60	0.142028	223.1	01Jan2015, 12:15	27.3
EL-90	0.100143	238.1	01Jan2015, 12:10	23.7
EL-70	0.094086	316	01Jan2015, 12:00	21.7
EL-80	0.091741	210.3	01Jan2015, 12:10	20.2
EL-100	0.087147	210.1	01Jan2015, 12:15	25.9
Eastwood Lake	4.522046	2601.5	01Jan2015, 13:25	1044.3
LBC-10	0.097332	157	01Jan2015, 12:20	21.3
U/S Limit - Sierra	0.097332	138.8	01Jan2015, 12:35	21.3
LBC-20	0.084519	158.6	01Jan2015, 12:20	20.1
ADD-LBC-10-20	0.181851	282.6	01Jan2015, 12:25	41.4

Town of Chapel Hill -Eastwood Lake Subwatershed Study - HMS Output

50-YEAR ALTERNATIVE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Reach-LBC-20	0.181851	280.1	01Jan2015, 12:25	41.4
Honeysuckle Road	0.181851	280.1	01Jan2015, 12:25	41.4
Reach-LBC-30	0.181851	276.6	01Jan2015, 12:35	41.4
LBC-30	0.159799	190.1	01Jan2015, 13:00	45.2
Booker Creek Road	0.34165	430.5	01Jan2015, 12:40	86.6
Reach-LBC-40	0.34165	409.7	01Jan2015, 12:50	86.3
LBC-40	0.156492	297.7	01Jan2015, 12:25	45.4
LBC-50	0.022218	49.8	01Jan2015, 12:10	4.7
ADD-LBC-40-50	5.042406	3159.2	01Jan2015, 12:50	1180.7
LBC-60	0.142061	318.9	01Jan2015, 12:10	33.9
ADD-LBC-60	5.184467	3241.2	01Jan2015, 12:50	1214.6
Reach-LBC-60	5.184467	3213.6	01Jan2015, 13:00	1213.9
LBC-70	0.107956	243.8	01Jan2015, 12:10	24
LBC-130	0.03607	66.8	01Jan2015, 12:30	10.9
ADD-LBC-70-130	5.328493	3293	01Jan2015, 12:55	1248.8
LBC-90	0.115064	162.3	01Jan2015, 12:50	35.6
LBC-80	0.06417	115.1	01Jan2015, 12:30	19.4
Fordham Blvd - Upstream	0.06417	115.1	01Jan2015, 12:30	19.4
LBC-100	0.029058	44.2	01Jan2015, 12:45	9.4
Dobbins Drive	0.208292	309.1	01Jan2015, 12:40	64.3
LBC-110	0.0333	49.4	01Jan2015, 12:45	10.5
Summerfield Crossing	0.241592	357.8	01Jan2015, 12:40	74.8
LBC-120	0.049799	68.7	01Jan2015, 12:50	14.9
Foxcroft Drive	0.291391	428.1	01Jan2015, 12:45	89.7
East Franklin Street	5.619884	3631.9	01Jan2015, 13:05	1338.5
LBC-140	0.088638	213	01Jan2015, 12:20	29.2
ADD-LBC-140	5.708522	3690	01Jan2015, 13:05	1367.7
Reach-LBC-140	5.708522	3221.6	01Jan2015, 13:30	1361.3
LBC-150	0.107836	193.4	01Jan2015, 12:25	28.5
ADD-LBC-150	5.816358	3263.1	01Jan2015, 13:30	1389.9
LBC-160	0.077625	169	01Jan2015, 12:20	24.9
Fordham Blvd - Downstream	5.893983	3289.6	01Jan2015, 13:35	1414.7
LBC-180	0.14221	389.5	01Jan2015, 12:15	45.9
LBC-170	0.027436	86.1	01Jan2015, 12:10	9.2
ADD-LBC-170-180	6.063629	3338.6	01Jan2015, 13:30	1469.8
Reach-LBC-190	6.063629	3330.9	01Jan2015, 13:40	1469.5
LBC-190	0.05069	93	01Jan2015, 12:25	13.6
Willow Drive	6.114319	3349.2	01Jan2015, 13:40	1483.2
Reach-LBC-200	6.114319	3181.7	01Jan2015, 14:15	1479.8
LBC-200	0.168071	221.3	01Jan2015, 12:45	42.9
ADD-LBC-200	6.28239	3238.7	01Jan2015, 14:10	1522.7
OUTLET	6.28239	3238.7	01Jan2015, 14:10	1522.7

Town of Chapel Hill -Eastwood Lake Subwatershed Study - HMS Output

100-YEAR ALTERNATIVE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
BH-10	0.139076	162.2	01Jan2015, 12:40	31.1
BH-20	0.07669	132.1	01Jan2015, 12:25	19.3
ADD-BH-10-20	0.215766	277.9	01Jan2015, 12:35	50.4
Parkside Storage	0.215766	30.1	01Jan2015, 15:35	47.4
Reach-BH-20	0.215766	30.1	01Jan2015, 15:40	47.4
BH-30	0.165073	218.2	01Jan2015, 12:50	46.1
ADD-BH-30	0.380839	224.3	01Jan2015, 13:05	93.4
BH-40	0.105607	301.7	01Jan2015, 12:10	29.3
ADD-BH-40	0.486446	338.3	01Jan2015, 12:10	122.7
Reach-BH-40	0.486446	330.3	01Jan2015, 12:15	122.6
BH-60	0.129437	174.9	01Jan2015, 12:45	35.2
BH-50	0.117491	243.2	01Jan2015, 12:20	30.1
Weaver Dairy Rd Ext	0.117491	206.1	01Jan2015, 12:30	30.1
Northern Park	0.246928	366	01Jan2015, 12:35	65.3
ADD-BH	0.733374	616.8	01Jan2015, 12:20	187.9
BH-70	0.062883	167	01Jan2015, 12:10	17.2
MLK Jr. Blvd	0.796257	703.5	01Jan2015, 12:25	205.1
BH-80	0.10254	188.2	01Jan2015, 12:30	29.1
Stateside Drive	0.10254	188.2	01Jan2015, 12:30	29.1
BH-90	0.094578	112.9	01Jan2015, 12:50	24.4
ADD-BH-90	0.197118	279.8	01Jan2015, 12:35	53.5
BH-100	0.110825	191.7	01Jan2015, 12:30	29.3
ADD-BH-100	1.1042	1171.5	01Jan2015, 12:30	287.9
MLK - Storage	1.1042	1133.8	01Jan2015, 12:35	287.8
Reach-BH-100	1.1042	1133	01Jan2015, 12:35	287.8
Lake Ellen	1.349553	1045.5	01Jan2015, 13:10	361.6
BH-110	0.117356	321	01Jan2015, 12:10	36.9
MLK Jr. - Kings Br	0.117356	224.8	01Jan2015, 12:25	36.9
BH-120	0.02747	72.9	01Jan2015, 12:10	7.3
ADD-BH-120	1.249026	1376.7	01Jan2015, 12:35	332
BH-130	0.100527	189.6	01Jan2015, 12:30	29.7
CB-10	0.144686	188.5	01Jan2015, 12:55	43.2
Reach-CB-10	0.144686	188.4	01Jan2015, 12:55	43.2
CB-20	0.112513	133.6	01Jan2015, 12:40	24.8
ADD-CB-20	0.257199	316.5	01Jan2015, 12:50	68
Reach-CB-20	0.257199	313.3	01Jan2015, 13:00	68
CB-40	0.051355	156.8	01Jan2015, 12:15	19
CB-30	0.026991	47.8	01Jan2015, 12:40	9.4
ADD-CB-30-40	0.335545	371.5	01Jan2015, 13:05	96.3
CB-50	0.072003	147.3	01Jan2015, 12:35	27.7
Municipal Drive	0.072003	147.3	01Jan2015, 12:35	27.7
CB-60	0.031973	85.1	01Jan2015, 12:20	12
RT CB-50-60	0.103976	168.3	01Jan2015, 12:50	39.7
ADD-CB-60	0.439521	533.6	01Jan2015, 13:00	136
Reach-CB-60	0.439521	530.6	01Jan2015, 13:10	136
CB-70	0.149895	208.2	01Jan2015, 12:55	48.6
RT CB-70	0.149895	157.9	01Jan2015, 13:30	48.6
ADD-CB-70	0.589416	678.6	01Jan2015, 13:10	184.6
Reach-CB-70	0.589416	671.3	01Jan2015, 13:30	184.5
CB-80	0.083068	153.8	01Jan2015, 12:20	20.9
ADD-CB-80	0.672484	701.1	01Jan2015, 13:30	205.4
Reach-CB-80	0.672484	699.5	01Jan2015, 13:40	205.4
ADD- CB-BH	2.022037	1738.3	01Jan2015, 13:40	567
EL-20	0.137538	418.9	01Jan2015, 12:05	36.8
ADD-EL-20	2.159575	1769.1	01Jan2015, 13:40	603.8
Reach-EL-20	2.159575	1769.1	01Jan2015, 13:40	603.8

Town of Chapel Hill -Eastwood Lake Subwatershed Study - HMS Output

100-YEAR ALTERNATIVE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
EL-10	0.138871	439.1	01Jan2015, 12:10	42.7
Piney Mountain Rd	0.138871	439.1	01Jan2015, 12:10	42.7
Piney Mountain Rd -Booker Ck	2.298446	1803.1	01Jan2015, 13:40	646.5
EL-30	0.119754	280.8	01Jan2015, 12:10	27.6
Reach- EL-30	2.4182	1827.7	01Jan2015, 13:45	674
EL-50	0.11573	304.7	01Jan2015, 12:10	29.1
ADD-EL-50	2.53393	1852.4	01Jan2015, 13:45	703.1
Reach-EL-50	2.53393	1850.7	01Jan2015, 13:55	703
EL-40	0.074895	219.9	01Jan2015, 12:10	21.4
Kensington Drive	0.074895	219.9	01Jan2015, 12:10	21.4
N Lakeshore Dr - Booker Ck	2.608825	1866.6	01Jan2015, 13:55	724.4
CF-10	0.078889	244.9	01Jan2015, 12:10	25.5
Kingston Drive	0.078889	244.9	01Jan2015, 12:10	25.5
CF-20	0.076885	112	01Jan2015, 12:50	25.4
ADD-CF-20	0.155774	289.1	01Jan2015, 12:10	50.9
Weaver Dairy - Cedar Fk	0.155774	289.1	01Jan2015, 12:10	50.9
CF-30	0.044849	45.9	01Jan2015, 13:00	10.9
ADD-CF-30	0.200623	302.9	01Jan2015, 12:10	61.8
Cross Creek Drive	0.200623	302.9	01Jan2015, 12:10	61.8
Reach-CF-50	0.200623	296.9	01Jan2015, 12:15	61.8
CF-40	0.092855	132.9	01Jan2015, 12:40	24.9
Weaver Dairy Rd - 1	0.092855	108.7	01Jan2015, 13:00	24.9
CF-50	0.029148	57.2	01Jan2015, 12:15	6.3
ADD-CF-50	0.322626	390.2	01Jan2015, 12:15	93
CF-60	0.12336	145.6	01Jan2015, 12:50	30.6
Cedar Hills Circle	0.445986	470.7	01Jan2015, 12:45	123.6
Reach-CF-80	0.445986	469.9	01Jan2015, 12:50	123.6
CF-80	0.176821	314.2	01Jan2015, 12:25	43.1
CF-70	0.120239	128.6	01Jan2015, 13:05	31.8
Weaver Dairy Rd -2	0.120239	128.6	01Jan2015, 13:05	31.8
Kenmore Road	0.743046	845	01Jan2015, 12:25	198.5
Reach-CF-130	0.743046	843.3	01Jan2015, 12:30	198.5
CF-90	0.184752	235.5	01Jan2015, 12:40	41.7
CF-100	0.085353	221.2	01Jan2015, 12:05	19.2
Piney Mountain Rd - Cedar Fk	0.085353	221.2	01Jan2015, 12:05	19.2
CF-110	0.044111	87.3	01Jan2015, 12:15	10.2
ADD-CF-110	0.129464	292.3	01Jan2015, 12:10	29.3
ADD-CF-90-120	0.314216	408	01Jan2015, 12:10	71
CF-120	0.096092	320.8	01Jan2015, 12:00	21.7
Brookview Drive	1.153354	1256.8	01Jan2015, 12:30	291.2
Reach-CF-140	1.153354	1255.3	01Jan2015, 12:30	291.2
CF-130	0.151403	213.3	01Jan2015, 12:35	36.8
CF-140	0.042477	73.8	01Jan2015, 12:20	9.8
North Lakeshore Drive	1.347234	1529.2	01Jan2015, 12:30	337.8
CF-150	0.050842	124	01Jan2015, 12:10	11.7
ADD-CF-150	1.398076	1581.3	01Jan2015, 12:30	349.5
EL-60	0.142028	265.5	01Jan2015, 12:15	32.1
EL-90	0.100143	276.3	01Jan2015, 12:10	27.4
EL-70	0.094086	367.2	01Jan2015, 12:00	25.2
EL-80	0.091741	245.8	01Jan2015, 12:10	23.5
EL-100	0.087147	238	01Jan2015, 12:15	29.4
Eastwood Lake	4.522046	2823.1	01Jan2015, 13:25	1209.7
LBC-10	0.097332	184.1	01Jan2015, 12:20	24.8
U/S Limit - Sierra	0.097332	155.7	01Jan2015, 12:35	24.8
LBC-20	0.084519	183.9	01Jan2015, 12:20	23.3
ADD-LBC-10-20	0.181851	324.6	01Jan2015, 12:25	48.1

Town of Chapel Hill -Eastwood Lake Subwatershed Study - HMS Output

100-YEAR ALTERNATIVE				
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Discharge (CFS)**	**Time of Peak**	**Volume (AC-FT)**
Reach-LBC-20	0.181851	322.6	01Jan2015, 12:25	48.1
Honeysuckle Road	0.181851	322.6	01Jan2015, 12:25	48.1
Reach-LBC-30	0.181851	318.6	01Jan2015, 12:30	48.1
LBC-30	0.159799	216.8	01Jan2015, 13:00	51.5
Booker Creek Road	0.34165	491.7	01Jan2015, 12:40	99.7
Reach-LBC-40	0.34165	469.8	01Jan2015, 12:50	99.4
LBC-40	0.156492	338.5	01Jan2015, 12:25	51.7
LBC-50	0.022218	58.5	01Jan2015, 12:10	5.5
ADD-LBC-40-50	5.042406	3426	01Jan2015, 12:50	1366.2
LBC-60	0.142061	370.1	01Jan2015, 12:10	39.2
ADD-LBC-60	5.184467	3535.7	01Jan2015, 12:40	1405.4
Reach-LBC-60	5.184467	3522.5	01Jan2015, 12:50	1404.7
LBC-70	0.107956	284.7	01Jan2015, 12:10	27.9
LBC-130	0.03607	75.6	01Jan2015, 12:30	12.4
ADD-LBC-70-130	5.328493	3639.2	01Jan2015, 12:50	1445
LBC-90	0.115064	183.5	01Jan2015, 12:50	40.2
LBC-80	0.06417	130.4	01Jan2015, 12:30	22
Fordham Blvd - Upstream	0.06417	130.4	01Jan2015, 12:30	22
LBC-100	0.029058	49.7	01Jan2015, 12:45	10.6
Dobbins Drive	0.208292	349.5	01Jan2015, 12:40	72.8
LBC-110	0.0333	55.7	01Jan2015, 12:45	11.9
Summerfield Crossing	0.241592	404	01Jan2015, 12:45	84.7
LBC-120	0.049799	77.9	01Jan2015, 12:50	16.9
Foxcroft Drive	0.291391	479.8	01Jan2015, 12:40	101.5
East Franklin Street	5.619884	4040.6	01Jan2015, 13:00	1546.6
LBC-140	0.088638	239.4	01Jan2015, 12:20	32.8
ADD-LBC-140	5.708522	4115.9	01Jan2015, 13:00	1579.4
Reach-LBC-140	5.708522	3586.8	01Jan2015, 13:30	1572
LBC-150	0.107836	222.1	01Jan2015, 12:25	32.6
ADD-LBC-150	5.816358	3638.5	01Jan2015, 13:25	1604.6
LBC-160	0.077625	190.6	01Jan2015, 12:20	28
Fordham Blvd - Downstream	5.893983	3672.7	01Jan2015, 13:30	1632.7
LBC-180	0.14221	438.4	01Jan2015, 12:15	51.7
LBC-170	0.027436	96.5	01Jan2015, 12:10	10.3
ADD-LBC-170-180	6.063629	3731.9	01Jan2015, 13:25	1694.7
Reach-LBC-190	6.063629	3723.8	01Jan2015, 13:35	1694.5
LBC-190	0.05069	106.5	01Jan2015, 12:25	15.6
Willow Drive	6.114319	3747.7	01Jan2015, 13:30	1710.2
Reach-LBC-200	6.114319	3565.6	01Jan2015, 14:10	1706.1
LBC-200	0.168071	254.9	01Jan2015, 12:45	49.5
ADD-LBC-200	6.28239	3636.5	01Jan2015, 14:05	1755.6
OUTLET	6.28239	3636.5	01Jan2015, 14:05	1755.6

EXISTING CONDITIONS:
HEC-RAS OUTPUT

HEC-RAS Plan: Existing

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	26670.3	2-Year	197.00	470.17	472.19	472.19	472.93	0.028175	6.92	28.46	19.44	1.01
Reach - 1	26670.3	10-Year	446.00	470.17	473.97		474.65	0.010760	6.60	68.07	25.76	0.68
Reach - 1	26670.3	25-Year	608.00	470.17	475.71		476.17	0.003984	5.50	127.45	46.54	0.45
Reach - 1	26670.3	50-Year	739.00	470.17	476.66		477.07	0.002927	5.33	200.16	97.44	0.40
Reach - 1	26670.3	100-Year	872.00	470.17	477.55		477.91	0.002202	5.11	317.04	145.99	0.35
Reach - 1	26133.4	2-Year	197.00	467.03	470.88	468.57	470.95	0.000797	2.17	106.64	43.71	0.20
Reach - 1	26133.4	10-Year	446.00	467.03	473.28	469.48	473.40	0.000715	2.88	186.17	56.17	0.21
Reach - 1	26133.4	25-Year	608.00	467.03	475.30	469.97	475.42	0.000495	2.91	253.29	66.15	0.18
Reach - 1	26133.4	50-Year	739.00	467.03	476.26	470.32	476.40	0.000499	3.15	285.07	70.88	0.19
Reach - 1	26133.4	100-Year	872.00	467.03	477.15	470.65	477.31	0.000504	3.37	314.76	132.75	0.19
Reach - 1	26050.4		Culvert									
Reach - 1	25967.4	2-Year	197.00	463.47	465.50	465.01	465.82	0.008982	4.55	46.78	31.23	0.60
Reach - 1	25967.4	10-Year	446.00	463.47	466.57	465.93	467.16	0.009141	6.28	81.70	38.57	0.66
Reach - 1	25967.4	25-Year	608.00	463.47	467.12	466.41	467.87	0.009287	7.11	99.84	42.31	0.68
Reach - 1	25967.4	50-Year	739.00	463.47	467.50	466.76	468.38	0.009542	7.74	112.42	44.91	0.70
Reach - 1	25967.4	100-Year	872.00	463.47	467.84	467.09	468.86	0.009853	8.33	123.83	46.90	0.72
Reach - 1	25524.2	2-Year	197.00	456.43	458.45	458.45	459.19	0.028097	6.92	28.48	19.45	1.01
Reach - 1	25524.2	10-Year	446.00	456.43	459.55	459.55	460.70	0.025022	8.62	51.76	22.95	1.01
Reach - 1	25524.2	25-Year	608.00	456.43	460.09	460.09	461.48	0.023420	9.45	64.78	24.79	1.00
Reach - 1	25524.2	50-Year	739.00	456.43	460.50	460.50	462.04	0.021907	9.99	76.21	29.95	0.99
Reach - 1	25524.2	100-Year	872.00	456.43	460.89	460.89	462.58	0.020451	10.44	88.69	33.47	0.98
Reach - 1	24962.5	2-Year	197.00	444.33	447.13		447.43	0.007515	4.41	44.70	21.94	0.54
Reach - 1	24962.5	10-Year	446.00	444.33	448.26		448.88	0.009297	6.32	71.53	25.92	0.64
Reach - 1	24962.5	25-Year	608.00	444.33	448.77		449.61	0.010186	7.34	85.48	28.24	0.69
Reach - 1	24962.5	50-Year	739.00	444.33	449.07		450.11	0.011482	8.22	94.00	29.56	0.74
Reach - 1	24962.5	100-Year	872.00	444.33	449.38	448.77	450.62	0.012239	8.95	103.52	30.97	0.77
Reach - 1	24504.7	2-Year	335.00	437.03	439.67	439.67	440.62	0.025146	7.84	43.25	24.95	1.00
Reach - 1	24504.7	10-Year	734.00	437.03	441.09	441.09	442.48	0.018388	9.54	89.78	47.57	0.93
Reach - 1	24504.7	25-Year	979.00	437.03	441.76	441.76	443.33	0.016577	10.27	125.63	59.11	0.92
Reach - 1	24504.7	50-Year	1158.00	437.03	442.24	442.24	443.87	0.015093	10.59	156.00	66.99	0.89
Reach - 1	24504.7	100-Year	1321.00	437.03	442.58	442.58	444.31	0.014749	11.00	179.27	69.44	0.89

HEC-RAS Plan: Existing (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	23991.1	2-Year	335.00	426.45	431.80		431.93	0.001247	2.99	195.94	179.29	0.25
Reach - 1	23991.1	10-Year	734.00	426.45	433.36		433.52	0.001300	3.73	531.35	239.95	0.27
Reach - 1	23991.1	25-Year	979.00	426.45	434.13		434.28	0.001220	3.92	718.05	249.89	0.27
Reach - 1	23991.1	50-Year	1158.00	426.45	434.64		434.79	0.001168	4.02	848.62	259.20	0.26
Reach - 1	23991.1	100-Year	1321.00	426.45	435.07		435.22	0.001125	4.10	962.05	262.74	0.26
Reach - 1	23524.2	2-Year	335.00	425.63	431.51		431.56	0.000489	2.02	409.71	180.60	0.16
Reach - 1	23524.2	10-Year	734.00	425.63	432.99		433.06	0.000692	2.86	710.53	215.80	0.20
Reach - 1	23524.2	25-Year	979.00	425.63	433.74		433.83	0.000728	3.15	874.46	219.46	0.21
Reach - 1	23524.2	50-Year	1158.00	425.63	434.25		434.34	0.000742	3.33	986.56	221.90	0.21
Reach - 1	23524.2	100-Year	1321.00	425.63	434.68		434.78	0.000751	3.48	1083.48	223.99	0.21
Reach - 1	23024.2	2-Year	335.00	425.63	431.36		431.37	0.000261	1.45	756.07	321.19	0.12
Reach - 1	23024.2	10-Year	734.00	425.63	432.79		432.81	0.000335	1.95	1223.88	331.58	0.14
Reach - 1	23024.2	25-Year	979.00	425.63	433.54		433.56	0.000349	2.14	1473.56	336.73	0.14
Reach - 1	23024.2	50-Year	1158.00	425.63	434.04		434.07	0.000358	2.27	1645.64	344.21	0.15
Reach - 1	23024.2	100-Year	1321.00	425.63	434.48		434.51	0.000362	2.37	1796.09	348.83	0.15
Reach - 1	22524.2	2-Year	335.00	419.97	431.31		431.32	0.000053	1.09	588.22	92.11	0.06
Reach - 1	22524.2	10-Year	734.00	419.97	432.65		432.70	0.000162	2.06	720.25	109.97	0.11
Reach - 1	22524.2	25-Year	979.00	419.97	433.34		433.42	0.000231	2.56	799.99	122.67	0.13
Reach - 1	22524.2	50-Year	1158.00	419.97	433.81		433.91	0.000280	2.89	859.53	131.22	0.14
Reach - 1	22524.2	100-Year	1321.00	419.97	434.21		434.33	0.000322	3.16	913.90	138.57	0.15
Reach - 1	22396.4	2-Year	335.00	420.03	431.32	421.57	431.32	0.000000	0.06	5409.63	747.78	0.00
Reach - 1	22396.4	10-Year	734.00	420.03	432.68	422.03	432.68	0.000001	0.12	6429.89	768.39	0.01
Reach - 1	22396.4	25-Year	979.00	420.03	433.39	422.22	433.39	0.000001	0.14	6967.91	779.13	0.01
Reach - 1	22396.4	50-Year	1158.00	420.03	433.88	422.33	433.88	0.000001	0.16	7334.86	786.41	0.01
Reach - 1	22396.4	100-Year	1321.00	420.03	434.29	422.41	434.29	0.000001	0.18	7652.15	792.67	0.01
Reach - 1	22383.4		Inl Struct									
Reach - 1	22370.4	2-Year	335.00	425.91	428.09	428.09	428.79	0.027750	6.70	49.97	36.65	1.01
Reach - 1	22370.4	10-Year	734.00	425.91	429.57		430.26	0.012730	6.66	110.27	45.20	0.75
Reach - 1	22370.4	25-Year	979.00	425.91	430.72		431.26	0.006956	5.88	166.36	51.90	0.58
Reach - 1	22370.4	50-Year	1158.00	425.91	431.62		432.07	0.004718	5.39	214.98	57.07	0.49
Reach - 1	22370.4	100-Year	1321.00	425.91	432.32		432.73	0.003751	5.15	256.35	61.13	0.44

HEC-RAS Plan: Existing (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	22255.4	2-Year	335.00	422.25	426.88	425.49	427.23	0.004275	4.73	75.34	25.36	0.45
Reach - 1	22255.4	10-Year	734.00	422.25	428.74	426.89	429.41	0.004711	6.63	126.42	29.66	0.51
Reach - 1	22255.4	25-Year	979.00	422.25	429.67	427.61	430.51	0.004810	7.47	155.16	32.18	0.53
Reach - 1	22255.4	50-Year	1158.00	422.25	430.53	428.09	431.42	0.004311	7.70	183.74	34.51	0.51
Reach - 1	22255.4	100-Year	1321.00	422.25	431.13	428.51	432.10	0.004228	8.06	205.77	38.38	0.51
Reach - 1	22230.4		Bridge									
Reach - 1	22205.4	2-Year	335.00	421.56	424.80	424.80	425.80	0.024676	8.03	42.30	22.14	0.99
Reach - 1	22205.4	10-Year	734.00	421.56	426.19	426.19	427.85	0.020547	10.37	75.31	25.36	0.99
Reach - 1	22205.4	25-Year	979.00	421.56	426.91	426.91	428.90	0.019160	11.37	94.15	27.03	0.99
Reach - 1	22205.4	50-Year	1158.00	421.56	427.40	427.40	429.60	0.018384	12.00	107.56	28.15	0.98
Reach - 1	22205.4	100-Year	1321.00	421.56	427.82	427.82	430.20	0.017807	12.51	119.56	29.13	0.98
Reach - 1	22061.4	2-Year	335.00	400.80	403.48	403.48	404.47	0.038849	7.97	42.01	21.54	1.01
Reach - 1	22061.4	10-Year	734.00	400.80	404.82	404.82	406.41	0.034076	10.10	72.79	23.67	1.01
Reach - 1	22061.4	25-Year	979.00	400.80	405.49	405.49	407.40	0.031711	11.09	88.80	24.24	1.00
Reach - 1	22061.4	50-Year	1158.00	400.80	405.95	405.95	408.07	0.030197	11.68	100.10	24.64	1.00
Reach - 1	22061.4	100-Year	1321.00	400.80	406.35	406.35	408.65	0.029142	12.18	109.96	24.98	1.00
Reach - 1	21877	2-Year	335.00	390.67	392.59	392.59	393.27	0.037863	6.77	50.48	39.23	1.04
Reach - 1	21877	10-Year	734.00	390.67	393.48	393.48	394.34	0.031487	8.32	103.91	67.05	1.02
Reach - 1	21877	25-Year	979.00	390.67	394.05	394.05	394.82	0.023743	8.27	158.73	143.93	0.91
Reach - 1	21877	50-Year	1158.00	390.67	394.36	394.22	395.10	0.021164	8.37	204.42	147.31	0.88
Reach - 1	21877	100-Year	1321.00	390.67	394.70	394.38	395.38	0.017359	8.18	256.10	152.14	0.81
Reach - 1	21577.4	2-Year	505.00	383.59	388.70		389.06	0.005421	4.92	134.56	97.13	0.42
Reach - 1	21577.4	10-Year	1018.00	383.59	390.07		390.59	0.006296	6.40	290.64	125.31	0.48
Reach - 1	21577.4	25-Year	1318.00	383.59	390.59		391.21	0.006952	7.13	357.09	130.82	0.51
Reach - 1	21577.4	50-Year	1600.00	383.59	390.94		391.68	0.008035	7.95	403.47	140.66	0.55
Reach - 1	21577.4	100-Year	1837.00	383.59	391.26		392.06	0.008401	8.40	449.64	144.66	0.57
Reach - 1	21329	2-Year	505.00	380.12	384.85	384.85	386.24	0.032187	9.46	53.36	19.50	1.01
Reach - 1	21329	10-Year	1018.00	380.12	387.16	387.16	388.24	0.014903	8.77	205.13	173.78	0.74
Reach - 1	21329	25-Year	1318.00	380.12	387.71	387.71	388.79	0.013865	9.16	315.26	221.71	0.73
Reach - 1	21329	50-Year	1600.00	380.12	388.18	388.18	389.19	0.012531	9.25	428.29	252.63	0.70
Reach - 1	21329	100-Year	1837.00	380.12	388.41	388.41	389.47	0.013058	9.71	486.12	257.96	0.72

HEC-RAS Plan: Existing (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	21024.2	2-Year	505.00	375.87	381.38		381.72	0.003570	4.67	113.78	29.56	0.38
Reach - 1	21024.2	10-Year	1018.00	375.87	384.84		385.07	0.001445	4.31	618.84	320.72	0.27
Reach - 1	21024.2	25-Year	1318.00	375.87	387.01		387.09	0.000532	3.06	1423.46	392.17	0.17
Reach - 1	21024.2	50-Year	1600.00	375.87	387.66		387.74	0.000529	3.18	1681.51	397.20	0.17
Reach - 1	21024.2	100-Year	1837.00	375.87	388.10		388.19	0.000546	3.32	1857.15	401.43	0.17
Reach - 1	20803	2-Year	505.00	373.95	379.83		380.47	0.009640	6.41	78.79	19.94	0.57
Reach - 1	20803	10-Year	1018.00	373.95	384.38		384.68	0.002085	4.86	416.91	136.96	0.30
Reach - 1	20803	25-Year	1318.00	373.95	386.74		386.92	0.001045	4.06	842.82	241.47	0.22
Reach - 1	20803	50-Year	1600.00	373.95	387.37		387.56	0.001141	4.40	1002.40	269.10	0.23
Reach - 1	20803	100-Year	1837.00	373.95	387.78		388.00	0.001239	4.70	1117.23	287.34	0.24
Reach - 1	20582.7	2-Year	505.00	372.04	379.71		379.85	0.000921	3.06	221.12	70.88	0.21
Reach - 1	20582.7	10-Year	1018.00	372.04	384.39		384.46	0.000342	2.65	1042.40	258.89	0.14
Reach - 1	20582.7	25-Year	1318.00	372.04	386.74		386.79	0.000207	2.33	1701.03	302.02	0.11
Reach - 1	20582.7	50-Year	1600.00	372.04	387.37		387.42	0.000239	2.58	1891.36	309.48	0.12
Reach - 1	20582.7	100-Year	1837.00	372.04	387.78		387.84	0.000269	2.79	2019.01	313.43	0.13
Reach - 1	20391.6	2-Year	505.00	371.31	378.56	376.41	379.30	0.005977	7.48	112.71	58.68	0.52
Reach - 1	20391.6	10-Year	1018.00	371.31	383.68	378.91	384.20	0.002325	6.88	324.62	296.64	0.36
Reach - 1	20391.6	25-Year	1318.00	371.31	386.70	380.05	386.74	0.000305	2.91	1927.37	361.20	0.13
Reach - 1	20391.6	50-Year	1600.00	371.31	387.32	381.21	387.36	0.000334	3.13	2152.17	365.87	0.14
Reach - 1	20391.6	100-Year	1837.00	371.31	387.72	382.17	387.77	0.000366	3.33	2301.23	368.94	0.15
Reach - 1	20349.6		Bridge									
Reach - 1	20307.6	2-Year	505.00	371.56	376.65	376.65	378.60	0.025599	11.82	61.41	19.59	1.00
Reach - 1	20307.6	10-Year	1018.00	371.56	379.40	379.40	381.79	0.017466	13.56	129.84	66.42	0.90
Reach - 1	20307.6	25-Year	1318.00	371.56	380.63	380.63	382.58	0.013156	13.09	247.81	85.27	0.80
Reach - 1	20307.6	50-Year	1600.00	371.56	381.46	381.46	383.35	0.012090	13.37	330.65	132.02	0.78
Reach - 1	20307.6	100-Year	1837.00	371.56	382.44	382.44	383.83	0.008780	12.20	513.71	223.74	0.68
Reach - 1	20223	2-Year	505.00	370.12	374.56	374.56	375.74	0.030695	8.74	57.80	24.77	1.01
Reach - 1	20223	10-Year	1018.00	370.12	376.23	376.23	377.59	0.019161	9.55	141.81	90.50	0.86
Reach - 1	20223	25-Year	1318.00	370.12	376.89	376.89	378.29	0.016771	9.95	208.36	107.42	0.83
Reach - 1	20223	50-Year	1600.00	370.12	377.34	377.34	378.85	0.016606	10.55	258.02	115.33	0.84
Reach - 1	20223	100-Year	1837.00	370.12	377.69	377.69	379.28	0.016310	10.95	300.06	121.62	0.84

HEC-RAS Plan: Existing (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	20024.2	2-Year	505.00	366.75	370.90	370.12	371.55	0.011122	6.53	86.69	36.11	0.64
Reach - 1	20024.2	10-Year	1018.00	366.75	372.60		373.61	0.010273	8.30	154.88	48.37	0.66
Reach - 1	20024.2	25-Year	1318.00	366.75	373.16	372.27	374.47	0.011687	9.51	184.67	58.16	0.71
Reach - 1	20024.2	50-Year	1600.00	366.75	373.55	372.93	375.20	0.013558	10.72	208.70	66.20	0.78
Reach - 1	20024.2	100-Year	1837.00	366.75	373.88	373.21	375.79	0.014703	11.57	232.56	78.95	0.82
Reach - 1	19751	2-Year	505.00	361.35	366.22	365.93	367.28	0.023041	8.23	61.32	22.56	0.88
Reach - 1	19751	10-Year	1018.00	361.35	367.64	367.64	369.31	0.025990	10.39	101.10	42.69	0.98
Reach - 1	19751	25-Year	1318.00	361.35	368.42	368.42	370.19	0.021513	10.80	144.27	65.67	0.92
Reach - 1	19751	50-Year	1600.00	361.35	369.08	369.08	370.89	0.018530	11.03	194.20	83.19	0.87
Reach - 1	19751	100-Year	1837.00	361.35	369.52	369.52	371.39	0.017589	11.37	231.80	89.30	0.86
Reach - 1	19524.2	2-Year	505.00	356.87	360.22	360.20	361.43	0.028840	8.83	57.45	24.56	0.99
Reach - 1	19524.2	10-Year	1018.00	356.87	361.82	361.82	363.45	0.021185	10.42	120.33	51.89	0.91
Reach - 1	19524.2	25-Year	1318.00	356.87	362.51	362.51	364.34	0.019794	11.19	157.69	56.43	0.91
Reach - 1	19524.2	50-Year	1600.00	356.87	363.05	363.05	365.08	0.019424	11.91	189.35	60.26	0.91
Reach - 1	19524.2	100-Year	1837.00	356.87	363.47	363.47	365.65	0.019145	12.45	215.37	63.01	0.92
Reach - 1	19222	2-Year	505.00	348.54	351.56	351.56	352.57	0.029391	8.10	63.72	34.74	1.00
Reach - 1	19222	10-Year	1018.00	348.54	352.80	352.80	354.30	0.023793	9.93	114.58	45.61	0.97
Reach - 1	19222	25-Year	1318.00	348.54	353.37	353.37	355.14	0.022788	10.82	141.56	48.59	0.97
Reach - 1	19222	50-Year	1600.00	348.54	353.89	353.89	355.85	0.021666	11.48	167.28	51.27	0.97
Reach - 1	19222	100-Year	1837.00	348.54	354.31	354.31	356.41	0.020718	11.93	189.04	52.79	0.96
Reach - 1	19024.2	2-Year	505.00	343.08	347.77		348.28	0.006944	5.71	88.57	23.64	0.52
Reach - 1	19024.2	10-Year	1018.00	343.08	349.57		350.51	0.007666	7.77	139.74	36.23	0.58
Reach - 1	19024.2	25-Year	1318.00	343.08	350.41	348.61	351.53	0.007792	8.60	193.12	96.09	0.60
Reach - 1	19024.2	50-Year	1600.00	343.08	351.03	349.33	352.29	0.007978	9.25	263.35	141.22	0.61
Reach - 1	19024.2	100-Year	1837.00	343.08	350.94	350.02	352.67	0.011046	10.80	251.97	131.96	0.72
Reach - 1	18833	2-Year	505.00	339.27	344.27	344.27	345.73	0.031481	9.69	52.11	17.85	1.00
Reach - 1	18833	10-Year	1018.00	339.27	346.21	346.21	348.08	0.022412	11.11	109.19	41.77	0.91
Reach - 1	18833	25-Year	1318.00	339.27	347.00	347.00	349.12	0.021247	12.00	145.93	54.60	0.91
Reach - 1	18833	50-Year	1600.00	339.27	347.75	347.75	349.95	0.019043	12.39	193.38	71.42	0.88
Reach - 1	18833	100-Year	1837.00	339.27	348.93	348.93	350.45	0.011531	10.83	356.00	158.78	0.70
Reach - 1	18524.2	2-Year	505.00	333.12	339.74		339.95	0.001737	3.76	143.76	30.93	0.28
Reach - 1	18524.2	10-Year	1018.00	333.12	341.67		342.14	0.002564	5.54	221.17	48.90	0.35

HEC-RAS Plan: Existing (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	18524.2	25-Year	1318.00	333.12	342.39		343.03	0.003126	6.50	264.47	84.66	0.40
Reach - 1	18524.2	50-Year	1600.00	333.12	342.94		343.73	0.003608	7.28	318.93	104.32	0.43
Reach - 1	18524.2	100-Year	1837.00	333.12	343.39		344.27	0.003891	7.81	365.95	108.55	0.45
Reach - 1	18317	2-Year	505.00	331.33	337.67	337.67	338.90	0.033045	8.96	61.82	34.74	0.95
Reach - 1	18317	10-Year	1018.00	331.33	339.23	339.23	340.81	0.025065	10.55	139.70	66.73	0.90
Reach - 1	18317	25-Year	1318.00	331.33	340.09	340.09	341.60	0.020128	10.67	210.92	97.60	0.83
Reach - 1	18317	50-Year	1600.00	331.33	340.62	340.62	342.19	0.019234	11.13	264.84	105.09	0.82
Reach - 1	18317	100-Year	1837.00	331.33	340.94	340.94	342.64	0.019874	11.74	299.21	109.60	0.84
Reach - 1	18024.2	2-Year	505.00	328.79	333.70		334.15	0.005667	5.36	100.15	32.35	0.47
Reach - 1	18024.2	10-Year	1018.00	328.79	335.23		336.11	0.007528	7.65	158.67	45.70	0.57
Reach - 1	18024.2	25-Year	1318.00	328.79	335.75		336.95	0.009122	8.95	184.43	52.09	0.64
Reach - 1	18024.2	50-Year	1600.00	328.79	336.20	335.04	337.70	0.010460	10.05	208.85	63.49	0.69
Reach - 1	18024.2	100-Year	1837.00	328.79	336.56	335.62	338.28	0.011320	10.84	233.01	71.83	0.73
Reach - 1	17810	2-Year	505.00	326.23	330.53	330.53	331.69	0.030984	8.61	58.64	25.45	1.00
Reach - 1	17810	10-Year	1018.00	326.23	332.20	332.00	333.51	0.021939	9.18	114.47	45.16	0.90
Reach - 1	17810	25-Year	1318.00	326.23	333.06	332.62	334.37	0.016362	9.27	160.20	61.56	0.81
Reach - 1	17810	50-Year	1600.00	326.23	333.75	333.13	335.09	0.013799	9.45	208.34	76.39	0.76
Reach - 1	17810	100-Year	1837.00	326.23	334.29	333.56	335.64	0.012328	9.58	251.90	86.77	0.73
Reach - 1	17524.2	2-Year	505.00	322.82	329.03		329.28	0.002203	4.03	137.77	35.98	0.31
Reach - 1	17524.2	10-Year	1018.00	322.82	330.92		331.42	0.003043	5.80	234.09	71.81	0.38
Reach - 1	17524.2	25-Year	1318.00	322.82	331.68		332.31	0.003453	6.60	292.95	82.05	0.41
Reach - 1	17524.2	50-Year	1600.00	322.82	332.29		333.04	0.003814	7.29	345.87	93.97	0.44
Reach - 1	17524.2	100-Year	1837.00	322.82	332.74		333.60	0.004126	7.85	393.43	114.58	0.46
Reach - 1	17294	2-Year	505.00	322.18	328.00		328.48	0.005860	5.75	121.91	56.72	0.48
Reach - 1	17294	10-Year	1018.00	322.18	329.61		330.38	0.006823	7.65	244.34	92.10	0.55
Reach - 1	17294	25-Year	1318.00	322.18	330.25		331.16	0.007378	8.51	307.23	102.82	0.58
Reach - 1	17294	50-Year	1600.00	322.18	330.79		331.80	0.007751	9.18	363.89	110.47	0.60
Reach - 1	17294	100-Year	1837.00	322.18	331.20	330.13	332.29	0.007956	9.66	410.67	115.65	0.62
Reach - 1	17020.0	2-Year	505.00	321.41	325.08	324.93	325.87	0.017531	7.37	94.86	70.10	0.78
Reach - 1	17020.0	10-Year	1018.00	321.41	326.10	326.10	327.35	0.020082	9.72	176.97	90.64	0.88
Reach - 1	17020.0	25-Year	1318.00	321.41	326.65	326.65	328.02	0.019464	10.45	229.07	101.89	0.89
Reach - 1	17020.0	50-Year	1600.00	321.41	327.08	327.08	328.57	0.019296	11.10	275.38	110.93	0.90

HEC-RAS Plan: Existing (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	17020.0	100-Year	1837.00	321.41	327.40	327.40	329.00	0.019458	11.63	311.56	117.51	0.91
Reach - 1	16807	2-Year	505.00	318.05	321.44		322.12	0.017355	6.65	75.92	33.00	0.77
Reach - 1	16807	10-Year	1018.00	318.05	323.00	322.46	323.81	0.012394	7.39	183.95	108.34	0.69
Reach - 1	16807	25-Year	1318.00	318.05	323.78		324.54	0.009670	7.38	280.07	142.25	0.63
Reach - 1	16807	50-Year	1600.00	318.05	324.33		325.10	0.008630	7.56	365.86	162.98	0.61
Reach - 1	16807	100-Year	1837.00	318.05	324.74		325.51	0.008087	7.72	433.45	171.07	0.60
Reach - 1	16524.2	2-Year	603.00	313.59	318.76		319.33	0.006696	6.07	99.86	23.89	0.52
Reach - 1	16524.2	10-Year	1059.00	313.59	320.29	318.48	321.20	0.007157	7.70	173.71	107.53	0.56
Reach - 1	16524.2	25-Year	1419.00	313.59	321.12	319.38	322.16	0.007307	8.50	264.39	111.29	0.58
Reach - 1	16524.2	50-Year	1714.00	313.59	321.71	320.74	322.83	0.007306	9.00	330.99	113.88	0.59
Reach - 1	16524.2	100-Year	1950.00	313.59	322.17		323.32	0.007180	9.30	383.72	115.89	0.59
Reach - 1	16219	2-Year	603.00	307.88	313.82	313.82	315.35	0.032946	9.92	60.82	20.18	1.01
Reach - 1	16219	10-Year	1059.00	307.88	315.31	315.31	317.20	0.028870	11.05	97.68	32.17	0.99
Reach - 1	16219	25-Year	1419.00	307.88	316.28	316.28	318.36	0.023896	11.66	137.88	48.84	0.93
Reach - 1	16219	50-Year	1714.00	307.88	316.97	316.97	319.16	0.021435	12.08	174.96	57.87	0.91
Reach - 1	16219	100-Year	1950.00	307.88	317.43	317.43	319.74	0.020635	12.50	202.88	63.83	0.90
Reach - 1	16024.2	2-Year	603.00	304.23	309.68		310.18	0.005328	5.65	112.24	29.96	0.47
Reach - 1	16024.2	10-Year	1059.00	304.23	311.33		312.12	0.005696	7.18	166.62	35.97	0.51
Reach - 1	16024.2	25-Year	1419.00	304.23	312.30		313.32	0.006162	8.23	208.52	50.46	0.54
Reach - 1	16024.2	50-Year	1714.00	304.23	312.95		314.16	0.006565	9.00	244.19	58.93	0.57
Reach - 1	16024.2	100-Year	1950.00	304.23	313.43		314.78	0.006837	9.56	273.67	64.05	0.58
Reach - 1	15740	2-Year	603.00	297.95	303.10	303.10	304.55	2.487171	9.65	62.49	22.00	1.01
Reach - 1	15740	10-Year	1059.00	297.95	304.79	304.79	306.27	1.689121	9.79	109.17	36.61	0.88
Reach - 1	15740	25-Year	1419.00	297.95	305.63	305.63	307.13	1.315985	9.76	144.92	50.61	0.80
Reach - 1	15740	50-Year	1714.00	297.95	306.17	306.17	307.70	1.092860	9.57	175.24	60.99	0.74
Reach - 1	15740	100-Year	1950.00	297.95	306.47	306.47	308.11	1.023933	9.62	194.39	65.25	0.72
Reach - 1	15524.2	2-Year	603.00	293.18	300.10		300.37	0.001682	4.25	170.97	88.14	0.31
Reach - 1	15524.2	10-Year	1059.00	293.18	302.06		302.41	0.001620	5.03	407.58	166.41	0.31
Reach - 1	15524.2	25-Year	1419.00	293.18	303.01		303.41	0.001738	5.62	585.41	208.57	0.33
Reach - 1	15524.2	50-Year	1714.00	293.18	303.40		303.89	0.002069	6.31	670.71	229.57	0.36
Reach - 1	15524.2	100-Year	1950.00	293.18	303.65		304.23	0.002352	6.85	733.11	255.72	0.39

HEC-RAS Plan: Existing (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	15291	2-Year	603.00	292.67	298.98		299.61	0.007631	6.35	94.91	22.91	0.55
Reach - 1	15291	10-Year	1059.00	292.67	301.31	298.84	301.80	0.004576	5.96	388.55	348.34	0.44
Reach - 1	15291	25-Year	1419.00	292.67	302.71		302.92	0.001987	4.56	1013.22	491.78	0.30
Reach - 1	15291	50-Year	1714.00	292.67	303.14		303.33	0.001955	4.70	1224.08	504.10	0.30
Reach - 1	15291	100-Year	1950.00	292.67	303.41		303.61	0.001994	4.87	1363.27	512.06	0.31
Reach - 1	15183.4	2-Year	603.00	292.43	298.73	296.30	299.02	0.002389	4.42	153.90	41.45	0.35
Reach - 1	15183.4	10-Year	1059.00	292.43	301.06	297.42	301.45	0.001903	5.12	249.37	119.77	0.34
Reach - 1	15183.4	25-Year	1419.00	292.43	302.31	298.21	302.68	0.001615	5.25	601.44	323.80	0.32
Reach - 1	15183.4	50-Year	1714.00	292.43	302.52	298.80	303.02	0.002163	6.17	674.49	403.31	0.37
Reach - 1	15183.4	100-Year	1950.00	292.43	302.61	299.27	303.23	0.002652	6.89	717.04	447.30	0.41
Reach - 1	15150.4		Bridge									
Reach - 1	15117.4	2-Year	603.00	292.69	297.82	296.55	298.35	0.005901	5.86	111.11	34.04	0.53
Reach - 1	15117.4	10-Year	1059.00	292.69	298.62	297.68	299.70	0.009600	8.42	139.92	37.55	0.70
Reach - 1	15117.4	25-Year	1419.00	292.69	299.01	298.50	300.64	0.013049	10.36	154.90	41.75	0.83
Reach - 1	15117.4	50-Year	1714.00	292.69	299.21	299.06	301.39	0.016595	12.00	163.57	44.86	0.94
Reach - 1	15117.4	100-Year	1950.00	292.69	299.54	299.54	302.00	0.017238	12.76	179.48	50.06	0.97
Reach - 1	15024.2	2-Year	603.00	291.44	297.73		297.96	0.001462	4.14	286.46	135.44	0.31
Reach - 1	15024.2	10-Year	1059.00	291.44	298.55		298.97	0.002416	5.85	420.04	175.78	0.41
Reach - 1	15024.2	25-Year	1419.00	291.44	299.02		299.59	0.003042	6.89	505.30	182.33	0.47
Reach - 1	15024.2	50-Year	1714.00	291.44	299.34		300.02	0.003546	7.68	563.57	185.41	0.51
Reach - 1	15024.2	100-Year	1950.00	291.44	299.54	298.47	300.46	0.004511	8.82	604.06	271.98	0.58
Reach - 1	14764	2-Year	603.00	290.94	296.60	295.55	297.21	0.006626	6.63	200.76	263.37	0.59
Reach - 1	14764	10-Year	1059.00	290.94	297.60		298.06	0.005516	6.71	528.01	397.76	0.54
Reach - 1	14764	25-Year	1419.00	290.94	298.10		298.53	0.005229	6.99	738.80	439.96	0.54
Reach - 1	14764	50-Year	1714.00	290.94	298.47		298.86	0.004842	7.04	903.19	450.86	0.52
Reach - 1	14764	100-Year	1950.00	290.94	298.71		299.09	0.004757	7.17	1014.05	458.07	0.52
Reach - 1	14524.2	2-Year	603.00	290.48	296.34		296.49	0.001256	3.63	547.73	415.59	0.29
Reach - 1	14524.2	10-Year	1059.00	290.48	297.22		297.38	0.001390	4.26	931.24	447.00	0.31
Reach - 1	14524.2	25-Year	1419.00	290.48	297.62		297.81	0.001645	4.84	1112.95	467.59	0.34
Reach - 1	14524.2	50-Year	1714.00	290.48	297.90		298.12	0.001895	5.35	1246.59	481.39	0.37
Reach - 1	14524.2	100-Year	1950.00	290.48	298.10		298.34	0.002036	5.66	1343.54	484.56	0.39

HEC-RAS Plan: Existing (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	14034.8	2-Year	603.00	287.46	296.37		296.38	0.000048	0.97	2186.00	434.52	0.06
Reach - 1	14034.8	10-Year	1059.00	287.46	297.21		297.22	0.000096	1.48	2559.53	459.89	0.09
Reach - 1	14034.8	25-Year	1419.00	287.46	297.57		297.59	0.000147	1.87	2729.11	475.50	0.11
Reach - 1	14034.8	50-Year	1714.00	287.46	297.82		297.84	0.000191	2.18	2850.49	485.96	0.13
Reach - 1	14034.8	100-Year	1950.00	287.46	297.99		298.02	0.000229	2.42	2934.96	490.96	0.14
Reach - 1	13555.6	2-Year	603.00	287.38	296.35		296.36	0.000045	0.95	2197.37	415.61	0.06
Reach - 1	13555.6	10-Year	1059.00	287.38	297.16		297.17	0.000093	1.46	2539.79	432.39	0.09
Reach - 1	13555.6	25-Year	1419.00	287.38	297.50		297.52	0.000143	1.85	2687.76	441.84	0.11
Reach - 1	13555.6	50-Year	1714.00	287.38	297.73		297.75	0.000189	2.17	2790.39	449.33	0.12
Reach - 1	13555.6	100-Year	1950.00	287.38	297.88		297.91	0.000230	2.41	2859.97	454.34	0.14
Reach - 1	13024.2	2-Year	603.00	287.30	296.33		296.33	0.000047	0.98	2138.87	412.76	0.06
Reach - 1	13024.2	10-Year	1059.00	287.30	297.11		297.12	0.000097	1.49	2462.93	417.93	0.09
Reach - 1	13024.2	25-Year	1419.00	287.30	297.42		297.44	0.000150	1.90	2593.53	422.62	0.11
Reach - 1	13024.2	50-Year	1714.00	287.30	297.62		297.65	0.000200	2.22	2680.21	425.71	0.13
Reach - 1	13024.2	100-Year	1950.00	287.30	297.76		297.79	0.000244	2.48	2736.09	427.75	0.14
Reach - 1	12524.2	2-Year	603.00	287.22	296.31		296.31	0.000036	0.86	2546.92	491.22	0.05
Reach - 1	12524.2	10-Year	1059.00	287.22	297.07		297.08	0.000074	1.31	2928.05	508.26	0.08
Reach - 1	12524.2	25-Year	1419.00	287.22	297.36		297.37	0.000116	1.67	3075.47	511.48	0.10
Reach - 1	12524.2	50-Year	1714.00	287.22	297.54		297.56	0.000154	1.95	3169.70	512.76	0.11
Reach - 1	12524.2	100-Year	1950.00	287.22	297.66		297.68	0.000189	2.18	3227.47	513.54	0.12
Reach - 1	12024.2	2-Year	603.00	287.14	296.30		296.30	0.000012	0.51	4374.06	738.22	0.03
Reach - 1	12024.2	10-Year	1059.00	287.14	297.05		297.06	0.000026	0.78	4930.59	739.96	0.05
Reach - 1	12024.2	25-Year	1419.00	287.14	297.33		297.34	0.000041	1.00	5137.67	740.61	0.06
Reach - 1	12024.2	50-Year	1714.00	287.14	297.51		297.51	0.000056	1.18	5267.48	741.02	0.07
Reach - 1	12024.2	100-Year	1950.00	287.14	297.61		297.62	0.000069	1.32	5345.01	741.26	0.07
Reach - 1	11747.1	2-Year	603.00	284.16	296.30		296.30	0.000004	0.35	7159.03	1112.58	0.02
Reach - 1	11747.1	10-Year	1059.00	284.16	297.05		297.05	0.000008	0.55	8000.42	1129.53	0.03
Reach - 1	11747.1	25-Year	1419.00	284.16	297.33		297.33	0.000013	0.70	8315.42	1137.68	0.04
Reach - 1	11747.1	50-Year	1714.00	284.16	297.50		297.50	0.000018	0.83	8513.19	1150.20	0.04
Reach - 1	11747.1	100-Year	1950.00	284.16	297.60		297.61	0.000023	0.93	8631.85	1153.34	0.05
Reach - 1	11352.3	2-Year	668.00	273.46	296.30	277.46	296.30	0.000001	0.17	3905.86	560.43	0.01
Reach - 1	11352.3	10-Year	1641.00	273.46	297.05	279.20	297.05	0.000006	0.39	4399.74	593.49	0.02

HEC-RAS Plan: Existing (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	11352.3	25-Year	2217.00	273.46	297.32	279.93	297.33	0.000009	0.51	4564.02	600.79	0.03
Reach - 1	11352.3	50-Year	2614.00	273.46	297.49	280.37	297.50	0.000012	0.59	4667.30	605.23	0.03
Reach - 1	11352.3	100-Year	2850.00	273.46	297.59	280.61	297.60	0.000014	0.63	4728.99	607.61	0.04
Reach - 1	11341.3		Inl Struct									
Reach - 1	11330.3	2-Year	668.00	277.80	281.74	281.74	283.12	0.013840	9.76	99.28	52.52	0.92
Reach - 1	11330.3	10-Year	1641.00	277.80	284.08	284.08	286.07	0.011384	12.50	260.43	83.14	0.91
Reach - 1	11330.3	25-Year	2217.00	277.80	285.06	285.06	287.35	0.011186	13.74	347.51	95.20	0.93
Reach - 1	11330.3	50-Year	2614.00	277.80	285.70	285.70	288.12	0.010815	14.35	410.91	103.09	0.93
Reach - 1	11330.3	100-Year	2850.00	277.80	286.05	286.05	288.55	0.010684	14.70	447.34	107.36	0.93
Reach - 1	11228.2	2-Year	668.00	274.45	278.67	278.47	280.21	0.018174	9.98	68.41	35.01	0.93
Reach - 1	11228.2	10-Year	1641.00	274.45	281.61	281.61	283.31	0.010590	11.35	282.67	117.67	0.78
Reach - 1	11228.2	25-Year	2217.00	274.45	282.48	282.48	284.36	0.010781	12.45	388.06	124.58	0.81
Reach - 1	11228.2	50-Year	2614.00	274.45	282.96	282.96	285.00	0.011206	13.23	448.57	129.19	0.83
Reach - 1	11228.2	100-Year	2850.00	274.45	283.24	283.24	285.36	0.011345	13.62	485.01	132.28	0.84
Reach - 1	10952.4	2-Year	668.00	270.52	274.14	274.14	275.29	0.016677	8.74	89.43	47.13	0.97
Reach - 1	10952.4	10-Year	1641.00	270.52	276.05	276.05	277.89	0.013420	11.40	211.31	73.31	0.95
Reach - 1	10952.4	25-Year	2217.00	270.52	276.72	276.72	279.10	0.014713	13.10	262.88	81.85	1.02
Reach - 1	10952.4	50-Year	2614.00	270.52	277.60	277.60	279.83	0.011460	12.85	351.61	120.56	0.92
Reach - 1	10952.4	100-Year	2850.00	270.52	278.01	278.01	280.21	0.010531	12.88	402.78	126.24	0.90
Reach - 1	10524.2	2-Year	668.00	263.63	268.71	267.47	269.34	0.006101	6.45	136.53	119.53	0.59
Reach - 1	10524.2	10-Year	1641.00	263.63	270.00	270.00	271.35	0.011039	10.12	312.79	162.95	0.82
Reach - 1	10524.2	25-Year	2217.00	263.63	270.58	270.58	272.23	0.012095	11.46	415.17	194.58	0.88
Reach - 1	10524.2	50-Year	2614.00	263.63	271.26	271.26	272.74	0.009868	11.21	560.40	231.45	0.81
Reach - 1	10524.2	100-Year	2850.00	263.63	271.49	271.49	272.99	0.009775	11.44	614.74	237.99	0.81
Reach - 1	10136.9	2-Year	668.00	261.02	268.74		268.79	0.000384	2.27	1044.57	590.43	0.16
Reach - 1	10136.9	10-Year	1641.00	261.02	269.99		270.09	0.000709	3.50	1847.68	686.27	0.23
Reach - 1	10136.9	25-Year	2217.00	261.02	270.67		270.78	0.000752	3.83	2327.17	725.62	0.24
Reach - 1	10136.9	50-Year	2614.00	261.02	271.22		271.31	0.000709	3.88	2730.05	757.03	0.23
Reach - 1	10136.9	100-Year	2850.00	261.02	271.79		271.87	0.000577	3.66	3176.72	787.94	0.21
Reach - 2	10024.2	2-Year	780.00	262.00	268.68		268.73	0.000787	2.48	1109.55	602.09	0.19
Reach - 2	10024.2	10-Year	1902.00	262.00	269.90		269.98	0.001316	3.66	1906.20	702.31	0.26

HEC-RAS Plan: Existing (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 2	10024.2	25-Year	2578.00	262.00	270.58		270.66	0.001321	3.93	2392.69	738.78	0.27
Reach - 2	10024.2	50-Year	3067.00	262.00	271.13		271.20	0.001221	3.98	2808.08	773.18	0.26
Reach - 2	10024.2	100-Year	3326.00	262.00	271.72		271.79	0.000988	3.77	3293.37	876.61	0.24
Reach - 2	9691.7	2-Year	780.00	260.63	267.84	265.62	268.23	0.002982	5.42	296.79	430.33	0.40
Reach - 2	9691.7	10-Year	1902.00	260.63	269.38	268.50	269.50	0.001501	4.52	1589.65	522.25	0.30
Reach - 2	9691.7	25-Year	2578.00	260.63	269.99	268.50	270.15	0.001749	5.16	1920.91	553.82	0.33
Reach - 2	9691.7	50-Year	3067.00	260.63	270.55	268.51	270.71	0.001773	5.44	2235.98	577.25	0.33
Reach - 2	9691.7	100-Year	3326.00	260.63	271.29	268.51	271.41	0.001278	4.89	2672.31	609.66	0.29
Reach - 2	9676.2		Bridge									
Reach - 2	9660.7	2-Year	780.00	260.97	266.18	265.96	267.61	0.016944	9.64	85.48	240.28	0.89
Reach - 2	9660.7	10-Year	1902.00	260.97	268.90	268.00	269.15	0.003019	5.92	1185.01	473.48	0.41
Reach - 2	9660.7	25-Year	2578.00	260.97	269.88	268.13	270.09	0.002416	5.83	1678.55	529.58	0.38
Reach - 2	9660.7	50-Year	3067.00	260.97	270.47	268.45	270.67	0.002252	5.92	1996.66	561.81	0.37
Reach - 2	9660.7	100-Year	3326.00	260.97	270.75	268.58	270.96	0.002292	6.12	2158.96	574.04	0.38
Reach - 2	9524.2	2-Year	780.00	259.17	265.36		265.87	0.005941	5.79	169.96	92.07	0.48
Reach - 2	9524.2	10-Year	1902.00	259.17	268.29		268.67	0.003413	5.99	892.82	406.65	0.39
Reach - 2	9524.2	25-Year	2578.00	259.17	269.40		269.71	0.002741	5.89	1408.38	487.09	0.36
Reach - 2	9524.2	50-Year	3067.00	259.17	270.06		270.33	0.002395	5.79	1734.74	498.83	0.34
Reach - 2	9524.2	100-Year	3326.00	259.17	270.38		270.64	0.002262	5.75	1896.95	503.14	0.33
Reach - 2	9024.2	2-Year	780.00	256.05	263.59		263.90	0.002648	4.49	207.55	76.17	0.33
Reach - 2	9024.2	10-Year	1902.00	256.05	266.45		267.00	0.003198	6.45	521.67	149.98	0.39
Reach - 2	9024.2	25-Year	2578.00	256.05	267.37		268.08	0.003746	7.46	667.67	164.14	0.43
Reach - 2	9024.2	50-Year	3067.00	256.05	267.93		268.74	0.004092	8.10	761.05	169.34	0.45
Reach - 2	9024.2	100-Year	3326.00	256.05	268.21		269.06	0.004254	8.41	808.46	171.92	0.46
Reach - 2	8588.6	2-Year	780.00	255.57	260.77		261.66	0.012727	7.56	103.11	27.00	0.68
Reach - 2	8588.6	10-Year	1902.00	255.57	264.07	262.90	264.97	0.007178	8.19	471.07	236.57	0.56
Reach - 2	8588.6	25-Year	2578.00	255.57	265.50		266.19	0.005031	7.79	859.26	329.61	0.48
Reach - 2	8588.6	50-Year	3067.00	255.57	266.22		266.83	0.004381	7.69	1103.90	347.53	0.45
Reach - 2	8588.6	100-Year	3326.00	255.57	266.57		267.15	0.004154	7.68	1224.82	356.18	0.45
Reach - 2	8024.2	2-Year	780.00	250.67	259.57		259.77	0.001300	3.62	246.70	50.92	0.24
Reach - 2	8024.2	10-Year	1902.00	250.67	263.12		263.38	0.001243	4.63	983.44	406.44	0.25

HEC-RAS Plan: Existing (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 2	8024.2	25-Year	2578.00	250.67	264.98		265.13	0.000767	4.05	1971.10	584.02	0.20
Reach - 2	8024.2	50-Year	3067.00	250.67	265.75		265.88	0.000702	4.03	2432.05	624.37	0.19
Reach - 2	8024.2	100-Year	3326.00	250.67	266.11		266.24	0.000677	4.03	2660.70	639.94	0.19
Reach - 2	7524.2	2-Year	791.00	249.35	259.09		259.23	0.000841	3.14	352.02	200.15	0.20
Reach - 2	7524.2	10-Year	1926.00	249.35	263.01		263.05	0.000282	2.37	2709.11	701.57	0.12
Reach - 2	7524.2	25-Year	2619.00	249.35	264.90		264.92	0.000185	2.12	4091.19	769.27	0.10
Reach - 2	7524.2	50-Year	3129.00	249.35	265.66		265.69	0.000183	2.18	4690.37	791.26	0.10
Reach - 2	7524.2	100-Year	3400.00	249.35	266.02		266.05	0.000183	2.22	4975.55	796.60	0.10
Reach - 3	7024.2	2-Year	807.00	250.01	258.55		258.71	0.001291	3.49	495.48	393.79	0.24
Reach - 3	7024.2	10-Year	1961.00	250.01	262.89		262.92	0.000255	2.15	2607.46	543.66	0.11
Reach - 3	7024.2	25-Year	2671.00	250.01	264.81		264.83	0.000186	2.04	3707.19	597.97	0.10
Reach - 3	7024.2	50-Year	3205.00	250.01	265.56		265.59	0.000212	2.27	4190.09	733.47	0.11
Reach - 3	7024.2	100-Year	3502.00	250.01	265.92		265.95	0.000214	2.32	4454.98	747.43	0.11
Reach - 3	6790.2	2-Year	807.00	249.25	258.43		258.51	0.000513	2.31	383.02	92.14	0.15
Reach - 3	6790.2	10-Year	1961.00	249.25	262.68		262.82	0.000533	3.20	999.53	216.18	0.17
Reach - 3	6790.2	25-Year	2671.00	249.25	264.60		264.75	0.000494	3.41	1643.03	411.88	0.16
Reach - 3	6790.2	50-Year	3205.00	249.25	265.33		265.50	0.000551	3.73	1952.22	449.42	0.17
Reach - 3	6790.2	100-Year	3502.00	249.25	265.67		265.86	0.000590	3.92	2112.14	491.05	0.18
Reach - 3	6733.5	2-Year	856.00	250.49	258.41	252.96	258.48	0.000310	2.02	427.39	135.97	0.13
Reach - 3	6733.5	10-Year	2155.00	250.49	262.64	254.67	262.79	0.000404	3.17	691.31	316.34	0.17
Reach - 3	6733.5	25-Year	2951.00	250.49	264.61	255.55	264.71	0.000267	2.86	2271.79	441.68	0.14
Reach - 3	6733.5	50-Year	3531.00	250.49	265.34	256.14	265.45	0.000298	3.14	2611.10	505.84	0.15
Reach - 3	6733.5	100-Year	3904.00	250.49	265.67	256.48	265.80	0.000328	3.34	2790.40	542.93	0.16
Reach - 3	6670.0		Culvert									
Reach - 3	6606.5	2-Year	856.00	249.54	258.24	252.00	258.29	0.000218	1.82	475.93	236.95	0.11
Reach - 3	6606.5	10-Year	2155.00	249.54	262.06	253.72	262.21	0.000363	3.06	714.64	329.05	0.16
Reach - 3	6606.5	25-Year	2951.00	249.54	263.83	254.60	263.92	0.000251	2.80	2346.83	451.61	0.13
Reach - 3	6606.5	50-Year	3531.00	249.54	264.88	255.18	264.98	0.000253	2.96	2879.75	571.13	0.14
Reach - 3	6606.5	100-Year	3904.00	249.54	265.40	255.54	265.51	0.000270	3.13	3197.56	657.11	0.14
Reach - 3	6606.4	2-Year	856.00	249.54	258.15	252.17	258.26	0.000526	2.72	340.15	52.35	0.16
Reach - 3	6606.4	10-Year	2155.00	249.54	261.81	254.39	262.13	0.000946	4.62	730.40	400.56	0.23

HEC-RAS Plan: Existing (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 3	6606.4	25-Year	2951.00	249.54	263.58	255.50	263.85	0.000798	4.65	1910.28	740.85	0.22
Reach - 3	6606.4	50-Year	3531.00	249.54	264.72	256.27	264.93	0.000652	4.43	2781.10	782.61	0.20
Reach - 3	6606.4	100-Year	3904.00	249.54	265.26	256.73	265.46	0.000617	4.41	3214.48	810.13	0.20
Reach - 3	6268.9		Culvert									
Reach - 3	5547.5	2-Year	856.00	250.00	257.91	254.66	258.17	0.001740	4.23	261.70	108.56	0.31
Reach - 3	5547.5	10-Year	2155.00	250.00	261.22	257.30	261.74	0.002035	6.17	588.67	489.19	0.36
Reach - 3	5547.5	25-Year	2951.00	250.00	263.29	258.45	263.36	0.000406	3.16	2610.76	892.39	0.17
Reach - 3	5547.5	50-Year	3531.00	250.00	264.55	259.21	264.58	0.000204	2.40	3749.05	937.78	0.12
Reach - 3	5547.5	100-Year	3904.00	250.00	265.10	259.69	265.13	0.000169	2.25	4272.72	960.51	0.11
Reach - 3	5486.5	2-Year	856.00	249.08	257.75	253.41	258.06	0.001669	4.56	252.24	101.17	0.29
Reach - 3	5486.5	10-Year	2155.00	249.08	261.15	256.76	261.57	0.001850	6.11	776.18	458.40	0.32
Reach - 3	5486.5	25-Year	2951.00	249.08	263.21	258.39	263.31	0.000597	3.88	1934.68	783.01	0.19
Reach - 3	5486.5	50-Year	3531.00	249.08	264.52	259.22	264.56	0.000265	2.76	3348.50	936.09	0.13
Reach - 3	5486.5	100-Year	3904.00	249.08	265.08	259.71	265.12	0.000216	2.55	3876.28	952.17	0.12
Reach - 3	5420.5	2-Year	856.00	248.52	257.70	252.47	257.92	0.001158	3.83	279.88	110.00	0.23
Reach - 3	5420.5	10-Year	2155.00	248.52	261.01	255.50	261.45	0.001746	5.87	714.41	398.91	0.30
Reach - 3	5420.5	25-Year	2951.00	248.52	263.16	257.12	263.27	0.000593	3.83	1895.40	784.94	0.18
Reach - 3	5420.5	50-Year	3531.00	248.52	264.50	258.13	264.55	0.000256	2.68	3452.07	916.30	0.12
Reach - 3	5420.5	100-Year	3904.00	248.52	265.07	258.72	265.10	0.000212	2.50	3972.53	942.48	0.11
Reach - 3	5370.5	2-Year	856.00	249.58	257.58	253.31	257.85	0.001480	4.27	261.14	123.58	0.27
Reach - 3	5370.5	10-Year	2155.00	249.58	261.04	256.35	261.33	0.001338	5.23	1246.28	541.48	0.28
Reach - 3	5370.5	25-Year	2951.00	249.58	263.18	257.83	263.23	0.000364	3.07	3280.97	1086.93	0.15
Reach - 3	5370.5	50-Year	3531.00	249.58	264.51	258.76	264.53	0.000177	2.28	4778.06	1137.82	0.11
Reach - 3	5370.5	100-Year	3904.00	249.58	265.07	259.48	265.09	0.000145	2.12	5417.44	1139.37	0.10
Reach - 3	5319.5	2-Year	856.00	249.46	257.64	253.64	257.74	0.000841	3.12	788.76	365.42	0.20
Reach - 3	5319.5	10-Year	2155.00	249.46	261.15	256.83	261.22	0.000535	3.24	2051.45	446.53	0.17
Reach - 3	5319.5	25-Year	2951.00	249.46	263.15	257.54	263.21	0.000414	3.19	2797.88	642.26	0.16
Reach - 3	5319.5	50-Year	3531.00	249.46	264.46	258.02	264.51	0.000367	3.20	3288.80	702.21	0.15
Reach - 3	5319.5	100-Year	3904.00	249.46	265.01	258.22	265.07	0.000373	3.31	3497.30	709.90	0.15
Reach - 3	5270.5	2-Year	856.00	250.41	257.62	253.73	257.70	0.000735	2.80	866.41	413.92	0.19
Reach - 3	5270.5	10-Year	2155.00	250.41	261.14	256.57	261.19	0.000403	2.74	2307.61	480.64	0.15

HEC-RAS Plan: Existing (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 3	5270.5	25-Year	2951.00	250.41	263.14	257.39	263.19	0.000308	2.70	3140.80	662.50	0.14
Reach - 3	5270.5	50-Year	3531.00	250.41	264.45	257.82	264.49	0.000272	2.71	3686.33	724.56	0.13
Reach - 3	5270.5	100-Year	3904.00	250.41	265.01	258.07	265.05	0.000276	2.81	3917.88	735.81	0.13
Reach - 3	5219.5	2-Year	856.00	249.89	257.60	253.41	257.66	0.000602	2.58	922.93	419.17	0.17
Reach - 3	5219.5	10-Year	2155.00	249.89	261.12	256.44	261.17	0.000404	2.77	2191.96	486.66	0.15
Reach - 3	5219.5	25-Year	2951.00	249.89	263.12	257.18	263.17	0.000326	2.80	2914.37	728.78	0.14
Reach - 3	5219.5	50-Year	3531.00	249.89	264.43	257.52	264.48	0.000296	2.85	3385.94	836.61	0.13
Reach - 3	5219.5	100-Year	3904.00	249.89	265.00	257.74	265.04	0.000258	2.73	4068.43	849.07	0.13
Reach - 3	5169.5	2-Year	856.00	249.88	257.57	253.71	257.63	0.000515	2.49	851.85	384.92	0.16
Reach - 3	5169.5	10-Year	2155.00	249.88	261.09	255.79	261.15	0.000438	2.99	1974.65	489.75	0.16
Reach - 3	5169.5	25-Year	2951.00	249.88	263.09	256.40	263.15	0.000383	3.13	2554.40	641.11	0.15
Reach - 3	5169.5	50-Year	3531.00	249.88	264.40	256.79	264.46	0.000361	3.24	2932.83	709.76	0.15
Reach - 3	5169.5	100-Year	3904.00	249.88	264.98	257.03	265.02	0.000266	2.86	3973.01	729.48	0.13
Reach - 3	5118.5	2-Year	856.00	249.56	257.51	253.85	257.60	0.000699	2.86	765.46	331.00	0.19
Reach - 3	5118.5	10-Year	2155.00	249.56	261.03	256.37	261.12	0.000582	3.44	1662.01	442.51	0.19
Reach - 3	5118.5	25-Year	2951.00	249.56	263.04	257.11	263.13	0.000492	3.55	2213.86	700.22	0.18
Reach - 3	5118.5	50-Year	3531.00	249.56	264.40	257.50	264.44	0.000228	2.60	3614.17	792.44	0.12
Reach - 3	5118.5	100-Year	3904.00	249.56	264.98	257.73	265.01	0.000162	2.25	4849.96	821.35	0.10
Reach - 3	5067.5	2-Year	856.00	249.11	257.41		257.55	0.000863	3.37	551.45	183.54	0.21
Reach - 3	5067.5	10-Year	2155.00	249.11	260.93		261.08	0.000770	4.08	1492.67	397.32	0.21
Reach - 3	5067.5	25-Year	2951.00	249.11	263.02		263.10	0.000424	3.39	2565.50	669.90	0.16
Reach - 3	5067.5	50-Year	3531.00	249.11	264.38		264.43	0.000260	2.83	3547.69	782.85	0.13
Reach - 3	5067.5	100-Year	3904.00	249.11	264.96		265.00	0.000220	2.67	4011.93	830.80	0.12
Reach - 3	5018.5	2-Year	856.00	249.02	257.34	252.82	257.50	0.001017	3.68	494.93	166.50	0.23
Reach - 3	5018.5	10-Year	2155.00	249.02	260.80	256.47	261.03	0.001094	4.85	1085.05	258.87	0.25
Reach - 3	5018.5	25-Year	2951.00	249.02	262.83	257.51	263.05	0.000963	5.07	1458.22	409.01	0.24
Reach - 3	5018.5	50-Year	3531.00	249.02	264.19	258.05	264.39	0.000806	4.95	1818.64	575.38	0.23
Reach - 3	5018.5	100-Year	3904.00	249.02	264.90	258.35	264.98	0.000401	3.60	2925.35	638.36	0.16
Reach - 3	4972.5	2-Year	856.00	249.35	257.23		257.45	0.001242	3.98	361.93	117.16	0.25
Reach - 3	4972.5	10-Year	2155.00	249.35	260.58		260.95	0.001563	5.69	822.17	155.00	0.30
Reach - 3	4972.5	25-Year	2951.00	249.35	262.63		262.99	0.001340	5.90	1160.08	167.12	0.29
Reach - 3	4972.5	50-Year	3531.00	249.35	263.98		264.33	0.001213	6.00	1391.98	188.00	0.28

HEC-RAS Plan: Existing (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 3	4972.5	100-Year	3904.00	249.35	264.56		264.92	0.001225	6.18	1505.37	201.13	0.28
Reach - 3	4922.5	2-Year	856.00	249.34	257.15		257.38	0.001301	3.97	266.03	55.37	0.26
Reach - 3	4922.5	10-Year	2155.00	249.34	260.21		260.83	0.002317	6.68	474.68	80.74	0.36
Reach - 3	4922.5	25-Year	2951.00	249.34	262.07		262.86	0.002407	7.60	675.35	143.53	0.38
Reach - 3	4922.5	50-Year	3531.00	249.34	263.45		264.21	0.002117	7.65	877.20	153.39	0.36
Reach - 3	4922.5	100-Year	3904.00	249.34	264.02		264.80	0.002136	7.89	969.35	173.60	0.37
Reach - 3	4871.5	2-Year	856.00	248.79	257.12		257.31	0.000984	3.66	291.16	57.90	0.23
Reach - 3	4871.5	10-Year	2155.00	248.79	260.15		260.71	0.001841	6.27	487.92	71.75	0.34
Reach - 3	4871.5	25-Year	2951.00	248.79	262.06		262.71	0.001794	6.91	713.79	184.23	0.34
Reach - 3	4871.5	50-Year	3531.00	248.79	263.48		264.07	0.001528	6.85	1011.07	235.70	0.32
Reach - 3	4871.5	100-Year	3904.00	248.79	264.09		264.64	0.001439	6.84	1159.42	250.66	0.32
Reach - 3	4817.5	2-Year	856.00	249.04	256.98	252.88	257.24	0.001452	4.20	250.46	55.81	0.28
Reach - 3	4817.5	10-Year	2155.00	249.04	259.86	255.81	260.57	0.002650	7.11	432.57	70.80	0.40
Reach - 3	4817.5	25-Year	2951.00	249.04	261.75	257.13	262.57	0.002547	7.82	634.25	165.39	0.40
Reach - 3	4817.5	50-Year	3531.00	249.04	263.29	257.95	263.97	0.001952	7.43	892.87	169.26	0.36
Reach - 3	4817.5	100-Year	3904.00	249.04	263.88	258.47	264.54	0.001891	7.52	997.53	210.91	0.35
Reach - 3	4766.5	2-Year	856.00	248.79	256.97	252.59	257.16	0.001058	3.53	275.35	59.89	0.24
Reach - 3	4766.5	10-Year	2155.00	248.79	259.88	255.11	260.40	0.001870	5.95	456.81	76.03	0.34
Reach - 3	4766.5	25-Year	2951.00	248.79	261.79	256.40	262.40	0.001796	6.57	637.25	134.00	0.34
Reach - 3	4766.5	50-Year	3531.00	248.79	263.27	257.17	263.85	0.001525	6.56	878.67	137.67	0.32
Reach - 3	4766.5	100-Year	3904.00	248.79	263.83	257.62	264.44	0.001556	6.81	955.50	138.76	0.32
Reach - 3	4696.5	2-Year	832.00	249.54	256.97	252.34	257.06	0.000501	2.48	401.73	95.28	0.17
Reach - 3	4696.5	10-Year	1964.00	249.54	259.96	254.06	260.17	0.000726	3.85	647.91	157.61	0.22
Reach - 3	4696.5	25-Year	2686.00	249.54	261.89	254.99	262.15	0.000706	4.30	807.05	176.17	0.23
Reach - 3	4696.5	50-Year	3225.00	249.54	263.42	255.62	263.59	0.000454	3.76	1422.25	245.64	0.18
Reach - 3	4696.5	100-Year	3597.00	249.54	264.00	256.00	264.16	0.000442	3.82	1566.84	259.72	0.18
Reach - 3	4645.0		Culvert									
Reach - 3	4593.5	2-Year	832.00	249.19	256.85	251.24	256.90	0.000187	1.68	539.28	99.38	0.11
Reach - 3	4593.5	10-Year	1964.00	249.19	259.40	252.55	259.53	0.000381	2.93	741.45	176.45	0.16
Reach - 3	4593.5	25-Year	2686.00	249.19	260.70	253.25	260.89	0.000469	3.54	845.10	210.85	0.19
Reach - 3	4593.5	50-Year	3225.00	249.19	261.65	253.73	261.84	0.000460	3.70	1364.00	225.49	0.19

HEC-RAS Plan: Existing (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 3	4593.5	100-Year	3597.00	249.19	262.30	254.05	262.51	0.000469	3.86	1514.12	235.61	0.19
Reach - 3	4500.596	2-Year	832.00	248.23	256.70	252.40	256.84	0.000988	3.00	314.72	99.57	0.23
Reach - 3	4500.596	10-Year	1964.00	248.23	259.14	254.62	259.42	0.001483	4.45	587.73	164.15	0.30
Reach - 3	4500.596	25-Year	2686.00	248.23	260.43	255.74	260.77	0.001580	4.97	740.17	170.76	0.31
Reach - 3	4500.596	50-Year	3225.00	248.23	261.33	256.51	261.71	0.001601	5.25	849.60	175.39	0.32
Reach - 3	4500.596	100-Year	3597.00	248.23	261.98	256.95	262.38	0.001573	5.38	929.67	239.95	0.32
Reach - 3	4486		Bridge									
Reach - 3	4452.7	2-Year	832.00	248.28	255.40	250.92	255.55	0.000769	3.12	290.24	166.75	0.21
Reach - 3	4452.7	10-Year	1964.00	248.28	257.58	252.85	258.02	0.001640	5.47	407.73	428.53	0.32
Reach - 3	4452.7	25-Year	2686.00	248.28	258.83	253.95	259.44	0.001940	6.47	477.85	487.77	0.35
Reach - 3	4452.7	50-Year	3225.00	248.28	259.81	254.74	260.53	0.002030	7.03	532.65	618.88	0.37
Reach - 3	4452.7	100-Year	3597.00	248.28	260.67	255.18	261.43	0.001945	7.23	581.17	691.50	0.36
Reach - 3	4387.2		Culvert									
Reach - 3	4321.7	2-Year	832.00	249.27	255.18	251.91	255.41	0.001511	3.85	227.63	52.70	0.28
Reach - 3	4321.7	10-Year	1964.00	249.27	256.75	253.85	257.51	0.003697	7.08	308.51	204.98	0.46
Reach - 3	4321.7	25-Year	2686.00	249.27	257.48	254.90	258.65	0.004978	8.75	347.70	299.40	0.54
Reach - 3	4321.7	50-Year	3225.00	249.27	258.08	255.63	259.52	0.005600	9.74	380.41	403.49	0.58
Reach - 3	4321.7	100-Year	3597.00	249.27	258.94	256.10	260.39	0.005025	9.82	427.54	444.75	0.56
Reach - 3	4294.441	2-Year	832.00	246.73	255.18		255.34	0.001113	3.36	399.37	196.74	0.24
Reach - 3	4294.441	10-Year	1964.00	246.73	256.88		257.23	0.002036	5.28	900.58	330.01	0.34
Reach - 3	4294.441	25-Year	2686.00	246.73	257.78		258.18	0.002176	5.89	1198.86	335.47	0.36
Reach - 3	4294.441	50-Year	3225.00	246.73	258.51		258.92	0.002084	6.10	1446.75	339.94	0.36
Reach - 3	4294.441	100-Year	3597.00	246.73	259.42		259.76	0.001645	5.78	1759.03	345.49	0.32
Reach - 3	4000.0	2-Year	832.00	248.37	254.62		254.78	0.003952	4.65	629.08	400.41	0.41
Reach - 3	4000.0	10-Year	1964.00	248.37	256.33		256.46	0.002883	4.92	1421.52	509.31	0.37
Reach - 3	4000.0	25-Year	2686.00	248.37	257.34		257.44	0.002217	4.82	1946.59	542.21	0.33
Reach - 3	4000.0	50-Year	3225.00	248.37	258.17		258.26	0.001742	4.63	2407.14	568.78	0.30
Reach - 3	4000.0	100-Year	3597.00	248.37	259.22		259.28	0.001127	4.06	3013.66	586.32	0.25
Reach - 3	3500.0	2-Year	832.00	246.98	253.61		253.65	0.001385	2.88	1230.91	760.15	0.24
Reach - 3	3500.0	10-Year	1964.00	246.98	255.84		255.86	0.000603	2.49	3096.77	909.55	0.17

HEC-RAS Plan: Existing (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 3	3500.0	25-Year	2686.00	246.98	256.96		256.98	0.000465	2.43	4129.30	922.34	0.16
Reach - 3	3500.0	50-Year	3225.00	246.98	257.87		257.89	0.000379	2.37	4978.93	947.63	0.14
Reach - 3	3500.0	100-Year	3597.00	246.98	259.02		259.03	0.000254	2.11	6085.29	969.42	0.12
Reach - 3	3185.2	2-Year	849.00	246.10	252.87	249.95	253.10	0.001795	3.87	226.61	673.91	0.31
Reach - 3	3185.2	10-Year	1990.00	246.10	254.63	251.90	255.29	0.003439	6.58	346.62	864.25	0.45
Reach - 3	3185.2	25-Year	2732.00	246.10	255.40	252.90	256.36	0.004383	7.99	411.34	886.37	0.52
Reach - 3	3185.2	50-Year	3281.00	246.10	256.19	253.57	257.28	0.004395	8.55	480.65	904.10	0.53
Reach - 3	3185.2	100-Year	3665.00	246.10	257.68	254.02	258.57	0.002992	7.88	624.35	1069.89	0.45
Reach - 3	3157.2		Bridge									
Reach - 3	3129.2	2-Year	849.00	245.86	252.60	249.70	252.83	0.001834	3.90	224.96	664.92	0.31
Reach - 3	3129.2	10-Year	1990.00	245.86	253.40	251.66	254.34	0.005986	7.80	274.86	826.85	0.58
Reach - 3	3129.2	25-Year	2732.00	245.86	253.94	252.67	255.39	0.008246	9.72	312.94	849.12	0.69
Reach - 3	3129.2	50-Year	3281.00	245.86	254.38	253.34	256.17	0.009379	10.85	346.54	864.01	0.74
Reach - 3	3129.2	100-Year	3665.00	245.86	254.59	253.79	256.67	0.010490	11.72	363.58	871.10	0.79
Reach - 3	2957.4	2-Year	849.00	243.96	252.63		252.64	0.000217	1.50	2080.68	842.79	0.10
Reach - 3	2957.4	10-Year	1990.00	243.96	253.66		253.69	0.000463	2.42	2962.76	857.38	0.16
Reach - 3	2957.4	25-Year	2732.00	243.96	254.43		254.46	0.000491	2.66	3626.83	867.48	0.16
Reach - 3	2957.4	50-Year	3281.00	243.96	255.04		255.07	0.000478	2.75	4156.85	875.60	0.16
Reach - 3	2957.4	100-Year	3665.00	243.96	255.39		255.42	0.000485	2.85	4461.39	880.84	0.17
Reach - 3	2362.9	2-Year	849.00	243.50	252.42		252.45	0.000465	2.25	1590.08	702.56	0.15
Reach - 3	2362.9	10-Year	1990.00	243.50	253.19		253.27	0.001169	3.84	2137.81	724.17	0.25
Reach - 3	2362.9	25-Year	2732.00	243.50	253.95		254.03	0.001157	4.08	2696.20	744.50	0.25
Reach - 3	2362.9	50-Year	3281.00	243.50	254.59		254.66	0.001043	4.07	3179.74	760.48	0.24
Reach - 3	2362.9	100-Year	3665.00	243.50	254.94		255.01	0.001034	4.16	3443.58	768.40	0.24
Reach - 3	1661.6	2-Year	849.00	242.95	252.29		252.30	0.000116	1.15	2667.54	751.17	0.08
Reach - 3	1661.6	10-Year	1990.00	242.95	252.75		252.77	0.000448	2.35	3011.30	759.90	0.15
Reach - 3	1661.6	25-Year	2732.00	242.95	253.47		253.49	0.000514	2.67	3575.44	824.02	0.17
Reach - 3	1661.6	50-Year	3281.00	242.95	254.13		254.16	0.000501	2.78	4151.99	902.15	0.17
Reach - 3	1661.6	100-Year	3665.00	242.95	254.47		254.50	0.000513	2.89	4462.52	932.32	0.17
Reach - 3	920.6	2-Year	849.00	242.61	252.25	248.32	252.25	0.000040	0.73	4297.09	996.23	0.05
Reach - 3	920.6	10-Year	1990.00	242.61	252.56	248.93	252.57	0.000178	1.59	4606.72	1001.47	0.10

HEC-RAS Plan: Existing (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 3	920.6	25-Year	2732.00	242.61	253.24	249.20	253.25	0.000218	1.86	5291.71	1013.16	0.11
Reach - 3	920.6	50-Year	3281.00	242.61	253.91	249.30	253.92	0.000216	1.94	5974.25	1023.93	0.11
Reach - 3	920.6	100-Year	3665.00	242.61	254.24	249.41	254.25	0.000227	2.04	6313.41	1032.04	0.12

FUTURE CONDITIONS:
HEC-RAS OUTPUT

HEC-RAS Plan: Future

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	26670.3	2-Year	176.00	470.17	472.07	472.07	472.77	0.028500	6.70	26.28	19.08	1.01
Reach - 1	26670.3	10-Year	426.00	470.17	473.98		474.59	0.009722	6.29	68.29	25.89	0.65
Reach - 1	26670.3	25-Year	585.00	470.17	475.82		476.23	0.003414	5.17	133.42	71.68	0.42
Reach - 1	26670.3	50-Year	731.00	470.17	476.91		477.28	0.002447	5.03	229.77	127.09	0.37
Reach - 1	26670.3	100-Year	891.00	470.17	478.38		478.61	0.001295	4.25	444.52	157.79	0.28
Reach - 1	26133.4	2-Year	211.00	467.03	471.03	468.62	471.11	0.000793	2.22	111.73	44.76	0.20
Reach - 1	26133.4	10-Year	449.00	467.03	473.30	469.49	473.42	0.000714	2.89	187.03	56.30	0.21
Reach - 1	26133.4	25-Year	619.00	467.03	475.43	470.00	475.55	0.000486	2.91	257.60	66.80	0.18
Reach - 1	26133.4	50-Year	764.00	467.03	476.54	470.38	476.68	0.000480	3.16	294.47	89.87	0.18
Reach - 1	26133.4	100-Year	937.00	467.03	478.05	470.82	478.21	0.000434	3.32	344.64	166.76	0.18
Reach - 1	26050.4		Culvert									
Reach - 1	25967.4	2-Year	211.00	463.47	465.57	465.06	465.91	0.009005	4.68	49.02	31.72	0.61
Reach - 1	25967.4	10-Year	447.00	463.47	466.57	465.93	467.16	0.009139	6.29	81.83	38.59	0.66
Reach - 1	25967.4	25-Year	611.00	463.47	467.13	466.42	467.88	0.009294	7.13	100.14	42.37	0.68
Reach - 1	25967.4	50-Year	750.00	463.47	467.53	466.79	468.42	0.009564	7.79	113.42	45.11	0.70
Reach - 1	25967.4	100-Year	865.00	463.47	467.82	467.08	468.83	0.009829	8.30	123.28	46.82	0.72
Reach - 1	25524.2	2-Year	211.00	456.43	458.52	458.52	459.29	0.027875	7.05	29.91	19.68	1.01
Reach - 1	25524.2	10-Year	447.00	456.43	459.55	459.55	460.70	0.025018	8.63	51.83	22.96	1.01
Reach - 1	25524.2	25-Year	611.00	456.43	460.10	460.10	461.49	0.023378	9.46	65.04	24.86	1.00
Reach - 1	25524.2	50-Year	750.00	456.43	460.53	460.53	462.09	0.021791	10.04	77.19	30.21	0.99
Reach - 1	25524.2	100-Year	865.00	456.43	460.87	460.87	462.55	0.020517	10.42	88.02	33.23	0.98
Reach - 1	24962.5	2-Year	211.00	444.33	447.17		447.50	0.008131	4.63	45.61	22.07	0.57
Reach - 1	24962.5	10-Year	447.00	444.33	448.35		448.94	0.008441	6.14	73.95	26.34	0.61
Reach - 1	24962.5	25-Year	611.00	444.33	448.74		449.60	0.010645	7.46	84.47	28.08	0.70
Reach - 1	24962.5	50-Year	750.00	444.33	449.07		450.15	0.011749	8.33	94.23	29.60	0.75
Reach - 1	24962.5	100-Year	865.00	444.33	449.31	448.75	450.57	0.012773	9.04	101.32	30.65	0.79
Reach - 1	24504.7	2-Year	328.00	437.03	439.64	439.64	440.58	0.025249	7.80	42.54	24.73	1.00
Reach - 1	24504.7	10-Year	680.00	437.03	440.77	440.77	442.26	0.022511	9.85	76.02	35.27	1.02
Reach - 1	24504.7	25-Year	916.00	437.03	441.58	441.58	443.12	0.017200	10.14	115.38	56.06	0.93
Reach - 1	24504.7	50-Year	1109.00	437.03	442.09	442.09	443.73	0.015709	10.56	146.38	64.87	0.90
Reach - 1	24504.7	100-Year	1263.00	437.03	442.47	442.47	444.16	0.014787	10.84	171.49	68.63	0.89

HEC-RAS Plan: Future (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	23991.1	2-Year	328.00	426.45	432.16		432.25	0.000832	2.57	265.26	198.31	0.21
Reach - 1	23991.1	10-Year	680.00	426.45	433.74		433.84	0.000803	3.06	622.99	244.58	0.21
Reach - 1	23991.1	25-Year	916.00	426.45	434.56		434.66	0.000774	3.25	828.11	258.77	0.21
Reach - 1	23991.1	50-Year	1109.00	426.45	435.17		435.27	0.000743	3.36	988.20	263.97	0.21
Reach - 1	23991.1	100-Year	1263.00	426.45	435.78		435.87	0.000664	3.34	1150.59	274.75	0.20
Reach - 1	23524.2	2-Year	328.00	425.63	431.97		432.00	0.000313	1.71	497.29	198.36	0.13
Reach - 1	23524.2	10-Year	680.00	425.63	433.52		433.56	0.000407	2.31	825.77	218.39	0.15
Reach - 1	23524.2	25-Year	916.00	425.63	434.32		434.37	0.000445	2.60	1002.25	222.24	0.16
Reach - 1	23524.2	50-Year	1109.00	425.63	434.93		434.99	0.000463	2.78	1138.32	225.16	0.17
Reach - 1	23524.2	100-Year	1263.00	425.63	435.55		435.61	0.000437	2.84	1279.41	228.16	0.17
Reach - 1	23024.2	2-Year	328.00	425.63	431.89		431.90	0.000145	1.16	927.09	325.34	0.09
Reach - 1	23024.2	10-Year	680.00	425.63	433.41		433.42	0.000184	1.53	1430.43	335.85	0.10
Reach - 1	23024.2	25-Year	916.00	425.63	434.20		434.22	0.000204	1.74	1700.20	345.89	0.11
Reach - 1	23024.2	50-Year	1109.00	425.63	434.80		434.82	0.000214	1.87	1911.26	353.86	0.11
Reach - 1	23024.2	100-Year	1263.00	425.63	435.43		435.45	0.000203	1.92	2137.94	366.29	0.11
Reach - 1	22524.2	2-Year	472.00	419.97	431.81		431.84	0.000088	1.45	635.75	95.34	0.08
Reach - 1	22524.2	10-Year	942.00	419.97	433.24		433.31	0.000221	2.49	787.83	120.92	0.12
Reach - 1	22524.2	25-Year	1225.00	419.97	433.98		434.08	0.000297	3.00	881.83	134.29	0.15
Reach - 1	22524.2	50-Year	1459.00	419.97	434.54		434.67	0.000355	3.37	960.12	144.45	0.16
Reach - 1	22524.2	100-Year	1677.00	419.97	435.14		435.30	0.000402	3.70	1054.78	168.24	0.17
Reach - 1	22396.4	2-Year	472.00	420.03	431.83	421.77	431.83	0.000000	0.08	5792.90	755.54	0.01
Reach - 1	22396.4	10-Year	942.00	420.03	433.29	422.19	433.29	0.000001	0.14	6890.06	777.58	0.01
Reach - 1	22396.4	25-Year	1225.00	420.03	434.05	422.36	434.05	0.000001	0.17	7466.89	789.02	0.01
Reach - 1	22396.4	50-Year	1459.00	420.03	434.63	422.49	434.63	0.000001	0.19	7911.45	797.77	0.01
Reach - 1	22396.4	100-Year	1677.00	420.03	435.25	422.60	435.25	0.000001	0.20	8384.81	807.04	0.01
Reach - 1	22383.4		Inl Struct									
Reach - 1	22370.4	2-Year	472.00	425.91	428.47	428.47	429.31	0.026061	7.37	64.06	38.82	1.01
Reach - 1	22370.4	10-Year	942.00	425.91	430.56		431.11	0.007479	5.97	157.85	50.94	0.60
Reach - 1	22370.4	25-Year	1225.00	425.91	431.91		432.34	0.004274	5.28	231.81	58.76	0.47
Reach - 1	22370.4	50-Year	1459.00	425.91	432.89		433.27	0.003183	4.99	292.10	64.43	0.41
Reach - 1	22370.4	100-Year	1677.00	425.91	434.43		434.71	0.001594	4.25	416.29	100.76	0.31

HEC-RAS Plan: Future (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	22255.4	2-Year	472.00	422.25	427.59	426.02	428.05	0.004502	5.50	93.79	27.00	0.48
Reach - 1	22255.4	10-Year	942.00	422.25	429.54	427.49	430.35	0.004802	7.35	150.85	31.82	0.53
Reach - 1	22255.4	25-Year	1225.00	422.25	430.78	428.27	431.70	0.004283	7.86	192.51	35.93	0.51
Reach - 1	22255.4	50-Year	1459.00	422.25	431.65	428.83	432.67	0.004110	8.30	226.17	41.90	0.51
Reach - 1	22255.4	100-Year	1677.00	422.25	433.45	429.36	434.30	0.002677	7.65	304.54	264.90	0.43
Reach - 1	22230.4		Bridge									
Reach - 1	22205.4	2-Year	460.00	421.56	425.28	425.28	426.51	0.022842	8.90	53.20	23.25	0.99
Reach - 1	22205.4	10-Year	842.00	421.56	426.52	426.52	428.32	0.019886	10.84	83.68	26.12	0.99
Reach - 1	22205.4	25-Year	1065.00	421.56	427.15	427.15	429.24	0.018709	11.67	100.73	27.59	0.98
Reach - 1	22205.4	50-Year	1270.00	421.56	427.69	427.69	430.01	0.017924	12.34	115.94	28.84	0.98
Reach - 1	22205.4	100-Year	1281.00	421.56	427.71	427.71	430.05	0.017965	12.39	116.57	28.89	0.98
Reach - 1	22061.4	2-Year	460.00	400.80	403.96	403.96	405.14	0.037122	8.70	52.88	22.83	1.01
Reach - 1	22061.4	10-Year	842.00	400.80	405.14	405.14	406.86	0.032402	10.51	80.38	23.94	1.00
Reach - 1	22061.4	25-Year	1065.00	400.80	405.71	405.71	407.73	0.031113	11.40	94.12	24.43	1.00
Reach - 1	22061.4	50-Year	1270.00	400.80	406.23	406.23	408.47	0.029433	12.03	106.93	24.87	1.00
Reach - 1	22061.4	100-Year	1281.00	400.80	406.25	406.25	408.51	0.029367	12.06	107.59	24.90	1.00
Reach - 1	21877	2-Year	460.00	390.67	393.01	393.01	393.65	0.028609	6.90	73.17	65.44	0.94
Reach - 1	21877	10-Year	842.00	390.67	393.78	393.78	394.58	0.026070	8.16	125.62	93.64	0.94
Reach - 1	21877	25-Year	1065.00	390.67	394.14	394.14	394.95	0.024515	8.57	172.35	144.59	0.93
Reach - 1	21877	50-Year	1270.00	390.67	394.59	394.33	395.29	0.018717	8.28	238.07	150.75	0.83
Reach - 1	21877	100-Year	1281.00	390.67	394.82	394.34	395.39	0.014105	7.55	273.96	153.51	0.73
Reach - 1	21577.4	2-Year	583.00	383.59	389.02		389.40	0.005287	5.10	167.47	105.48	0.42
Reach - 1	21577.4	10-Year	1128.00	383.59	390.27		390.83	0.006524	6.67	316.33	126.65	0.49
Reach - 1	21577.4	25-Year	1478.00	383.59	390.77		391.46	0.007646	7.63	381.03	133.98	0.54
Reach - 1	21577.4	50-Year	1750.00	383.59	391.15		391.93	0.008261	8.24	433.23	143.25	0.56
Reach - 1	21577.4	100-Year	1976.00	383.59	391.44		392.28	0.008616	8.66	475.68	147.72	0.58
Reach - 1	21329	2-Year	583.00	380.12	385.19	385.19	386.65	0.031194	9.70	60.12	20.66	1.00
Reach - 1	21329	10-Year	1128.00	380.12	387.38	387.38	388.46	0.014408	8.91	246.18	193.05	0.73
Reach - 1	21329	25-Year	1478.00	380.12	388.04	388.04	389.04	0.012531	9.08	391.27	249.15	0.70
Reach - 1	21329	50-Year	1750.00	380.12	388.33	388.33	389.37	0.012889	9.55	465.02	256.03	0.71
Reach - 1	21329	100-Year	1976.00	380.12	388.53	388.53	389.62	0.013366	9.96	517.81	260.84	0.73

HEC-RAS Plan: Future (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	21024.2	2-Year	583.00	375.87	382.04		382.38	0.003039	4.70	133.84	32.22	0.36
Reach - 1	21024.2	10-Year	1128.00	375.87	386.46		386.54	0.000560	3.03	1208.51	387.65	0.17
Reach - 1	21024.2	25-Year	1478.00	375.87	387.45		387.53	0.000509	3.09	1599.12	395.53	0.17
Reach - 1	21024.2	50-Year	1750.00	375.87	388.05		388.13	0.000510	3.20	1836.66	400.92	0.17
Reach - 1	21024.2	100-Year	1976.00	375.87	388.39		388.48	0.000542	3.37	1975.08	404.39	0.17
Reach - 1	20803	2-Year	583.00	373.95	380.95		381.45	0.005815	5.70	109.99	41.96	0.45
Reach - 1	20803	10-Year	1128.00	373.95	386.21		386.37	0.000999	3.84	719.72	219.63	0.21
Reach - 1	20803	25-Year	1478.00	373.95	387.18		387.36	0.001065	4.21	952.80	260.82	0.22
Reach - 1	20803	50-Year	1750.00	373.95	387.76		387.95	0.001138	4.50	1110.06	286.23	0.23
Reach - 1	20803	100-Year	1976.00	373.95	388.07		388.29	0.001255	4.81	1201.64	299.90	0.24
Reach - 1	20582.7	2-Year	583.00	372.04	380.89		381.01	0.000661	2.89	320.30	111.90	0.18
Reach - 1	20582.7	10-Year	1128.00	372.04	386.21		386.26	0.000185	2.15	1544.06	287.09	0.10
Reach - 1	20582.7	25-Year	1478.00	372.04	387.18		387.23	0.000219	2.45	1833.96	307.68	0.11
Reach - 1	20582.7	50-Year	1750.00	372.04	387.75		387.81	0.000247	2.67	2011.36	313.19	0.12
Reach - 1	20582.7	100-Year	1976.00	372.04	388.06		388.13	0.000281	2.89	2108.59	316.94	0.13
Reach - 1	20391.6	2-Year	638.00	371.31	379.79	377.15	380.54	0.004979	7.67	149.88	74.75	0.49
Reach - 1	20391.6	10-Year	1184.00	371.31	386.15	379.55	386.20	0.000370	3.12	1530.29	356.08	0.15
Reach - 1	20391.6	25-Year	1537.00	371.31	387.13	381.00	387.18	0.000336	3.11	2084.01	364.46	0.14
Reach - 1	20391.6	50-Year	1820.00	371.31	387.70	382.13	387.75	0.000363	3.31	2292.29	368.75	0.15
Reach - 1	20391.6	100-Year	2039.00	371.31	388.00	382.61	388.06	0.000399	3.52	2404.78	371.05	0.16
Reach - 1	20349.6		Bridge									
Reach - 1	20307.6	2-Year	634.00	371.56	377.39	377.39	379.53	0.023194	12.50	76.87	22.44	0.98
Reach - 1	20307.6	10-Year	1134.00	371.56	380.10	380.10	382.00	0.013404	12.64	205.66	75.51	0.80
Reach - 1	20307.6	25-Year	1519.00	371.56	380.80	380.80	383.18	0.015839	14.56	261.89	89.80	0.88
Reach - 1	20307.6	50-Year	1804.00	371.56	382.39	382.39	383.78	0.008748	12.14	503.09	221.27	0.67
Reach - 1	20307.6	100-Year	2030.00	371.56	383.24	383.24	384.42	0.007282	11.68	714.11	275.31	0.62
Reach - 1	20223	2-Year	634.00	370.12	375.00	375.00	376.30	0.029417	9.13	69.51	28.53	1.00
Reach - 1	20223	10-Year	1134.00	370.12	376.52	376.52	377.88	0.017652	9.64	170.16	99.77	0.84
Reach - 1	20223	25-Year	1519.00	370.12	377.21	377.21	378.70	0.016650	10.39	243.96	113.15	0.84
Reach - 1	20223	50-Year	1804.00	370.12	377.65	377.65	379.22	0.016264	10.88	295.03	120.89	0.84
Reach - 1	20223	100-Year	2030.00	370.12	377.94	377.94	379.60	0.016453	11.34	330.13	125.93	0.85

HEC-RAS Plan: Future (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	20024.2	2-Year	634.00	366.75	371.38	370.55	372.13	0.010858	7.06	104.17	37.46	0.64
Reach - 1	20024.2	10-Year	1134.00	366.75	372.83		373.95	0.010878	8.80	166.07	51.62	0.68
Reach - 1	20024.2	25-Year	1519.00	366.75	373.46	372.69	375.00	0.012955	10.37	202.53	64.39	0.76
Reach - 1	20024.2	50-Year	1804.00	366.75	373.83	373.17	375.71	0.014611	11.47	228.71	78.33	0.81
Reach - 1	20024.2	100-Year	2030.00	366.75	374.17	373.76	376.22	0.015081	12.08	255.76	81.93	0.83
Reach - 1	19751	2-Year	634.00	361.35	366.70	366.43	367.88	0.023422	8.73	72.61	24.79	0.90
Reach - 1	19751	10-Year	1134.00	361.35	367.97	367.97	369.68	0.023638	10.52	117.31	54.87	0.95
Reach - 1	19751	25-Year	1519.00	361.35	368.90	368.90	370.70	0.019309	10.98	179.09	79.50	0.89
Reach - 1	19751	50-Year	1804.00	361.35	369.46	369.46	371.32	0.017670	11.32	226.83	88.51	0.86
Reach - 1	19751	100-Year	2030.00	361.35	369.81	369.81	371.77	0.017455	11.73	258.35	93.37	0.87
Reach - 1	19524.2	2-Year	634.00	356.87	360.62	360.62	362.03	0.028309	9.53	67.69	27.78	1.00
Reach - 1	19524.2	10-Year	1134.00	356.87	362.11	362.11	363.81	0.020410	10.71	135.48	53.78	0.91
Reach - 1	19524.2	25-Year	1519.00	356.87	362.91	362.91	364.87	0.019353	11.68	181.07	59.36	0.91
Reach - 1	19524.2	50-Year	1804.00	356.87	363.42	363.42	365.57	0.019156	12.37	211.90	62.65	0.92
Reach - 1	19524.2	100-Year	2030.00	356.87	363.83	363.83	366.09	0.018592	12.77	238.15	65.32	0.91
Reach - 1	19222	2-Year	634.00	348.54	351.92	351.92	353.06	0.027048	8.59	77.14	38.71	0.98
Reach - 1	19222	10-Year	1134.00	348.54	353.04	353.04	354.64	0.023130	10.27	125.63	46.85	0.97
Reach - 1	19222	25-Year	1519.00	348.54	353.74	353.74	355.65	0.022115	11.32	159.51	50.48	0.97
Reach - 1	19222	50-Year	1804.00	348.54	354.25	354.25	356.34	0.020791	11.86	186.20	52.62	0.96
Reach - 1	19222	100-Year	2030.00	348.54	354.61	354.61	356.85	0.020385	12.33	205.15	53.74	0.96
Reach - 1	19024.2	2-Year	634.00	343.08	348.33		348.94	0.006915	6.25	101.85	23.81	0.53
Reach - 1	19024.2	10-Year	1134.00	343.08	349.91	348.15	350.93	0.007739	8.13	155.15	55.04	0.59
Reach - 1	19024.2	25-Year	1519.00	343.08	350.83	349.14	352.07	0.008029	9.11	238.35	117.62	0.61
Reach - 1	19024.2	50-Year	1804.00	343.08	350.90	349.89	352.59	0.010898	10.68	246.32	126.39	0.72
Reach - 1	19024.2	100-Year	2030.00	343.08	351.19	350.68	353.07	0.011631	11.35	288.48	160.31	0.74
Reach - 1	18833	2-Year	634.00	339.27	344.81	344.81	346.42	0.030290	10.20	62.47	22.15	1.00
Reach - 1	18833	10-Year	1134.00	339.27	346.50	346.50	348.49	0.022271	11.53	121.65	44.46	0.92
Reach - 1	18833	25-Year	1519.00	339.27	347.59	347.59	349.72	0.018987	12.16	182.44	67.91	0.87
Reach - 1	18833	50-Year	1804.00	339.27	348.88	348.88	350.40	0.011512	10.78	348.38	158.40	0.70
Reach - 1	18833	100-Year	2030.00	339.27	349.20	349.20	350.76	0.011564	11.12	400.38	160.98	0.71
Reach - 1	18524.2	2-Year	634.00	333.12	340.33		340.61	0.001954	4.25	163.76	36.43	0.30
Reach - 1	18524.2	10-Year	1134.00	333.12	341.99		342.51	0.002763	5.91	237.00	53.26	0.37

HEC-RAS Plan: Future (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	18524.2	25-Year	1519.00	333.12	342.79		343.53	0.003496	7.09	302.70	102.82	0.42
Reach - 1	18524.2	50-Year	1804.00	333.12	343.33		344.19	0.003853	7.74	359.61	107.99	0.45
Reach - 1	18524.2	100-Year	2030.00	333.12	343.64		344.63	0.004245	8.31	394.02	111.81	0.47
Reach - 1	18317	2-Year	634.00	331.33	338.14	338.14	339.48	0.029379	9.40	80.27	43.69	0.92
Reach - 1	18317	10-Year	1134.00	331.33	339.58	339.58	341.14	0.023004	10.63	164.88	79.89	0.87
Reach - 1	18317	25-Year	1519.00	331.33	340.50	340.50	342.03	0.019182	10.95	251.47	103.28	0.82
Reach - 1	18317	50-Year	1804.00	331.33	340.90	340.90	342.58	0.019807	11.66	294.38	108.97	0.84
Reach - 1	18317	100-Year	2030.00	331.33	341.38	341.20	342.98	0.017747	11.62	348.35	115.73	0.81
Reach - 1	18024.2	2-Year	634.00	328.79	334.20		334.74	0.005990	5.95	117.06	35.99	0.49
Reach - 1	18024.2	10-Year	1134.00	328.79	335.44		336.44	0.008167	8.17	168.65	48.00	0.60
Reach - 1	18024.2	25-Year	1519.00	328.79	336.07	334.85	337.47	0.010049	9.72	201.60	55.30	0.68
Reach - 1	18024.2	50-Year	1804.00	328.79	336.51	335.50	338.20	0.011208	10.73	229.60	70.90	0.72
Reach - 1	18024.2	100-Year	2030.00	328.79	336.83	335.96	338.72	0.011957	11.42	252.91	77.01	0.75
Reach - 1	17810	2-Year	634.00	326.23	331.00	331.00	332.23	0.030063	8.87	71.50	29.24	1.00
Reach - 1	17810	10-Year	1134.00	326.23	332.55	332.22	333.85	0.019136	9.18	131.56	51.90	0.85
Reach - 1	17810	25-Year	1519.00	326.23	333.56	333.01	334.90	0.014433	9.40	193.96	72.63	0.77
Reach - 1	17810	50-Year	1804.00	326.23	334.22	333.51	335.57	0.012490	9.56	245.86	85.41	0.74
Reach - 1	17810	100-Year	2030.00	326.23	334.67	333.88	336.05	0.011553	9.72	287.01	93.31	0.72
Reach - 1	17524.2	2-Year	634.00	322.82	329.60		329.92	0.002438	4.54	159.27	39.33	0.33
Reach - 1	17524.2	10-Year	1134.00	322.82	331.23		331.78	0.003203	6.12	257.48	76.16	0.39
Reach - 1	17524.2	25-Year	1519.00	322.82	332.12		332.84	0.003710	7.10	330.62	89.50	0.43
Reach - 1	17524.2	50-Year	1804.00	322.82	332.68		333.53	0.004087	7.77	386.63	112.05	0.46
Reach - 1	17524.2	100-Year	2030.00	322.82	333.08		334.02	0.004324	8.23	435.34	129.02	0.47
Reach - 1	17294	2-Year	634.00	322.18	328.44		329.03	0.006400	6.41	149.91	68.64	0.51
Reach - 1	17294	10-Year	1134.00	322.18	329.88		330.70	0.007047	8.00	269.46	97.16	0.56
Reach - 1	17294	25-Year	1519.00	322.18	330.64		331.63	0.007670	9.01	347.46	108.35	0.60
Reach - 1	17294	50-Year	1804.00	322.18	331.15		332.23	0.007914	9.59	404.61	114.99	0.62
Reach - 1	17294	100-Year	2030.00	322.18	331.51		332.66	0.008132	10.03	446.90	119.51	0.63
Reach - 1	17020.0	2-Year	634.00	321.41	325.44	325.28	326.31	0.016965	7.86	121.43	76.87	0.78
Reach - 1	17020.0	10-Year	1134.00	321.41	326.31	326.31	327.62	0.020003	10.05	196.38	94.99	0.89
Reach - 1	17020.0	25-Year	1519.00	321.41	326.96	326.96	328.42	0.019295	10.91	262.47	108.48	0.89
Reach - 1	17020.0	50-Year	1804.00	321.41	327.35	327.35	328.94	0.019500	11.57	306.11	116.54	0.91

HEC-RAS Plan: Future (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	17020.0	100-Year	2030.00	321.41	327.65	327.65	329.32	0.019471	12.01	341.33	122.66	0.92
Reach - 1	16807	2-Year	634.00	318.05	321.79		322.60	0.017738	7.21	87.94	34.29	0.79
Reach - 1	16807	10-Year	1134.00	318.05	323.26	322.73	324.08	0.011775	7.51	213.76	117.29	0.68
Reach - 1	16807	25-Year	1519.00	318.05	324.07	323.37	324.90	0.009878	7.78	323.21	157.66	0.64
Reach - 1	16807	50-Year	1804.00	318.05	324.58		325.41	0.008832	7.91	407.83	168.05	0.62
Reach - 1	16807	100-Year	2030.00	318.05	324.94		325.77	0.008366	8.06	469.49	175.24	0.61
Reach - 1	16524.2	2-Year	675.00	313.59	319.04		319.67	0.006768	6.37	106.67	24.57	0.53
Reach - 1	16524.2	10-Year	1165.00	313.59	320.55	318.75	321.51	0.007231	7.97	201.93	108.79	0.57
Reach - 1	16524.2	25-Year	1559.00	313.59	321.41	319.89	322.49	0.007310	8.75	296.73	112.56	0.59
Reach - 1	16524.2	50-Year	1853.00	313.59	321.98	321.03	323.12	0.007243	9.18	362.04	115.07	0.59
Reach - 1	16524.2	100-Year	2075.00	313.59	322.44		323.59	0.006965	9.37	415.18	117.07	0.59
Reach - 1	16219	2-Year	675.00	307.88	314.14	314.14	315.69	0.032244	9.98	67.64	22.05	1.00
Reach - 1	16219	10-Year	1165.00	307.88	315.61	315.61	317.57	0.027083	11.25	108.28	38.25	0.97
Reach - 1	16219	25-Year	1559.00	307.88	316.62	316.62	318.75	0.022628	11.87	155.13	53.23	0.92
Reach - 1	16219	50-Year	1853.00	307.88	317.26	317.26	319.51	0.020830	12.31	191.85	61.54	0.90
Reach - 1	16219	100-Year	2075.00	307.88	317.60	317.60	320.03	0.021100	12.87	213.57	65.97	0.91
Reach - 1	16024.2	2-Year	675.00	304.23	309.99		310.53	0.005354	5.92	121.55	31.07	0.47
Reach - 1	16024.2	10-Year	1165.00	304.23	311.64		312.50	0.005823	7.50	178.42	40.52	0.52
Reach - 1	16024.2	25-Year	1559.00	304.23	312.62		313.73	0.006361	8.60	225.23	54.36	0.55
Reach - 1	16024.2	50-Year	1853.00	304.23	313.24		314.53	0.006730	9.33	261.57	62.05	0.58
Reach - 1	16024.2	100-Year	2075.00	304.23	313.67	311.39	315.09	0.006966	9.83	289.30	66.55	0.59
Reach - 1	15740	2-Year	675.00	297.95	303.37	303.37	304.88	2.445524	9.84	68.60	23.19	1.01
Reach - 1	15740	10-Year	1165.00	297.95	305.05	305.05	306.55	1.608710	9.87	118.78	39.52	0.86
Reach - 1	15740	25-Year	1559.00	297.95	305.92	305.92	307.41	1.175953	9.60	160.42	56.16	0.76
Reach - 1	15740	50-Year	1853.00	297.95	306.36	306.36	307.94	1.049711	9.60	186.77	63.90	0.73
Reach - 1	15740	100-Year	2075.00	297.95	306.61	306.61	308.32	1.000241	9.67	203.60	66.84	0.72
Reach - 1	15524.2	2-Year	675.00	293.18	300.45		300.74	0.001695	4.43	204.59	102.41	0.31
Reach - 1	15524.2	10-Year	1165.00	293.18	302.44		302.80	0.001595	5.15	474.62	184.27	0.31
Reach - 1	15524.2	25-Year	1559.00	293.18	303.20		303.64	0.001891	5.94	626.51	216.56	0.35
Reach - 1	15524.2	50-Year	1853.00	293.18	303.55		304.09	0.002247	6.64	707.48	243.00	0.38
Reach - 1	15524.2	100-Year	2075.00	293.18	303.78		304.40	0.002519	7.15	765.38	267.84	0.40

HEC-RAS Plan: Future (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	15291	2-Year	675.00	292.67	299.28		299.96	0.008051	6.63	101.84	24.02	0.57
Reach - 1	15291	10-Year	1165.00	292.67	301.99		302.30	0.002822	5.06	666.58	469.20	0.36
Reach - 1	15291	25-Year	1559.00	292.67	302.92		303.12	0.001968	4.63	1116.05	497.83	0.30
Reach - 1	15291	50-Year	1853.00	292.67	303.30		303.50	0.001977	4.80	1307.28	508.87	0.31
Reach - 1	15291	100-Year	2075.00	292.67	303.54		303.75	0.002018	4.95	1432.43	515.97	0.31
Reach - 1	15183.4	2-Year	675.00	292.43	299.02	296.48	299.35	0.002450	4.66	165.47	45.99	0.36
Reach - 1	15183.4	10-Year	1165.00	292.43	301.75	297.67	302.07	0.001490	4.82	452.46	230.46	0.30
Reach - 1	15183.4	25-Year	1559.00	292.43	302.44	298.49	302.86	0.001808	5.61	646.13	360.14	0.34
Reach - 1	15183.4	50-Year	1853.00	292.43	302.57	299.10	303.14	0.002470	6.62	696.58	436.28	0.40
Reach - 1	15183.4	100-Year	2075.00	292.43	302.66	299.49	303.35	0.002916	7.25	736.79	457.69	0.43
Reach - 1	15150.4		Bridge									
Reach - 1	15117.4	2-Year	675.00	292.69	298.03	296.74	298.62	0.006142	6.20	118.23	34.96	0.55
Reach - 1	15117.4	10-Year	1165.00	292.69	298.78	297.92	299.99	0.010350	8.94	145.83	38.23	0.73
Reach - 1	15117.4	25-Year	1559.00	292.69	299.13	298.75	301.00	0.014445	11.09	160.26	43.70	0.87
Reach - 1	15117.4	50-Year	1853.00	292.69	299.34	299.34	301.75	0.017709	12.62	169.84	46.98	0.97
Reach - 1	15117.4	100-Year	2075.00	292.69	299.84	299.84	302.31	0.016223	12.83	196.13	63.86	0.94
Reach - 1	15024.2	2-Year	687.00	291.44	297.93		298.20	0.001661	4.52	315.39	158.33	0.34
Reach - 1	15024.2	10-Year	1174.00	291.44	298.72		299.19	0.002600	6.18	450.92	178.49	0.43
Reach - 1	15024.2	25-Year	1570.00	291.44	299.19		299.81	0.003304	7.30	535.82	183.90	0.49
Reach - 1	15024.2	50-Year	1865.00	291.44	299.48		300.24	0.003867	8.13	590.71	194.43	0.54
Reach - 1	15024.2	100-Year	2086.00	291.44	299.65	298.65	300.65	0.004825	9.22	635.88	294.47	0.60
Reach - 1	14764	2-Year	687.00	290.94	296.83	295.80	297.41	0.006396	6.67	263.64	292.25	0.58
Reach - 1	14764	10-Year	1174.00	290.94	297.75		298.23	0.005677	6.95	589.28	421.93	0.55
Reach - 1	14764	25-Year	1570.00	290.94	298.29		298.70	0.005023	7.01	823.81	445.63	0.53
Reach - 1	14764	50-Year	1865.00	290.94	298.61		299.00	0.004851	7.16	969.29	455.18	0.53
Reach - 1	14764	100-Year	2086.00	290.94	298.83		299.22	0.004768	7.28	1070.73	461.72	0.53
Reach - 1	14524.2	2-Year	687.00	290.48	296.55		296.70	0.001258	3.74	636.06	428.25	0.29
Reach - 1	14524.2	10-Year	1174.00	290.48	297.33		297.50	0.001518	4.51	980.25	450.97	0.33
Reach - 1	14524.2	25-Year	1570.00	290.48	297.74		297.95	0.001863	5.22	1167.41	477.94	0.36
Reach - 1	14524.2	50-Year	1865.00	290.48	298.00		298.24	0.002042	5.61	1295.31	483.48	0.38
Reach - 1	14524.2	100-Year	2086.00	290.48	298.19		298.44	0.002145	5.87	1387.86	485.55	0.40

HEC-RAS Plan: Future (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	14034.8	2-Year	687.00	287.46	296.57		296.58	0.000056	1.07	2273.47	443.19	0.07
Reach - 1	14034.8	10-Year	1174.00	287.46	297.31		297.32	0.000113	1.61	2605.46	463.69	0.10
Reach - 1	14034.8	25-Year	1570.00	287.46	297.67		297.69	0.000172	2.04	2779.06	480.57	0.12
Reach - 1	14034.8	50-Year	1865.00	287.46	297.90		297.93	0.000218	2.34	2891.24	488.38	0.13
Reach - 1	14034.8	100-Year	2086.00	287.46	298.07		298.10	0.000254	2.55	2971.68	493.11	0.14
Reach - 1	13555.6	2-Year	687.00	287.38	296.55		296.55	0.000053	1.05	2279.10	419.77	0.06
Reach - 1	13555.6	10-Year	1174.00	287.38	297.25		297.27	0.000109	1.59	2579.50	434.34	0.09
Reach - 1	13555.6	25-Year	1570.00	287.38	297.59		297.61	0.000168	2.02	2728.73	444.85	0.12
Reach - 1	13555.6	50-Year	1865.00	287.38	297.80		297.83	0.000218	2.33	2822.08	451.62	0.13
Reach - 1	13555.6	100-Year	2086.00	287.38	297.95		297.98	0.000256	2.56	2888.28	456.20	0.15
Reach - 1	13024.2	2-Year	687.00	287.30	296.52		296.53	0.000055	1.08	2217.89	413.43	0.07
Reach - 1	13024.2	10-Year	1174.00	287.30	297.19		297.21	0.000114	1.63	2497.40	419.17	0.10
Reach - 1	13024.2	25-Year	1570.00	287.30	297.50		297.52	0.000177	2.07	2626.60	423.80	0.12
Reach - 1	13024.2	50-Year	1865.00	287.30	297.68		297.71	0.000231	2.40	2703.28	426.53	0.14
Reach - 1	13024.2	100-Year	2086.00	287.30	297.80		297.84	0.000273	2.63	2756.18	428.57	0.15
Reach - 1	12524.2	2-Year	687.00	287.22	296.50		296.50	0.000042	0.94	2639.56	493.90	0.06
Reach - 1	12524.2	10-Year	1174.00	287.22	297.15		297.15	0.000088	1.43	2966.29	509.48	0.08
Reach - 1	12524.2	25-Year	1570.00	287.22	297.43		297.44	0.000137	1.82	3109.70	511.94	0.11
Reach - 1	12524.2	50-Year	1865.00	287.22	297.58		297.60	0.000179	2.11	3190.76	513.04	0.12
Reach - 1	12524.2	100-Year	2086.00	287.22	297.69		297.71	0.000213	2.32	3245.15	513.78	0.13
Reach - 1	12024.2	2-Year	687.00	287.14	296.49		296.49	0.000015	0.56	4511.96	738.65	0.03
Reach - 1	12024.2	10-Year	1174.00	287.14	297.13		297.13	0.000031	0.86	4983.96	740.13	0.05
Reach - 1	12024.2	25-Year	1570.00	287.14	297.40		297.40	0.000049	1.10	5183.62	740.75	0.06
Reach - 1	12024.2	50-Year	1865.00	287.14	297.54		297.55	0.000065	1.27	5293.72	741.10	0.07
Reach - 1	12024.2	100-Year	2086.00	287.14	297.64		297.65	0.000077	1.40	5366.51	741.33	0.08
Reach - 1	11747.1	2-Year	687.00	284.16	296.49		296.49	0.000004	0.39	7366.75	1115.48	0.02
Reach - 1	11747.1	10-Year	1174.00	284.16	297.12		297.12	0.000010	0.60	8081.26	1131.64	0.03
Reach - 1	11747.1	25-Year	1570.00	284.16	297.39		297.39	0.000016	0.77	8385.01	1139.38	0.04
Reach - 1	11747.1	50-Year	1865.00	284.16	297.54		297.54	0.000021	0.90	8552.66	1151.24	0.05
Reach - 1	11747.1	100-Year	2086.00	284.16	297.63		297.64	0.000026	0.99	8664.07	1154.19	0.05
Reach - 1	11352.3	2-Year	823.00	273.46	296.48	277.81	296.49	0.000002	0.21	3993.25	578.59	0.01
Reach - 1	11352.3	10-Year	1773.00	273.46	297.12	279.38	297.12	0.000006	0.41	4441.90	595.37	0.02

HEC-RAS Plan: Future (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	11352.3	25-Year	2353.00	273.46	297.38	280.09	297.39	0.000010	0.53	4600.37	602.39	0.03
Reach - 1	11352.3	50-Year	2685.00	273.46	297.53	280.44	297.53	0.000013	0.60	4687.88	606.02	0.03
Reach - 1	11352.3	100-Year	2928.00	273.46	297.62	280.69	297.63	0.000015	0.65	4745.68	608.25	0.04
Reach - 1	11341.3		Inl Struct									
Reach - 1	11330.3	2-Year	823.00	277.80	282.25	282.25	283.72	0.012607	10.21	128.05	60.96	0.90
Reach - 1	11330.3	10-Year	1773.00	277.80	284.33	284.33	286.39	0.011298	12.80	280.99	86.14	0.92
Reach - 1	11330.3	25-Year	2353.00	277.80	285.29	285.29	287.62	0.011029	13.95	369.59	98.02	0.93
Reach - 1	11330.3	50-Year	2685.00	277.80	285.80	285.80	288.25	0.010810	14.47	421.25	104.32	0.93
Reach - 1	11330.3	100-Year	2928.00	277.80	286.17	286.17	288.68	0.010547	14.77	461.18	108.83	0.93
Reach - 1	11228.2	2-Year	823.00	274.45	279.26	279.26	280.91	0.016072	10.38	94.39	51.37	0.89
Reach - 1	11228.2	10-Year	1773.00	274.45	281.83	281.83	283.57	0.010639	11.62	308.09	119.37	0.79
Reach - 1	11228.2	25-Year	2353.00	274.45	282.68	282.68	284.59	0.010743	12.64	412.67	126.14	0.81
Reach - 1	11228.2	50-Year	2685.00	274.45	283.05	283.05	285.11	0.011248	13.35	459.66	130.13	0.83
Reach - 1	11228.2	100-Year	2928.00	274.45	283.33	283.33	285.47	0.011387	13.75	496.87	133.27	0.84
Reach - 1	10952.4	2-Year	823.00	270.52	274.54	274.54	275.79	0.015113	9.17	111.07	59.93	0.94
Reach - 1	10952.4	10-Year	1773.00	270.52	276.27	276.27	278.17	0.013212	11.67	227.14	75.37	0.95
Reach - 1	10952.4	25-Year	2353.00	270.52	276.83	276.83	279.38	0.015435	13.60	271.29	83.76	1.05
Reach - 1	10952.4	50-Year	2685.00	270.52	277.84	277.84	279.96	0.010436	12.58	380.85	123.84	0.89
Reach - 1	10952.4	100-Year	2928.00	270.52	277.86	277.86	280.36	0.012264	13.67	383.17	124.10	0.96
Reach - 1	10524.2	2-Year	823.00	263.63	268.94	268.02	269.73	0.007494	7.33	164.15	124.57	0.66
Reach - 1	10524.2	10-Year	1773.00	263.63	270.18	270.18	271.56	0.010888	10.31	343.29	168.02	0.82
Reach - 1	10524.2	25-Year	2353.00	263.63	270.85	270.85	272.42	0.011031	11.31	469.45	211.78	0.85
Reach - 1	10524.2	50-Year	2685.00	263.63	271.32	271.32	272.82	0.009897	11.31	575.39	233.69	0.81
Reach - 1	10524.2	100-Year	2928.00	263.63	271.57	271.57	273.07	0.009682	11.49	634.40	240.11	0.81
Reach - 1	10136.9	2-Year	823.00	261.02	269.01		269.07	0.000438	2.50	1210.57	612.09	0.18
Reach - 1	10136.9	10-Year	1773.00	261.02	270.14		270.24	0.000732	3.61	1948.08	694.77	0.23
Reach - 1	10136.9	25-Year	2353.00	261.02	270.84		270.95	0.000747	3.87	2452.32	735.52	0.24
Reach - 1	10136.9	50-Year	2685.00	261.02	271.28		271.38	0.000718	3.93	2775.69	760.51	0.24
Reach - 1	10136.9	100-Year	2928.00	261.02	271.86		271.94	0.000585	3.70	3227.54	791.30	0.22
Reach - 2	10024.2	2-Year	929.00	262.00	268.96		269.00	0.000811	2.59	1278.32	627.94	0.20
Reach - 2	10024.2	10-Year	2048.00	262.00	270.04		270.12	0.001325	3.73	2008.21	707.02	0.26

HEC-RAS Plan: Future (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 2	10024.2	25-Year	2731.00	262.00	270.75		270.83	0.001289	3.95	2521.73	749.05	0.26
Reach - 2	10024.2	50-Year	3124.00	262.00	271.19		271.26	0.001211	3.99	2855.44	777.09	0.26
Reach - 2	10024.2	100-Year	3395.00	262.00	271.78		271.85	0.000981	3.78	3350.74	883.70	0.23
Reach - 2	9691.7	2-Year	929.00	260.63	267.90	266.14	268.44	0.004010	6.34	308.47	436.77	0.47
Reach - 2	9691.7	10-Year	2048.00	260.63	269.50	268.50	269.64	0.001577	4.69	1655.35	527.51	0.31
Reach - 2	9691.7	25-Year	2731.00	260.63	270.17	268.50	270.33	0.001729	5.21	2022.65	564.52	0.33
Reach - 2	9691.7	50-Year	3124.00	260.63	270.61	268.51	270.77	0.001757	5.45	2274.26	578.85	0.33
Reach - 2	9691.7	100-Year	3395.00	260.63	271.35	268.51	271.47	0.001305	4.96	2708.21	613.72	0.29
Reach - 2	9676.2		Bridge									
Reach - 2	9660.7	2-Year	929.00	260.97	266.57	266.47	268.20	0.016823	10.29	101.20	256.44	0.91
Reach - 2	9660.7	10-Year	2048.00	260.97	269.20	268.01	269.42	0.002674	5.74	1326.06	488.97	0.39
Reach - 2	9660.7	25-Year	2731.00	260.97	270.07	268.23	270.28	0.002356	5.86	1779.84	539.43	0.38
Reach - 2	9660.7	50-Year	3124.00	260.97	270.53	268.48	270.73	0.002232	5.93	2033.94	565.70	0.37
Reach - 2	9660.7	100-Year	3395.00	260.97	270.83	268.62	271.04	0.002257	6.11	2204.55	575.94	0.37
Reach - 2	9524.2	2-Year	929.00	259.17	265.89		266.41	0.005611	5.98	226.89	125.44	0.47
Reach - 2	9524.2	10-Year	2048.00	259.17	268.56		268.96	0.003406	6.13	1011.02	467.62	0.39
Reach - 2	9524.2	25-Year	2731.00	259.17	269.61		269.91	0.002623	5.86	1514.04	494.02	0.35
Reach - 2	9524.2	50-Year	3124.00	259.17	270.13		270.40	0.002361	5.78	1771.32	499.71	0.34
Reach - 2	9524.2	100-Year	3395.00	259.17	270.46		270.72	0.002233	5.75	1939.33	505.22	0.33
Reach - 2	9024.2	2-Year	929.00	256.05	264.15		264.49	0.002659	4.79	253.23	87.81	0.33
Reach - 2	9024.2	10-Year	2048.00	256.05	266.64		267.24	0.003365	6.71	551.84	154.72	0.40
Reach - 2	9024.2	25-Year	2731.00	256.05	267.55		268.29	0.003862	7.67	697.37	165.81	0.43
Reach - 2	9024.2	50-Year	3124.00	256.05	267.99		268.81	0.004124	8.17	772.08	169.94	0.45
Reach - 2	9024.2	100-Year	3395.00	256.05	268.28		269.15	0.004296	8.49	820.77	172.58	0.46
Reach - 2	8588.6	2-Year	929.00	255.57	261.37		262.30	0.011742	7.76	120.27	34.54	0.66
Reach - 2	8588.6	10-Year	2048.00	255.57	264.44	263.14	265.26	0.006355	7.99	562.18	257.37	0.53
Reach - 2	8588.6	25-Year	2731.00	255.57	265.73		266.39	0.004827	7.77	934.43	335.32	0.47
Reach - 2	8588.6	50-Year	3124.00	255.57	266.32		266.92	0.004278	7.65	1137.28	350.09	0.45
Reach - 2	8588.6	100-Year	3395.00	255.57	266.65		267.23	0.004108	7.69	1255.37	358.28	0.44
Reach - 2	8024.2	2-Year	929.00	250.67	260.06		260.30	0.001454	4.00	272.40	53.63	0.26
Reach - 2	8024.2	10-Year	2048.00	250.67	263.65		263.87	0.001059	4.42	1223.19	509.40	0.23

HEC-RAS Plan: Future (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 2	8024.2	25-Year	2731.00	250.67	265.23		265.37	0.000738	4.02	2119.37	589.97	0.20
Reach - 2	8024.2	50-Year	3124.00	250.67	265.86		265.99	0.000686	4.00	2499.49	629.01	0.19
Reach - 2	8024.2	100-Year	3395.00	250.67	266.20		266.32	0.000673	4.03	2717.53	643.76	0.19
Reach - 2	7524.2	2-Year	941.00	249.35	259.53		259.70	0.000943	3.44	501.07	439.12	0.21
Reach - 2	7524.2	10-Year	2077.00	249.35	263.57		263.60	0.000233	2.22	3101.23	713.84	0.11
Reach - 2	7524.2	25-Year	2777.00	249.35	265.15		265.17	0.000185	2.14	4284.53	783.10	0.10
Reach - 2	7524.2	50-Year	3203.00	249.35	265.77		265.80	0.000183	2.19	4775.13	792.74	0.10
Reach - 2	7524.2	100-Year	3470.00	249.35	266.11		266.14	0.000184	2.23	5045.62	798.42	0.10
Reach - 3	7024.2	2-Year	956.00	250.01	259.04		259.18	0.001131	3.42	695.75	428.60	0.22
Reach - 3	7024.2	10-Year	2116.00	250.01	263.46		263.48	0.000221	2.07	2924.87	563.29	0.11
Reach - 3	7024.2	25-Year	2836.00	250.01	265.06		265.08	0.000187	2.07	3856.67	604.51	0.10
Reach - 3	7024.2	50-Year	3294.00	250.01	265.67		265.70	0.000213	2.28	4268.53	736.35	0.11
Reach - 3	7024.2	100-Year	3576.00	250.01	266.01		266.04	0.000214	2.33	4520.76	753.25	0.11
Reach - 3	6790.2	2-Year	956.00	249.25	258.88		258.98	0.000580	2.56	426.23	98.94	0.16
Reach - 3	6790.2	10-Year	2116.00	249.25	263.26		263.40	0.000507	3.22	1147.87	320.39	0.16
Reach - 3	6790.2	25-Year	2836.00	249.25	264.84		265.00	0.000511	3.51	1743.15	419.92	0.17
Reach - 3	6790.2	50-Year	3294.00	249.25	265.43		265.61	0.000563	3.79	1998.16	462.82	0.18
Reach - 3	6790.2	100-Year	3576.00	249.25	265.75		265.94	0.000599	3.97	2153.41	499.78	0.18
Reach - 3	6733.5	2-Year	966.00	250.49	258.87	253.12	258.94	0.000319	2.14	455.86	208.60	0.14
Reach - 3	6733.5	10-Year	2334.00	250.49	263.20	254.88	263.37	0.000403	3.26	726.62	335.57	0.17
Reach - 3	6733.5	25-Year	3132.00	250.49	264.85	255.76	264.95	0.000275	2.94	2380.01	455.93	0.14
Reach - 3	6733.5	50-Year	3639.00	250.49	265.43	256.25	265.56	0.000312	3.22	2662.43	527.04	0.15
Reach - 3	6733.5	100-Year	3999.00	250.49	265.76	256.57	265.89	0.000334	3.39	2836.08	551.22	0.16
Reach - 3	6670.0		Culvert									
Reach - 3	6606.5	2-Year	966.00	249.54	258.67	252.17	258.73	0.000232	1.95	502.84	240.75	0.12
Reach - 3	6606.5	10-Year	2334.00	249.54	262.51	253.94	262.67	0.000375	3.19	742.63	346.29	0.16
Reach - 3	6606.5	25-Year	3132.00	249.54	264.16	254.81	264.26	0.000252	2.85	2501.22	475.17	0.14
Reach - 3	6606.5	50-Year	3639.00	249.54	265.03	255.29	265.13	0.000255	2.99	2965.57	606.67	0.14
Reach - 3	6606.5	100-Year	3999.00	249.54	265.51	255.60	265.63	0.000272	3.16	3276.79	672.99	0.14
Reach - 3	6606.4	2-Year	966.00	249.54	258.56	252.39	258.69	0.000569	2.92	362.35	54.21	0.17
Reach - 3	6606.4	10-Year	2334.00	249.54	262.27	254.65	262.59	0.000932	4.71	979.08	652.27	0.23

HEC-RAS Plan: Future (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 3	6606.4	25-Year	3132.00	249.54	263.94	255.75	264.19	0.000750	4.58	2180.92	753.79	0.21
Reach - 3	6606.4	50-Year	3639.00	249.54	264.87	256.41	265.08	0.000645	4.43	2899.15	790.20	0.20
Reach - 3	6606.4	100-Year	3999.00	249.54	265.39	256.86	265.58	0.000611	4.41	3315.74	816.43	0.20
Reach - 3	6268.9		Culvert									
Reach - 3	5547.5	2-Year	966.00	250.00	258.31	254.95	258.60	0.001737	4.42	292.60	123.75	0.31
Reach - 3	5547.5	10-Year	2334.00	250.00	261.69	257.53	262.23	0.002014	6.35	673.76	747.61	0.36
Reach - 3	5547.5	25-Year	3132.00	250.00	263.69	258.75	263.74	0.000317	2.86	2972.43	893.51	0.15
Reach - 3	5547.5	50-Year	3639.00	250.00	264.70	259.33	264.73	0.000193	2.36	3894.17	942.46	0.12
Reach - 3	5547.5	100-Year	3999.00	250.00	265.22	259.78	265.25	0.000164	2.23	4391.77	969.58	0.11
Reach - 3	5486.5	2-Year	966.00	249.08	258.13	253.73	258.47	0.001764	4.84	277.22	108.39	0.30
Reach - 3	5486.5	10-Year	2334.00	249.08	261.71	257.14	262.00	0.001365	5.42	1032.79	551.28	0.28
Reach - 3	5486.5	25-Year	3132.00	249.08	263.65	258.66	263.72	0.000427	3.36	2581.89	834.83	0.16
Reach - 3	5486.5	50-Year	3639.00	249.08	264.68	259.36	264.72	0.000251	2.70	3495.02	940.82	0.12
Reach - 3	5486.5	100-Year	3999.00	249.08	265.21	259.83	265.24	0.000209	2.52	3994.72	954.93	0.11
Reach - 3	5420.5	2-Year	966.00	248.52	258.08	252.77	258.33	0.001248	4.09	305.12	117.84	0.24
Reach - 3	5420.5	10-Year	2334.00	248.52	261.49	255.89	261.88	0.001546	5.68	848.09	471.79	0.29
Reach - 3	5420.5	25-Year	3132.00	248.52	263.62	257.46	263.69	0.000396	3.20	2707.44	801.81	0.15
Reach - 3	5420.5	50-Year	3639.00	248.52	264.66	258.34	264.70	0.000243	2.63	3596.17	920.31	0.12
Reach - 3	5420.5	100-Year	3999.00	248.52	265.19	258.85	265.22	0.000205	2.47	4090.40	946.40	0.11
Reach - 3	5370.5	2-Year	966.00	249.58	257.95	253.60	258.25	0.001579	4.56	285.77	133.23	0.29
Reach - 3	5370.5	10-Year	2334.00	249.58	261.53	256.71	261.77	0.001117	4.92	1527.50	712.94	0.26
Reach - 3	5370.5	25-Year	3132.00	249.58	263.62	257.91	263.66	0.000277	2.74	3775.85	1121.37	0.13
Reach - 3	5370.5	50-Year	3639.00	249.58	264.66	258.83	264.69	0.000167	2.24	4956.64	1138.25	0.10
Reach - 3	5370.5	100-Year	3999.00	249.58	265.19	260.55	265.21	0.000140	2.09	5559.47	1139.71	0.09
Reach - 3	5319.5	2-Year	966.00	249.46	258.04	253.94	258.14	0.000768	3.09	925.58	371.78	0.20
Reach - 3	5319.5	10-Year	2334.00	249.46	261.61	257.16	261.68	0.000501	3.22	2223.01	451.55	0.17
Reach - 3	5319.5	25-Year	3132.00	249.46	263.59	257.54	263.64	0.000395	3.18	2961.27	665.73	0.15
Reach - 3	5319.5	50-Year	3639.00	249.46	264.61	258.09	264.67	0.000370	3.24	3346.92	704.92	0.15
Reach - 3	5319.5	100-Year	3999.00	249.46	265.14	258.25	265.20	0.000376	3.35	3543.56	711.13	0.15
Reach - 3	5270.5	2-Year	966.00	250.41	258.02	254.00	258.09	0.000656	2.75	1028.20	427.85	0.18
Reach - 3	5270.5	10-Year	2334.00	250.41	261.60	256.87	261.65	0.000376	2.73	2499.58	507.54	0.15

HEC-RAS Plan: Future (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 3	5270.5	25-Year	3132.00	250.41	263.58	257.43	263.62	0.000293	2.69	3322.38	693.93	0.13
Reach - 3	5270.5	50-Year	3639.00	250.41	264.61	257.87	264.65	0.000274	2.74	3750.86	727.12	0.13
Reach - 3	5270.5	100-Year	3999.00	250.41	265.13	258.11	265.18	0.000279	2.84	3969.23	750.70	0.13
Reach - 3	5219.5	2-Year	966.00	249.89	258.00	253.74	258.06	0.000550	2.56	1068.56	423.40	0.17
Reach - 3	5219.5	10-Year	2334.00	249.89	261.58	256.76	261.63	0.000382	2.78	2358.99	523.24	0.15
Reach - 3	5219.5	25-Year	3132.00	249.89	263.56	257.30	263.61	0.000313	2.80	3071.40	788.61	0.14
Reach - 3	5219.5	50-Year	3639.00	249.89	264.60	257.57	264.64	0.000255	2.66	3898.86	840.53	0.13
Reach - 3	5219.5	100-Year	3999.00	249.89	265.12	257.79	265.16	0.000261	2.76	4120.64	851.69	0.13
Reach - 3	5169.5	2-Year	966.00	249.88	257.98	254.15	258.03	0.000461	2.44	1075.74	393.81	0.16
Reach - 3	5169.5	10-Year	2334.00	249.88	261.55	255.93	261.61	0.000424	3.02	2108.66	552.41	0.16
Reach - 3	5169.5	25-Year	3132.00	249.88	263.52	256.54	263.59	0.000373	3.16	2680.47	683.98	0.15
Reach - 3	5169.5	50-Year	3639.00	249.88	264.58	256.84	264.62	0.000261	2.78	3816.99	711.25	0.13
Reach - 3	5169.5	100-Year	3999.00	249.88	265.13	257.09	265.15	0.000104	1.80	5275.38	758.13	0.08
Reach - 3	5118.5	2-Year	966.00	249.56	257.92	254.19	258.00	0.000660	2.88	869.07	332.60	0.19
Reach - 3	5118.5	10-Year	2334.00	249.56	261.49	256.55	261.58	0.000560	3.47	1780.47	477.39	0.19
Reach - 3	5118.5	25-Year	3132.00	249.56	263.49	257.30	263.57	0.000411	3.33	2522.26	742.07	0.16
Reach - 3	5118.5	50-Year	3639.00	249.56	264.58	257.57	264.61	0.000174	2.29	4523.45	802.10	0.11
Reach - 3	5118.5	100-Year	3999.00	249.56	265.11	257.77	265.14	0.000159	2.24	4957.74	823.72	0.10
Reach - 3	5067.5	2-Year	966.00	249.11	257.82		257.96	0.000852	3.47	631.91	212.25	0.21
Reach - 3	5067.5	10-Year	2334.00	249.11	261.42		261.55	0.000681	3.94	1695.76	435.03	0.20
Reach - 3	5067.5	25-Year	3132.00	249.11	263.48		263.54	0.000355	3.16	2881.74	707.20	0.15
Reach - 3	5067.5	50-Year	3639.00	249.11	264.55		264.59	0.000247	2.77	3683.32	792.46	0.13
Reach - 3	5067.5	100-Year	3999.00	249.11	265.09		265.13	0.000213	2.64	4122.78	845.68	0.12
Reach - 3	5018.5	2-Year	966.00	249.02	257.74	253.13	257.91	0.001010	3.79	561.93	167.36	0.23
Reach - 3	5018.5	10-Year	2334.00	249.02	261.27	256.86	261.50	0.001064	4.91	1166.96	273.74	0.25
Reach - 3	5018.5	25-Year	3132.00	249.02	263.28	257.70	263.50	0.000917	5.06	1561.44	456.04	0.24
Reach - 3	5018.5	50-Year	3639.00	249.02	264.48	258.15	264.57	0.000453	3.76	2664.31	615.51	0.17
Reach - 3	5018.5	100-Year	3999.00	249.02	265.04	258.44	265.11	0.000387	3.56	3012.56	651.38	0.16
Reach - 3	4972.5	2-Year	966.00	249.35	257.62		257.85	0.001276	4.17	408.30	122.32	0.26
Reach - 3	4972.5	10-Year	2334.00	249.35	261.04		261.42	0.001558	5.83	894.83	166.70	0.30
Reach - 3	4972.5	25-Year	3132.00	249.35	263.08		263.44	0.001287	5.92	1236.06	167.27	0.28
Reach - 3	4972.5	50-Year	3639.00	249.35	264.16		264.51	0.001214	6.05	1427.20	194.35	0.28

HEC-RAS Plan: Future (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 3	4972.5	100-Year	3999.00	249.35	264.68		265.05	0.001232	6.24	1531.22	203.32	0.28
Reach - 3	4922.5	2-Year	966.00	249.34	257.51		257.78	0.001395	4.25	286.81	58.45	0.27
Reach - 3	4922.5	10-Year	2334.00	249.34	260.65		261.30	0.002321	6.87	510.80	83.52	0.37
Reach - 3	4922.5	25-Year	3132.00	249.34	262.54		263.31	0.002284	7.59	743.46	144.35	0.37
Reach - 3	4922.5	50-Year	3639.00	249.34	263.63		264.40	0.002115	7.71	905.42	160.76	0.37
Reach - 3	4922.5	100-Year	3999.00	249.34	264.14		264.93	0.002147	7.96	990.84	175.94	0.37
Reach - 3	4871.5	2-Year	966.00	248.79	257.48		257.71	0.001059	3.92	312.53	59.56	0.25
Reach - 3	4871.5	10-Year	2334.00	248.79	260.59		261.18	0.001864	6.48	519.62	73.74	0.34
Reach - 3	4871.5	25-Year	3132.00	248.79	262.51		263.18	0.001778	7.05	802.28	205.61	0.34
Reach - 3	4871.5	50-Year	3639.00	248.79	263.68		264.25	0.001494	6.84	1057.57	243.12	0.32
Reach - 3	4871.5	100-Year	3999.00	248.79	264.22		264.77	0.001426	6.85	1192.71	253.07	0.31
Reach - 3	4817.5	2-Year	966.00	249.04	257.33	253.17	257.63	0.001553	4.48	270.39	57.64	0.29
Reach - 3	4817.5	10-Year	2334.00	249.04	260.29	256.13	261.04	0.002656	7.32	463.59	73.05	0.40
Reach - 3	4817.5	25-Year	3132.00	249.04	262.29	257.39	263.06	0.002293	7.65	725.24	166.86	0.38
Reach - 3	4817.5	50-Year	3639.00	249.04	263.48	258.12	264.15	0.001924	7.44	925.55	194.84	0.36
Reach - 3	4817.5	100-Year	3999.00	249.04	264.00	258.59	264.67	0.001888	7.56	1020.79	217.76	0.35
Reach - 3	4766.5	2-Year	966.00	248.79	257.32	252.84	257.54	0.001125	3.76	296.02	61.75	0.25
Reach - 3	4766.5	10-Year	2334.00	248.79	260.32	255.43	260.87	0.001872	6.13	486.28	78.46	0.34
Reach - 3	4766.5	25-Year	3132.00	248.79	262.31	256.65	262.91	0.001685	6.55	699.80	135.29	0.33
Reach - 3	4766.5	50-Year	3639.00	248.79	263.45	257.30	264.03	0.001527	6.62	903.42	138.12	0.32
Reach - 3	4766.5	100-Year	3999.00	248.79	263.95	257.73	264.56	0.001572	6.88	972.00	138.92	0.33
Reach - 3	4696.5	2-Year	955.00	249.54	257.33	252.57	257.43	0.000546	2.68	431.02	98.14	0.18
Reach - 3	4696.5	10-Year	2132.00	249.54	260.40	254.27	260.63	0.000727	3.98	684.56	162.50	0.22
Reach - 3	4696.5	25-Year	2860.00	249.54	262.40	255.20	262.67	0.000685	4.37	849.42	180.89	0.22
Reach - 3	4696.5	50-Year	3336.00	249.54	263.61	255.74	263.77	0.000450	3.77	1467.82	250.21	0.18
Reach - 3	4696.5	100-Year	3706.00	249.54	264.12	256.10	264.29	0.000445	3.85	1603.32	329.06	0.18
Reach - 3	4645.0		Culvert									
Reach - 3	4593.5	2-Year	955.00	249.19	257.18	251.41	257.23	0.000213	1.85	565.42	102.46	0.12
Reach - 3	4593.5	10-Year	2132.00	249.19	259.72	252.73	259.86	0.000404	3.08	766.76	188.91	0.17
Reach - 3	4593.5	25-Year	2860.00	249.19	261.03	253.41	261.21	0.000441	3.49	1228.38	215.94	0.18
Reach - 3	4593.5	50-Year	3336.00	249.19	261.82	253.83	262.02	0.000466	3.76	1403.87	228.22	0.19

HEC-RAS Plan: Future (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 3	4593.5	100-Year	3706.00	249.19	262.47	254.14	262.69	0.000472	3.91	1555.79	238.35	0.19
Reach - 3	4500.596	2-Year	955.00	248.23	257.01	252.70	257.17	0.001082	3.23	346.55	106.12	0.24
Reach - 3	4500.596	10-Year	2132.00	248.23	259.45	254.90	259.75	0.001514	4.58	624.27	165.75	0.30
Reach - 3	4500.596	25-Year	2860.00	248.23	260.72	255.97	261.08	0.001589	5.06	776.00	172.28	0.32
Reach - 3	4500.596	50-Year	3336.00	248.23	261.50	256.65	261.89	0.001607	5.31	870.76	176.77	0.32
Reach - 3	4500.596	100-Year	3706.00	248.23	262.16	257.06	262.56	0.001571	5.42	952.20	272.91	0.32
Reach - 3	4486		Bridge									
Reach - 3	4452.7	2-Year	955.00	248.28	255.67	251.16	255.85	0.000889	3.44	304.16	198.18	0.23
Reach - 3	4452.7	10-Year	2132.00	248.28	257.88	253.12	258.37	0.001719	5.72	424.80	442.61	0.33
Reach - 3	4452.7	25-Year	2860.00	248.28	259.14	254.22	259.79	0.001977	6.67	495.52	510.10	0.36
Reach - 3	4452.7	50-Year	3336.00	248.28	260.01	254.87	260.75	0.002041	7.13	543.90	641.35	0.37
Reach - 3	4452.7	100-Year	3706.00	248.28	260.87	255.33	261.65	0.001950	7.32	592.35	707.69	0.37
Reach - 3	4387.2		Culvert									
Reach - 3	4321.7	2-Year	955.00	249.27	255.39	252.15	255.67	0.001760	4.26	238.35	60.21	0.31
Reach - 3	4321.7	10-Year	2132.00	249.27	256.95	254.10	257.80	0.003973	7.47	319.06	220.29	0.48
Reach - 3	4321.7	25-Year	2860.00	249.27	257.67	255.14	258.93	0.005203	9.09	358.12	351.65	0.56
Reach - 3	4321.7	50-Year	3336.00	249.27	258.21	255.79	259.70	0.005704	9.92	387.24	409.59	0.59
Reach - 3	4321.7	100-Year	3706.00	249.27	259.08	256.24	260.58	0.005063	9.96	435.50	449.41	0.56
Reach - 3	4294.441	2-Year	955.00	246.73	255.39		255.59	0.001283	3.68	446.87	240.57	0.26
Reach - 3	4294.441	10-Year	2132.00	246.73	257.11		257.48	0.002059	5.42	978.06	331.44	0.35
Reach - 3	4294.441	25-Year	2860.00	246.73	258.01		258.42	0.002154	5.97	1277.98	336.90	0.36
Reach - 3	4294.441	50-Year	3336.00	246.73	258.66		259.07	0.002059	6.13	1498.32	340.86	0.36
Reach - 3	4294.441	100-Year	3706.00	246.73	259.59		259.93	0.001616	5.79	1816.30	346.50	0.32
Reach - 3	4000.0	2-Year	955.00	248.37	254.80		254.96	0.004026	4.80	702.39	411.54	0.41
Reach - 3	4000.0	10-Year	2132.00	248.37	256.61		256.72	0.002589	4.82	1564.29	513.16	0.35
Reach - 3	4000.0	25-Year	2860.00	248.37	257.61		257.71	0.002038	4.75	2094.53	548.47	0.32
Reach - 3	4000.0	50-Year	3336.00	248.37	258.34		258.43	0.001666	4.59	2503.96	574.63	0.29
Reach - 3	4000.0	100-Year	3706.00	248.37	259.39		259.46	0.001083	4.04	3117.60	588.67	0.24
Reach - 3	3500.0	2-Year	955.00	246.98	253.85		253.89	0.001264	2.83	1414.11	771.15	0.24
Reach - 3	3500.0	10-Year	2132.00	246.98	256.17		256.19	0.000533	2.42	3404.29	915.57	0.16

HEC-RAS Plan: Future (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 3	3500.0	25-Year	2860.00	246.98	257.26		257.28	0.000431	2.40	4407.31	927.69	0.15
Reach - 3	3500.0	50-Year	3336.00	246.98	258.05		258.07	0.000365	2.35	5151.44	954.62	0.14
Reach - 3	3500.0	100-Year	3706.00	246.98	259.20		259.22	0.000247	2.10	6263.56	971.00	0.12
Reach - 3	3185.2	2-Year	971.00	246.10	253.02	250.21	253.31	0.002113	4.29	235.61	721.65	0.34
Reach - 3	3185.2	10-Year	2165.00	246.10	254.93	252.14	255.64	0.003474	6.81	371.64	874.58	0.45
Reach - 3	3185.2	25-Year	2909.00	246.10	255.67	253.11	256.67	0.004384	8.17	433.97	892.45	0.52
Reach - 3	3185.2	50-Year	3396.00	246.10	256.35	253.71	257.46	0.004398	8.66	494.93	907.51	0.53
Reach - 3	3185.2	100-Year	3779.00	246.10	257.84	254.15	258.76	0.002981	7.96	641.69	1072.19	0.45
Reach - 3	3157.2		Bridge									
Reach - 3	3129.2	2-Year	971.00	245.86	252.68	249.97	252.97	0.002271	4.39	229.51	689.09	0.35
Reach - 3	3129.2	10-Year	2165.00	245.86	253.48	251.91	254.56	0.006761	8.37	280.13	830.26	0.61
Reach - 3	3129.2	25-Year	2909.00	245.86	253.98	252.88	255.60	0.009167	10.29	315.54	850.48	0.72
Reach - 3	3129.2	50-Year	3396.00	245.86	254.39	253.47	256.30	0.010010	11.22	347.11	864.25	0.77
Reach - 3	3129.2	100-Year	3779.00	245.86	254.58	253.93	256.80	0.011206	12.10	362.81	870.78	0.81
Reach - 3	2957.4	2-Year	971.00	243.96	252.72		252.73	0.000258	1.65	2159.40	844.11	0.11
Reach - 3	2957.4	10-Year	2165.00	243.96	253.80		253.82	0.000494	2.53	3075.46	859.23	0.16
Reach - 3	2957.4	25-Year	2909.00	243.96	254.54		254.57	0.000518	2.76	3719.12	868.39	0.17
Reach - 3	2957.4	50-Year	3396.00	243.96	255.10		255.13	0.000494	2.81	4208.62	876.49	0.17
Reach - 3	2957.4	100-Year	3779.00	243.96	255.44		255.47	0.000500	2.90	4508.92	882.06	0.17
Reach - 3	2362.9	2-Year	971.00	243.50	252.47		252.51	0.000576	2.52	1624.81	703.90	0.17
Reach - 3	2362.9	10-Year	2165.00	243.50	253.28		253.37	0.001275	4.04	2205.40	729.79	0.26
Reach - 3	2362.9	25-Year	2909.00	243.50	254.03		254.11	0.001238	4.25	2752.81	747.48	0.26
Reach - 3	2362.9	50-Year	3396.00	243.50	254.63		254.71	0.001087	4.17	3210.50	761.40	0.25
Reach - 3	2362.9	100-Year	3779.00	243.50	254.97		255.05	0.001074	4.25	3471.89	769.25	0.25
Reach - 3	1661.6	2-Year	971.00	242.95	252.31		252.32	0.000151	1.31	2677.79	751.36	0.09
Reach - 3	1661.6	10-Year	2165.00	242.95	252.78		252.81	0.000518	2.53	3036.37	760.55	0.16
Reach - 3	1661.6	25-Year	2909.00	242.95	253.50		253.52	0.000572	2.83	3599.07	825.81	0.17
Reach - 3	1661.6	50-Year	3396.00	242.95	254.15		254.18	0.000532	2.87	4165.62	903.14	0.17
Reach - 3	1661.6	100-Year	3779.00	242.95	254.49		254.51	0.000541	2.97	4475.54	933.89	0.17
Reach - 3	920.6	2-Year	971.00	242.61	252.25	248.37	252.25	0.000053	0.84	4297.09	996.23	0.05
Reach - 3	920.6	10-Year	2165.00	242.61	252.56	248.99	252.57	0.000211	1.73	4606.72	1001.47	0.11

HEC-RAS Plan: Future (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 3	920.6	25-Year	2909.00	242.61	253.24	249.20	253.25	0.000248	1.98	5291.71	1013.16	0.12
Reach - 3	920.6	50-Year	3396.00	242.61	253.91	249.34	253.92	0.000231	2.01	5974.25	1023.93	0.12
Reach - 3	920.6	100-Year	3779.00	242.61	254.24	249.43	254.25	0.000241	2.11	6313.41	1032.04	0.12

ALTERNATIVE CONDITIONS:
HEC-RAS OUTPUT
(ALL PROJECTS)

HEC-RAS Plan: Prop 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	26670.3	2-Year	165.00	470.17	472.01	472.01	472.68	0.028898	6.59	25.05	18.88	1.01
Reach - 1	26670.3	10-Year	337.00	470.17	474.90		475.12	0.002373	3.74	97.44	34.13	0.34
Reach - 1	26670.3	25-Year	447.00	470.17	475.05		475.40	0.003659	4.76	102.57	34.60	0.42
Reach - 1	26670.3	50-Year	530.00	470.17	476.14		476.42	0.002206	4.34	156.66	76.69	0.34
Reach - 1	26670.3	100-Year	617.00	470.17	476.78		477.05	0.001868	4.32	213.19	118.20	0.32
Reach - 1	26133.4	2-Year	203.00	467.03	470.95	468.59	471.02	0.000795	2.19	108.83	44.17	0.20
Reach - 1	26133.4	10-Year	413.00	467.03	474.66	469.37	474.72	0.000303	2.15	231.95	62.98	0.14
Reach - 1	26133.4	25-Year	546.00	467.03	474.61	469.80	474.73	0.000541	2.87	230.51	62.77	0.19
Reach - 1	26133.4	50-Year	648.00	467.03	475.78	470.08	475.90	0.000461	2.92	269.35	68.54	0.18
Reach - 1	26133.4	100-Year	753.00	467.03	476.41	470.35	476.56	0.000489	3.15	290.30	76.49	0.18
Reach - 1	26050.4		Culvert									
Reach - 1	25967.4	2-Year	203.00	463.47	465.53	465.03	465.85	0.009037	4.61	47.66	31.43	0.60
Reach - 1	25967.4	10-Year	412.00	463.47	473.12	465.81	473.16	0.000121	1.60	382.42	98.05	0.09
Reach - 1	25967.4	25-Year	525.00	463.47	466.84	466.18	467.51	0.009301	6.72	90.58	40.40	0.67
Reach - 1	25967.4	50-Year	600.00	463.47	467.09	466.40	467.83	0.009267	7.07	99.05	42.15	0.68
Reach - 1	25967.4	100-Year	704.00	463.47	467.40	466.68	468.25	0.009460	7.57	109.23	44.25	0.70
Reach - 1	25524.2	2-Year	203.00	456.43	458.48	458.48	459.23	0.027778	6.96	29.18	19.56	1.00
Reach - 1	25524.2	10-Year	412.00	456.43	473.12		473.13	0.000014	0.73	1514.65	201.70	0.03
Reach - 1	25524.2	25-Year	525.00	456.43	459.83	459.83	461.09	0.023837	9.01	58.42	23.91	1.00
Reach - 1	25524.2	50-Year	600.00	456.43	460.06	460.06	461.44	0.023535	9.42	64.10	24.70	1.00
Reach - 1	25524.2	100-Year	704.00	456.43	460.39	460.39	461.90	0.022326	9.86	73.05	29.09	0.99
Reach - 1	24962.5	2-Year	203.00	444.33	458.60		458.60	0.000008	0.49	888.28	119.66	0.02
Reach - 1	24962.5	10-Year	412.00	444.33	473.12		473.13	0.000002	0.37	2849.28	136.00	0.01
Reach - 1	24962.5	25-Year	525.00	444.33	448.54		449.25	0.009578	6.80	78.95	27.18	0.66
Reach - 1	24962.5	50-Year	600.00	444.33	448.78		449.59	0.009799	7.22	85.84	28.30	0.68
Reach - 1	24962.5	100-Year	704.00	444.33	449.04		450.00	0.010687	7.89	93.16	29.43	0.71
Reach - 1	24504.7	2-Year	317.00	437.03	458.60		458.60	0.000003	0.39	2115.25	162.90	0.01
Reach - 1	24504.7	10-Year	652.00	437.03	473.12		473.13	0.000001	0.40	4481.85	162.90	0.01
Reach - 1	24504.7	25-Year	855.00	437.03	441.41	441.41	442.91	0.017656	9.97	106.35	53.22	0.93
Reach - 1	24504.7	50-Year	1003.00	437.03	441.82	441.82	443.40	0.016487	10.34	129.07	60.11	0.92
Reach - 1	24504.7	100-Year	1172.00	437.03	442.27	442.27	443.91	0.015083	10.63	157.91	67.19	0.89

HEC-RAS Plan: Prop 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	23991.1	2-Year	317.00	426.45	458.60		458.60	0.000000	0.10	9995.38	423.20	0.00
Reach - 1	23991.1	10-Year	652.00	426.45	473.12		473.12	0.000000	0.13	16143.59	423.20	0.00
Reach - 1	23991.1	25-Year	855.00	426.45	434.65		434.73	0.000632	2.96	851.48	259.26	0.19
Reach - 1	23991.1	50-Year	1003.00	426.45	435.03		435.12	0.000666	3.15	951.77	262.26	0.20
Reach - 1	23991.1	100-Year	1172.00	426.45	435.30		435.40	0.000765	3.45	1021.71	265.54	0.22
Reach - 1	23524.2	2-Year	317.00	425.63	458.60		458.60	0.000000	0.13	7672.68	291.70	0.00
Reach - 1	23524.2	10-Year	652.00	425.63	473.12		473.12	0.000000	0.17	11910.46	291.70	0.00
Reach - 1	23524.2	25-Year	855.00	425.63	434.45		434.50	0.000358	2.36	1032.54	222.89	0.15
Reach - 1	23524.2	50-Year	1003.00	425.63	434.82		434.87	0.000402	2.57	1114.12	224.65	0.16
Reach - 1	23524.2	100-Year	1172.00	425.63	435.04		435.11	0.000487	2.88	1164.36	225.72	0.17
Reach - 1	23024.2	2-Year	317.00	425.63	458.60		458.60	0.000000	0.08	13558.09	507.00	0.00
Reach - 1	23024.2	10-Year	652.00	425.63	473.12		473.12	0.000000	0.10	20923.74	507.00	0.00
Reach - 1	23024.2	25-Year	855.00	425.63	434.36		434.37	0.000162	1.57	1755.77	347.60	0.10
Reach - 1	23024.2	50-Year	1003.00	425.63	434.71		434.73	0.000183	1.72	1879.18	352.29	0.11
Reach - 1	23024.2	100-Year	1172.00	425.63	434.91		434.93	0.000226	1.94	1949.95	355.75	0.12
Reach - 1	22524.2	2-Year	317.00	419.97	458.60		458.60	0.000000	0.13	8623.38	352.50	0.00
Reach - 1	22524.2	10-Year	652.00	419.97	473.12		473.12	0.000000	0.16	13744.45	352.50	0.00
Reach - 1	22524.2	25-Year	855.00	419.97	434.25		434.30	0.000133	2.04	918.99	139.24	0.10
Reach - 1	22524.2	50-Year	1003.00	419.97	434.58		434.64	0.000166	2.31	965.38	146.44	0.11
Reach - 1	22524.2	100-Year	1172.00	419.97	434.73		434.82	0.000224	2.70	988.57	157.18	0.13
Reach - 1	22396.4	2-Year	317.00	420.03	458.60	421.54	458.60	0.000000	0.01	29667.47	922.10	0.00
Reach - 1	22396.4	10-Year	652.00	420.03	473.12	421.96	473.12	0.000000	0.02	43063.64	922.10	0.00
Reach - 1	22396.4	25-Year	855.00	420.03	434.28	422.12	434.28	0.000001	0.11	7644.07	792.51	0.01
Reach - 1	22396.4	50-Year	1003.00	420.03	434.62	422.24	434.62	0.000001	0.13	7901.88	797.58	0.01
Reach - 1	22396.4	100-Year	1172.00	420.03	434.79	422.33	434.79	0.000001	0.15	8032.26	800.14	0.01
Reach - 1	22383.4		Inl Struct									
Reach - 1	22370.4	2-Year	317.00	425.91	458.59		458.59	0.000000	0.10	7380.36	302.80	0.00
Reach - 1	22370.4	10-Year	652.00	425.91	473.12		473.12	0.000000	0.13	11779.41	302.80	0.00
Reach - 1	22370.4	25-Year	855.00	425.91	434.09		434.17	0.000506	2.30	383.63	91.57	0.17
Reach - 1	22370.4	50-Year	1003.00	425.91	434.38		434.49	0.000584	2.56	412.08	99.62	0.19
Reach - 1	22370.4	100-Year	1172.00	425.91	434.48		434.61	0.000756	2.94	421.40	102.12	0.21

HEC-RAS Plan: Prop 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	22255.4	2-Year	418.00	422.25	458.59	425.82	458.59	0.000000	0.16	9045.72	346.10	0.00
Reach - 1	22255.4	10-Year	850.00	422.25	473.12	427.24	473.12	0.000000	0.20	14073.81	346.10	0.01
Reach - 1	22255.4	25-Year	1151.00	422.25	433.60	428.07	433.99	0.001193	5.16	311.62	277.07	0.29
Reach - 1	22255.4	50-Year	1336.00	422.25	433.76	428.55	434.26	0.001520	5.88	318.93	292.18	0.32
Reach - 1	22255.4	100-Year	1539.00	422.25	433.61	429.04	434.30	0.002126	6.89	312.05	278.42	0.38
Reach - 1	22230.4		Bridge									
Reach - 1	22205.4	2-Year	56.00	421.56	422.91	422.91	423.40	0.032407	5.63	9.95	10.13	1.00
Reach - 1	22205.4	10-Year	108.00	421.56	423.53	423.53	424.15	0.030159	6.29	17.16	13.98	1.00
Reach - 1	22205.4	25-Year	140.00	421.56	423.86	423.86	424.46	0.029866	6.20	22.59	18.94	1.00
Reach - 1	22205.4	50-Year	165.00	421.56	424.01	424.01	424.66	0.029210	6.46	25.54	19.93	1.00
Reach - 1	22205.4	100-Year	190.00	421.56	424.15	424.15	424.85	0.028087	6.71	28.34	20.41	1.00
Reach - 1	22061.4	2-Year	56.00	400.80	401.87	401.87	402.24	0.051450	4.88	11.48	15.84	1.01
Reach - 1	22061.4	10-Year	108.00	400.80	402.28	402.28	402.81	0.046217	5.84	18.49	17.74	1.01
Reach - 1	22061.4	25-Year	140.00	400.80	402.49	402.49	403.10	0.044371	6.29	22.24	18.40	1.01
Reach - 1	22061.4	50-Year	165.00	400.80	402.64	402.64	403.31	0.042938	6.58	25.09	18.89	1.01
Reach - 1	22061.4	100-Year	190.00	400.80	402.78	402.78	403.51	0.042335	6.86	27.72	19.32	1.01
Reach - 1	21877	2-Year	56.00	390.67	391.58	391.58	391.81	0.050346	3.76	14.51	32.27	1.01
Reach - 1	21877	10-Year	108.00	390.67	392.39		392.49	0.006432	2.56	42.90	37.87	0.42
Reach - 1	21877	25-Year	140.00	390.67	393.02		393.08	0.002588	2.08	73.94	65.48	0.28
Reach - 1	21877	50-Year	165.00	390.67	393.56		393.60	0.001403	1.79	109.19	67.32	0.22
Reach - 1	21877	100-Year	190.00	390.67	393.81		393.85	0.001261	1.81	129.00	101.39	0.21
Reach - 1	21577.4	2-Year	549.00	383.59	388.89		389.26	0.005330	5.02	153.54	102.03	0.42
Reach - 1	21577.4	10-Year	1006.00	383.59	390.05		390.57	0.006267	6.36	287.80	125.16	0.48
Reach - 1	21577.4	25-Year	1311.00	383.59	390.60		391.20	0.006844	7.08	357.96	130.93	0.51
Reach - 1	21577.4	50-Year	1585.00	383.59	390.92		391.66	0.007996	7.92	400.80	140.43	0.55
Reach - 1	21577.4	100-Year	1744.00	383.59	391.14		391.92	0.008258	8.23	431.92	143.14	0.56
Reach - 1	21329	2-Year	549.00	380.12	385.03	385.03	386.48	0.031913	9.63	56.98	20.13	1.01
Reach - 1	21329	10-Year	1006.00	380.12	387.13	387.13	388.22	0.014990	8.76	200.38	171.42	0.74
Reach - 1	21329	25-Year	1311.00	380.12	387.68	387.68	388.78	0.014246	9.24	307.25	218.58	0.73
Reach - 1	21329	50-Year	1585.00	380.12	388.16	388.16	389.17	0.012535	9.23	423.74	252.20	0.70
Reach - 1	21329	100-Year	1744.00	380.12	388.32	388.32	389.36	0.012860	9.53	463.88	255.92	0.71

HEC-RAS Plan: Prop 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	21024.2	2-Year	549.00	375.87	381.63		381.99	0.003544	4.81	121.08	30.48	0.38
Reach - 1	21024.2	10-Year	1006.00	375.87	384.43		384.74	0.001946	4.83	490.40	310.20	0.31
Reach - 1	21024.2	25-Year	1311.00	375.87	386.38		386.50	0.000796	3.59	1179.38	386.62	0.20
Reach - 1	21024.2	50-Year	1585.00	375.87	387.40		387.49	0.000605	3.35	1577.58	395.12	0.18
Reach - 1	21024.2	100-Year	1744.00	375.87	387.83		387.92	0.000570	3.34	1749.84	398.78	0.18
Reach - 1	20803	2-Year	549.00	373.95	380.06		380.74	0.009705	6.58	83.43	20.25	0.57
Reach - 1	20803	10-Year	1006.00	373.95	383.85		384.23	0.002747	5.33	347.99	122.24	0.34
Reach - 1	20803	25-Year	1311.00	373.95	386.01		386.26	0.001490	4.62	677.85	211.91	0.26
Reach - 1	20803	50-Year	1585.00	373.95	387.07		387.29	0.001292	4.60	924.04	255.90	0.24
Reach - 1	20803	100-Year	1744.00	373.95	387.51		387.73	0.001270	4.68	1039.94	275.19	0.24
Reach - 1	20582.7	2-Year	549.00	372.04	379.94		380.09	0.000957	3.19	238.08	74.82	0.21
Reach - 1	20582.7	10-Year	1006.00	372.04	383.85		383.95	0.000436	2.90	906.08	250.59	0.15
Reach - 1	20582.7	25-Year	1311.00	372.04	386.02		386.09	0.000271	2.58	1489.75	284.80	0.13
Reach - 1	20582.7	50-Year	1585.00	372.04	387.07		387.13	0.000263	2.67	1800.11	306.53	0.13
Reach - 1	20582.7	100-Year	1744.00	372.04	387.50		387.57	0.000269	2.76	1933.93	310.80	0.13
Reach - 1	20391.6	2-Year	578.00	371.31	378.31	376.83	379.39	0.009040	8.97	105.91	34.02	0.63
Reach - 1	20391.6	10-Year	1051.00	371.31	382.87	379.04	383.58	0.003380	7.90	268.44	271.78	0.42
Reach - 1	20391.6	25-Year	1375.00	371.31	385.09	380.31	385.78	0.002709	8.01	357.85	338.49	0.39
Reach - 1	20391.6	50-Year	1648.00	371.31	387.01	381.30	387.07	0.000409	3.42	2040.10	363.55	0.16
Reach - 1	20391.6	100-Year	1805.00	371.31	387.45	381.68	387.50	0.000400	3.44	2199.03	366.84	0.15
Reach - 1	20349.6		Mult Open									
Reach - 1	20307.6	2-Year	524.00	371.56	376.76	376.76	378.75	0.025300	11.95	63.54	20.01	1.00
Reach - 1	20307.6	10-Year	1028.00	371.56	379.19	379.19	381.84	0.020033	14.23	123.62	63.67	0.96
Reach - 1	20307.6	25-Year	1365.00	371.56	380.75	380.75	382.72	0.013136	13.21	258.02	88.56	0.80
Reach - 1	20307.6	50-Year	1642.00	371.56	382.11	382.11	383.51	0.008761	11.92	443.70	206.88	0.67
Reach - 1	20307.6	100-Year	1803.00	371.56	382.38	382.38	383.77	0.008784	12.15	501.43	220.88	0.68
Reach - 1	20223	2-Year	524.00	370.12	374.63	374.63	375.83	0.030504	8.79	59.60	25.19	1.01
Reach - 1	20223	10-Year	1028.00	370.12	376.25	376.25	377.62	0.019021	9.56	144.21	91.49	0.86
Reach - 1	20223	25-Year	1365.00	370.12	376.97	376.97	378.39	0.016675	10.04	217.26	108.88	0.83
Reach - 1	20223	50-Year	1642.00	370.12	377.40	377.40	378.93	0.016600	10.63	265.12	116.42	0.84
Reach - 1	20223	100-Year	1803.00	370.12	377.65	377.65	379.22	0.016263	10.88	294.88	120.87	0.84

HEC-RAS Plan: Prop 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	20024.2	2-Year	524.00	366.75	370.97	370.19	371.64	0.011134	6.62	89.16	36.30	0.64
Reach - 1	20024.2	10-Year	1028.00	366.75	372.62		373.64	0.010326	8.34	155.86	48.66	0.66
Reach - 1	20024.2	25-Year	1365.00	366.75	373.26	372.37	374.60	0.011811	9.67	189.98	59.37	0.72
Reach - 1	20024.2	50-Year	1642.00	366.75	373.61	372.98	375.31	0.013814	10.89	212.32	67.46	0.79
Reach - 1	20024.2	100-Year	1803.00	366.75	373.83	373.17	375.71	0.014609	11.47	228.59	78.31	0.81
Reach - 1	19751	2-Year	524.00	361.35	366.31	366.01	367.37	0.022875	8.28	63.28	22.96	0.88
Reach - 1	19751	10-Year	1028.00	361.35	367.67	367.67	369.35	0.025751	10.40	102.39	43.84	0.97
Reach - 1	19751	25-Year	1365.00	361.35	368.51	368.51	370.32	0.021298	10.90	150.63	68.05	0.92
Reach - 1	19751	50-Year	1642.00	361.35	369.17	369.17	370.98	0.018261	11.08	201.41	84.40	0.87
Reach - 1	19751	100-Year	1803.00	361.35	369.46	369.46	371.32	0.017671	11.32	226.69	88.49	0.86
Reach - 1	19524.2	2-Year	524.00	356.87	360.27	360.27	361.53	0.029106	8.97	58.72	24.87	0.99
Reach - 1	19524.2	10-Year	1028.00	356.87	361.84	361.84	363.48	0.021129	10.45	121.60	52.05	0.91
Reach - 1	19524.2	25-Year	1365.00	356.87	362.61	362.61	364.46	0.019681	11.31	163.21	57.14	0.91
Reach - 1	19524.2	50-Year	1642.00	356.87	363.13	363.13	365.18	0.019342	12.01	194.14	60.77	0.91
Reach - 1	19524.2	100-Year	1803.00	356.87	363.42	363.42	365.57	0.019154	12.37	211.81	62.64	0.92
Reach - 1	19222	2-Year	524.00	348.54	351.61	351.61	352.65	0.029195	8.18	65.71	35.39	1.00
Reach - 1	19222	10-Year	1028.00	348.54	352.82	352.82	354.33	0.023726	9.96	115.55	45.72	0.97
Reach - 1	19222	25-Year	1365.00	348.54	353.46	353.46	355.26	0.022577	10.94	145.89	49.05	0.97
Reach - 1	19222	50-Year	1642.00	348.54	353.97	353.97	355.96	0.021463	11.56	171.25	51.67	0.97
Reach - 1	19222	100-Year	1803.00	348.54	354.25	354.25	356.33	0.020794	11.86	186.11	52.62	0.96
Reach - 1	19024.2	2-Year	524.00	343.08	347.86		348.38	0.006926	5.79	90.65	23.66	0.52
Reach - 1	19024.2	10-Year	1028.00	343.08	349.60		350.54	0.007660	7.80	140.94	36.63	0.58
Reach - 1	19024.2	25-Year	1365.00	343.08	350.51	348.73	351.67	0.007866	8.73	203.29	103.26	0.60
Reach - 1	19024.2	50-Year	1642.00	343.08	351.12	349.41	352.39	0.007953	9.32	277.00	152.36	0.61
Reach - 1	19024.2	100-Year	1803.00	343.08	350.90	349.89	352.59	0.010895	10.68	246.15	126.21	0.72
Reach - 1	18833	2-Year	524.00	339.27	344.35	344.35	345.84	0.031367	9.77	53.65	18.11	1.00
Reach - 1	18833	10-Year	1028.00	339.27	346.23	346.23	348.11	0.022485	11.16	110.06	41.97	0.91
Reach - 1	18833	25-Year	1365.00	339.27	347.14	347.14	349.27	0.020596	12.03	154.32	57.93	0.90
Reach - 1	18833	50-Year	1642.00	339.27	347.84	347.84	350.06	0.018957	12.48	199.80	73.40	0.88
Reach - 1	18833	100-Year	1803.00	339.27	348.88	348.88	350.40	0.011512	10.78	348.14	158.39	0.70
Reach - 1	18524.2	2-Year	524.00	333.12	339.83		340.06	0.001769	3.83	146.72	31.80	0.28
Reach - 1	18524.2	10-Year	1028.00	333.12	341.71		342.18	0.002576	5.57	222.75	49.23	0.35

HEC-RAS Plan: Prop 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	18524.2	25-Year	1365.00	333.12	342.49		343.15	0.003222	6.65	272.64	91.83	0.40
Reach - 1	18524.2	50-Year	1642.00	333.12	343.02		343.82	0.003663	7.38	327.32	105.09	0.43
Reach - 1	18524.2	100-Year	1803.00	333.12	343.33		344.19	0.003852	7.74	359.42	107.97	0.45
Reach - 1	18317	2-Year	524.00	331.33	337.74	337.74	338.99	0.032548	9.04	64.29	35.78	0.95
Reach - 1	18317	10-Year	1028.00	331.33	339.25	339.25	340.84	0.025157	10.60	140.89	67.42	0.90
Reach - 1	18317	25-Year	1365.00	331.33	340.20	340.20	341.71	0.019722	10.71	221.49	99.11	0.82
Reach - 1	18317	50-Year	1642.00	331.33	340.69	340.69	342.27	0.019304	11.23	271.39	105.96	0.83
Reach - 1	18317	100-Year	1803.00	331.33	340.90	340.90	342.57	0.019805	11.66	294.23	108.96	0.84
Reach - 1	18024.2	2-Year	524.00	328.79	333.78		334.24	0.005732	5.45	102.57	32.90	0.48
Reach - 1	18024.2	10-Year	1028.00	328.79	335.25		336.14	0.007584	7.70	159.54	45.91	0.58
Reach - 1	18024.2	25-Year	1365.00	328.79	335.83		337.07	0.009358	9.14	188.36	52.84	0.65
Reach - 1	18024.2	50-Year	1642.00	328.79	336.27	335.14	337.81	0.010625	10.20	213.01	65.05	0.70
Reach - 1	18024.2	100-Year	1803.00	328.79	336.51	335.50	338.20	0.011205	10.73	229.50	70.87	0.72
Reach - 1	17810	2-Year	524.00	326.23	330.61	330.61	331.77	0.030852	8.65	60.56	26.05	1.00
Reach - 1	17810	10-Year	1028.00	326.23	332.23	332.02	333.54	0.021649	9.18	115.90	45.77	0.89
Reach - 1	17810	25-Year	1365.00	326.23	333.18	332.71	334.50	0.015852	9.30	167.76	64.28	0.80
Reach - 1	17810	50-Year	1642.00	326.23	333.86	333.20	335.20	0.013407	9.45	216.63	78.47	0.75
Reach - 1	17810	100-Year	1803.00	326.23	334.21	333.50	335.57	0.012495	9.56	245.68	85.37	0.74
Reach - 1	17524.2	2-Year	524.00	322.82	329.11		329.37	0.002264	4.12	140.38	36.43	0.31
Reach - 1	17524.2	10-Year	1028.00	322.82	330.95		331.45	0.003057	5.83	236.11	72.19	0.38
Reach - 1	17524.2	25-Year	1365.00	322.82	331.79		332.44	0.003513	6.72	301.85	83.43	0.42
Reach - 1	17524.2	50-Year	1642.00	322.82	332.37		333.15	0.003894	7.41	353.88	101.48	0.44
Reach - 1	17524.2	100-Year	1803.00	322.82	332.68		333.52	0.004086	7.77	386.43	111.98	0.46
Reach - 1	17294	2-Year	524.00	322.18	328.01		328.53	0.006231	5.95	122.75	57.12	0.50
Reach - 1	17294	10-Year	1028.00	322.18	329.63		330.41	0.006846	7.68	246.46	92.54	0.55
Reach - 1	17294	25-Year	1365.00	322.18	330.35		331.28	0.007451	8.63	316.75	104.16	0.59
Reach - 1	17294	50-Year	1642.00	322.18	330.86		331.89	0.007791	9.27	372.28	111.42	0.61
Reach - 1	17294	100-Year	1803.00	322.18	331.15		332.23	0.007913	9.59	404.43	114.97	0.62
Reach - 1	17020.0	2-Year	524.00	321.41	325.23	324.99	325.96	0.015345	7.13	105.57	72.46	0.74
Reach - 1	17020.0	10-Year	1028.00	321.41	326.12	326.12	327.37	0.020046	9.74	178.77	91.06	0.88
Reach - 1	17020.0	25-Year	1365.00	321.41	326.72	326.72	328.12	0.019403	10.56	237.03	103.50	0.89
Reach - 1	17020.0	50-Year	1642.00	321.41	327.14	327.14	328.65	0.019313	11.19	281.94	112.15	0.90

HEC-RAS Plan: Prop 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	17020.0	100-Year	1803.00	321.41	327.35	327.35	328.94	0.019502	11.57	305.94	116.51	0.91
Reach - 1	16807	2-Year	524.00	318.05	321.34		322.15	0.021123	7.19	72.84	32.67	0.85
Reach - 1	16807	10-Year	1028.00	318.05	323.00	322.49	323.82	0.012624	7.46	184.08	108.38	0.70
Reach - 1	16807	25-Year	1365.00	318.05	323.77	323.11	324.59	0.010421	7.65	279.36	141.94	0.65
Reach - 1	16807	50-Year	1642.00	318.05	324.30		325.12	0.009351	7.83	360.61	162.34	0.63
Reach - 1	16807	100-Year	1803.00	318.05	324.58		325.40	0.008855	7.92	407.09	167.96	0.62
Reach - 1	16524.2	2-Year	538.00	313.59	318.48		319.00	0.006679	5.79	93.21	23.78	0.51
Reach - 1	16524.2	10-Year	1057.00	313.59	320.29	318.47	321.19	0.007155	7.69	173.15	107.50	0.56
Reach - 1	16524.2	25-Year	1407.00	313.59	321.09	319.35	322.13	0.007307	8.48	261.54	111.18	0.58
Reach - 1	16524.2	50-Year	1689.00	313.59	321.67	320.69	322.78	0.007273	8.95	326.42	113.71	0.59
Reach - 1	16524.2	100-Year	1850.00	313.59	321.98	321.02	323.11	0.007250	9.18	361.23	115.04	0.59
Reach - 1	16219	2-Year	538.00	307.88	313.50	313.50	315.01	0.033390	9.85	54.63	18.32	1.01
Reach - 1	16219	10-Year	1057.00	307.88	315.30	315.30	317.20	0.028902	11.04	97.50	32.06	0.99
Reach - 1	16219	25-Year	1407.00	307.88	316.25	316.25	318.32	0.024013	11.64	136.44	48.46	0.94
Reach - 1	16219	50-Year	1689.00	307.88	316.90	316.90	319.10	0.021815	12.08	170.93	56.96	0.91
Reach - 1	16219	100-Year	1850.00	307.88	317.25	317.25	319.50	0.020810	12.30	191.63	61.50	0.90
Reach - 1	16024.2	2-Year	538.00	304.23	309.39		309.84	0.005314	5.40	103.61	28.89	0.46
Reach - 1	16024.2	10-Year	1057.00	304.23	311.33		312.11	0.005693	7.17	166.41	35.95	0.51
Reach - 1	16024.2	25-Year	1407.00	304.23	312.27		313.28	0.006154	8.20	206.95	50.08	0.54
Reach - 1	16024.2	50-Year	1689.00	304.23	312.90		314.09	0.006534	8.94	241.08	58.23	0.57
Reach - 1	16024.2	100-Year	1850.00	304.23	313.23		314.52	0.006726	9.33	261.19	61.99	0.58
Reach - 1	15740	2-Year	538.00	297.95	302.86	302.86	304.23	2.489301	9.41	57.20	20.92	1.00
Reach - 1	15740	10-Year	1057.00	297.95	304.79	304.79	306.26	1.694295	9.80	108.90	36.51	0.88
Reach - 1	15740	25-Year	1407.00	297.95	305.62	305.62	307.11	1.302905	9.70	144.58	50.48	0.79
Reach - 1	15740	50-Year	1689.00	297.95	306.13	306.13	307.66	1.101706	9.57	173.05	60.31	0.74
Reach - 1	15740	100-Year	1850.00	297.95	306.35	306.35	307.94	1.050580	9.60	186.53	63.86	0.73
Reach - 1	15524.2	2-Year	538.00	293.18	299.79		300.03	0.001611	4.01	147.49	59.62	0.30
Reach - 1	15524.2	10-Year	1057.00	293.18	302.26		302.58	0.001456	4.85	441.15	176.61	0.30
Reach - 1	15524.2	25-Year	1407.00	293.18	303.08		303.46	0.001642	5.49	600.97	211.63	0.32
Reach - 1	15524.2	50-Year	1689.00	293.18	303.43		303.91	0.001990	6.20	679.32	238.41	0.36
Reach - 1	15524.2	100-Year	1850.00	293.18	303.59		304.12	0.002189	6.58	717.65	244.64	0.38

HEC-RAS Plan: Prop 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	15291	2-Year	538.00	292.67	298.76		299.32	0.006916	5.98	89.96	22.07	0.52
Reach - 1	15291	10-Year	1057.00	292.67	301.81		302.11	0.002772	4.92	585.84	437.65	0.35
Reach - 1	15291	25-Year	1407.00	292.67	302.83		303.01	0.001749	4.33	1070.17	495.14	0.29
Reach - 1	15291	50-Year	1689.00	292.67	303.20		303.38	0.001790	4.53	1257.48	506.02	0.29
Reach - 1	15291	100-Year	1850.00	292.67	303.36		303.55	0.001872	4.70	1337.82	510.61	0.30
Reach - 1	15183.4	2-Year	538.00	292.43	298.53	296.11	298.78	0.002194	4.12	146.14	38.27	0.34
Reach - 1	15183.4	10-Year	1057.00	292.43	301.62	297.42	301.90	0.001317	4.48	423.83	215.88	0.28
Reach - 1	15183.4	25-Year	1407.00	292.43	302.45	298.19	302.80	0.001461	5.05	651.14	363.98	0.30
Reach - 1	15183.4	50-Year	1689.00	292.43	302.64	298.75	303.10	0.001961	5.93	726.72	452.42	0.35
Reach - 1	15183.4	100-Year	1850.00	292.43	302.69	299.09	303.23	0.002265	6.40	752.46	465.77	0.38
Reach - 1	15150.4		Bridge									
Reach - 1	15117.4	2-Year	538.00	292.69	298.01	296.37	298.39	0.003969	4.97	117.56	34.88	0.44
Reach - 1	15117.4	10-Year	1057.00	292.69	299.12	297.68	299.98	0.006690	7.54	159.78	43.53	0.59
Reach - 1	15117.4	25-Year	1407.00	292.69	299.66	298.50	300.88	0.008324	9.00	185.56	52.36	0.67
Reach - 1	15117.4	50-Year	1689.00	292.69	299.95	299.02	301.52	0.010033	10.22	203.42	66.37	0.75
Reach - 1	15117.4	100-Year	1850.00	292.69	300.05	299.34	301.86	0.011343	10.99	210.07	69.30	0.79
Reach - 1	15024.2	2-Year	542.00	291.44	297.95		298.12	0.001011	3.54	319.80	159.11	0.26
Reach - 1	15024.2	10-Year	1065.00	291.44	299.14		299.43	0.001579	5.02	526.03	183.37	0.34
Reach - 1	15024.2	25-Year	1416.00	291.44	299.69		300.14	0.002171	6.21	647.48	305.40	0.40
Reach - 1	15024.2	50-Year	1699.00	291.44	300.05		300.59	0.002517	6.90	778.96	389.07	0.44
Reach - 1	15024.2	100-Year	1863.00	291.44	300.23		300.79	0.002617	7.14	849.23	393.06	0.45
Reach - 1	14764	2-Year	542.00	290.94	296.55	295.33	297.08	0.005716	6.13	187.53	256.89	0.55
Reach - 1	14764	10-Year	1065.00	290.94	297.58		298.06	0.005715	6.82	520.99	394.88	0.55
Reach - 1	14764	25-Year	1416.00	290.94	298.07		298.52	0.005381	7.06	727.65	439.08	0.55
Reach - 1	14764	50-Year	1699.00	290.94	298.45		298.84	0.004868	7.04	894.37	450.29	0.53
Reach - 1	14764	100-Year	1863.00	290.94	298.63		299.01	0.004773	7.12	975.01	455.55	0.52
Reach - 1	14524.2	2-Year	542.00	290.48	296.37		296.48	0.000980	3.22	559.28	416.97	0.25
Reach - 1	14524.2	10-Year	1065.00	290.48	297.18		297.34	0.001476	4.37	911.52	446.54	0.32
Reach - 1	14524.2	25-Year	1416.00	290.48	297.57		297.77	0.001718	4.93	1090.74	462.63	0.35
Reach - 1	14524.2	50-Year	1699.00	290.48	297.88		298.10	0.001898	5.35	1236.86	480.97	0.37
Reach - 1	14524.2	100-Year	1863.00	290.48	298.03		298.26	0.001980	5.55	1310.37	483.81	0.38

HEC-RAS Plan: Prop 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	14034.8	2-Year	542.00	287.46	296.39		296.40	0.000038	0.87	2194.63	435.39	0.05
Reach - 1	14034.8	10-Year	1065.00	287.46	297.16		297.17	0.000099	1.50	2540.19	458.81	0.09
Reach - 1	14034.8	25-Year	1416.00	287.46	297.52		297.54	0.000149	1.88	2707.29	473.27	0.11
Reach - 1	14034.8	50-Year	1699.00	287.46	297.80		297.83	0.000190	2.17	2841.55	485.43	0.12
Reach - 1	14034.8	100-Year	1863.00	287.46	297.94		297.96	0.000215	2.33	2906.48	489.28	0.13
Reach - 1	13555.6	2-Year	542.00	287.38	296.38		296.38	0.000036	0.85	2207.46	416.51	0.05
Reach - 1	13555.6	10-Year	1065.00	287.38	297.12		297.13	0.000096	1.47	2521.00	431.47	0.09
Reach - 1	13555.6	25-Year	1416.00	287.38	297.45		297.47	0.000145	1.86	2667.01	440.31	0.11
Reach - 1	13555.6	50-Year	1699.00	287.38	297.71		297.74	0.000187	2.15	2782.52	448.76	0.12
Reach - 1	13555.6	100-Year	1863.00	287.38	297.83		297.86	0.000214	2.32	2836.92	452.69	0.13
Reach - 1	13024.2	2-Year	542.00	287.30	296.36		296.36	0.000038	0.88	2151.00	412.86	0.05
Reach - 1	13024.2	10-Year	1065.00	287.30	297.06		297.08	0.000100	1.51	2444.05	417.25	0.09
Reach - 1	13024.2	25-Year	1416.00	287.30	297.37		297.39	0.000153	1.91	2573.07	421.89	0.11
Reach - 1	13024.2	50-Year	1699.00	287.30	297.61		297.63	0.000198	2.21	2673.20	425.46	0.13
Reach - 1	13024.2	100-Year	1863.00	287.30	297.71		297.74	0.000227	2.38	2718.19	427.07	0.14
Reach - 1	12524.2	2-Year	542.00	287.22	296.34		296.34	0.000028	0.77	2563.33	491.70	0.05
Reach - 1	12524.2	10-Year	1065.00	287.22	297.02		297.03	0.000077	1.33	2904.37	507.50	0.08
Reach - 1	12524.2	25-Year	1416.00	287.22	297.31		297.32	0.000118	1.68	3050.04	511.13	0.10
Reach - 1	12524.2	50-Year	1699.00	287.22	297.53		297.54	0.000152	1.94	3161.65	512.65	0.11
Reach - 1	12524.2	100-Year	1863.00	287.22	297.62		297.64	0.000175	2.09	3209.63	513.30	0.12
Reach - 1	12024.2	2-Year	542.00	287.14	296.34		296.34	0.000010	0.45	4399.95	738.30	0.03
Reach - 1	12024.2	10-Year	1065.00	287.14	297.01		297.01	0.000027	0.79	4895.66	739.85	0.05
Reach - 1	12024.2	25-Year	1416.00	287.14	297.28		297.29	0.000042	1.01	5100.42	740.49	0.06
Reach - 1	12024.2	50-Year	1699.00	287.14	297.49		297.50	0.000055	1.17	5256.11	740.98	0.07
Reach - 1	12024.2	100-Year	1863.00	287.14	297.58		297.59	0.000064	1.26	5321.58	741.19	0.07
Reach - 1	11747.1	2-Year	542.00	284.16	296.33		296.33	0.000003	0.31	7198.39	1113.15	0.02
Reach - 1	11747.1	10-Year	1065.00	284.16	297.00		297.00	0.000009	0.55	7946.99	1128.14	0.03
Reach - 1	11747.1	25-Year	1416.00	284.16	297.28		297.28	0.000014	0.71	8258.17	1136.25	0.04
Reach - 1	11747.1	50-Year	1699.00	284.16	297.49		297.49	0.000018	0.82	8495.78	1142.07	0.04
Reach - 1	11747.1	100-Year	1863.00	284.16	297.57		297.58	0.000021	0.89	8596.11	1152.39	0.04
Reach - 1	11352.3	2-Year	697.00	273.46	296.33	277.53	296.33	0.000001	0.18	3922.34	560.92	0.01
Reach - 1	11352.3	10-Year	1538.00	273.46	297.00	279.05	297.00	0.000005	0.36	4371.95	592.25	0.02

HEC-RAS Plan: Prop 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	11352.3	25-Year	2107.00	273.46	297.27	279.79	297.28	0.000009	0.48	4534.15	599.47	0.03
Reach - 1	11352.3	50-Year	2563.00	273.46	297.48	280.32	297.48	0.000012	0.57	4658.29	604.88	0.03
Reach - 1	11352.3	100-Year	2789.00	273.46	297.56	280.55	297.57	0.000013	0.62	4710.36	606.89	0.03
Reach - 1	11341.3		Inl Struct									
Reach - 1	11330.3	2-Year	697.00	277.80	281.83	281.83	283.24	0.013675	9.88	104.17	54.07	0.92
Reach - 1	11330.3	10-Year	1538.00	277.80	283.88	283.88	285.82	0.011488	12.27	244.00	80.66	0.91
Reach - 1	11330.3	25-Year	2107.00	277.80	284.89	284.89	287.12	0.011204	13.52	331.25	93.06	0.93
Reach - 1	11330.3	50-Year	2563.00	277.80	285.61	285.61	288.03	0.010927	14.31	401.63	101.97	0.93
Reach - 1	11330.3	100-Year	2789.00	277.80	285.95	285.95	288.44	0.010789	14.65	436.60	106.12	0.93
Reach - 1	11228.2	2-Year	697.00	274.45	278.73	278.64	280.35	0.018569	10.21	70.82	36.89	0.94
Reach - 1	11228.2	10-Year	1538.00	274.45	281.39	281.39	283.09	0.010884	11.24	256.96	113.69	0.79
Reach - 1	11228.2	25-Year	2107.00	274.45	282.35	282.35	284.17	0.010634	12.21	370.95	123.48	0.80
Reach - 1	11228.2	50-Year	2563.00	274.45	282.90	282.90	284.92	0.011168	13.14	440.70	128.51	0.83
Reach - 1	11228.2	100-Year	2789.00	274.45	283.18	283.18	285.27	0.011257	13.50	476.76	131.58	0.84
Reach - 1	10952.4	2-Year	697.00	270.52	274.21	274.21	275.39	0.016534	8.86	92.67	47.24	0.97
Reach - 1	10952.4	10-Year	1538.00	270.52	275.89	275.89	277.65	0.013449	11.14	199.81	71.77	0.95
Reach - 1	10952.4	25-Year	2107.00	270.52	276.62	276.62	278.87	0.014303	12.74	254.52	79.91	1.00
Reach - 1	10952.4	50-Year	2563.00	270.52	277.45	277.45	279.75	0.012145	13.00	334.54	109.81	0.95
Reach - 1	10952.4	100-Year	2789.00	270.52	277.95	277.95	280.12	0.010524	12.78	394.18	125.30	0.89
Reach - 1	10524.2	2-Year	697.00	263.63	268.68	267.57	269.38	0.006797	6.79	133.07	112.90	0.62
Reach - 1	10524.2	10-Year	1538.00	263.63	269.86	269.86	271.17	0.010942	9.88	291.41	155.70	0.81
Reach - 1	10524.2	25-Year	2107.00	263.63	270.42	270.42	272.06	0.012411	11.37	385.34	177.72	0.88
Reach - 1	10524.2	50-Year	2563.00	263.63	271.20	271.20	272.68	0.009960	11.18	546.11	228.95	0.81
Reach - 1	10524.2	100-Year	2789.00	263.63	271.44	271.44	272.93	0.009769	11.37	601.80	236.59	0.81
Reach - 1	10136.9	2-Year	697.00	261.02	268.70		268.76	0.000433	2.41	1024.69	587.50	0.17
Reach - 1	10136.9	10-Year	1538.00	261.02	269.86		269.96	0.000696	3.43	1757.39	676.25	0.23
Reach - 1	10136.9	25-Year	2107.00	261.02	270.55		270.65	0.000747	3.77	2237.25	718.43	0.24
Reach - 1	10136.9	50-Year	2563.00	261.02	271.20		271.29	0.000691	3.83	2714.82	755.87	0.23
Reach - 1	10136.9	100-Year	2789.00	261.02	271.78		271.86	0.000557	3.59	3165.73	787.21	0.21
Reach - 2	10024.2	2-Year	764.00	262.00	268.65		268.69	0.000786	2.47	1090.01	599.39	0.19
Reach - 2	10024.2	10-Year	1769.00	262.00	269.77		269.84	0.001301	3.59	1814.33	698.53	0.26

HEC-RAS Plan: Prop 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 2	10024.2	25-Year	2464.00	262.00	270.45		270.53	0.001348	3.92	2299.31	735.11	0.27
Reach - 2	10024.2	50-Year	3029.00	262.00	271.11		271.18	0.001208	3.95	2793.08	771.93	0.26
Reach - 2	10024.2	100-Year	3285.00	262.00	271.71		271.77	0.000973	3.74	3281.88	875.18	0.23
Reach - 2	9691.7	2-Year	764.00	260.63	267.82	265.57	268.21	0.002895	5.34	294.24	428.84	0.40
Reach - 2	9691.7	10-Year	1769.00	260.63	269.27	268.43	269.38	0.001418	4.35	1533.25	517.06	0.29
Reach - 2	9691.7	25-Year	2464.00	260.63	269.86	268.50	270.02	0.001755	5.11	1848.70	547.17	0.33
Reach - 2	9691.7	50-Year	3029.00	260.63	270.54	268.51	270.69	0.001742	5.39	2229.79	576.99	0.33
Reach - 2	9691.7	100-Year	3285.00	260.63	271.28	268.51	271.40	0.001250	4.83	2669.52	609.34	0.28
Reach - 2	9676.2		Bridge									
Reach - 2	9660.7	2-Year	764.00	260.97	266.13	265.91	267.54	0.016975	9.56	84.07	237.28	0.89
Reach - 2	9660.7	10-Year	1769.00	260.97	268.68	268.00	268.94	0.003238	5.99	1079.39	464.48	0.43
Reach - 2	9660.7	25-Year	2464.00	260.97	269.74	268.05	269.95	0.002464	5.81	1604.06	523.40	0.38
Reach - 2	9660.7	50-Year	3029.00	260.97	270.46	268.39	270.65	0.002212	5.87	1990.87	561.20	0.37
Reach - 2	9660.7	100-Year	3285.00	260.97	270.78	268.56	270.98	0.002191	6.00	2175.09	574.71	0.37
Reach - 2	9524.2	2-Year	764.00	259.17	265.30		265.80	0.005976	5.77	164.50	88.92	0.48
Reach - 2	9524.2	10-Year	1769.00	259.17	268.03		268.43	0.003613	6.01	791.79	375.98	0.40
Reach - 2	9524.2	25-Year	2464.00	259.17	269.24		269.56	0.002824	5.90	1331.23	481.59	0.36
Reach - 2	9524.2	50-Year	3029.00	259.17	270.06		270.32	0.002335	5.71	1735.01	498.83	0.33
Reach - 2	9524.2	100-Year	3285.00	259.17	270.43		270.67	0.002136	5.61	1922.25	504.27	0.32
Reach - 2	9024.2	2-Year	764.00	256.05	263.53		263.83	0.002647	4.46	202.73	75.12	0.33
Reach - 2	9024.2	10-Year	1769.00	256.05	266.21		266.74	0.003135	6.26	486.28	145.69	0.38
Reach - 2	9024.2	25-Year	2464.00	256.05	267.26		267.93	0.003608	7.27	649.59	163.11	0.42
Reach - 2	9024.2	50-Year	3029.00	256.05	268.06		268.81	0.003761	7.83	783.68	170.57	0.43
Reach - 2	9024.2	100-Year	3285.00	256.05	268.47		269.23	0.003735	8.01	853.63	178.66	0.43
Reach - 2	8588.6	2-Year	764.00	255.57	260.79		261.64	0.011982	7.36	103.81	27.06	0.66
Reach - 2	8588.6	10-Year	1769.00	255.57	264.06	262.63	264.84	0.006290	7.65	467.01	235.93	0.52
Reach - 2	8588.6	25-Year	2464.00	255.57	265.65		266.22	0.004128	7.15	910.43	333.61	0.44
Reach - 2	8588.6	50-Year	3029.00	255.57	266.89		267.29	0.002828	6.48	1342.07	363.01	0.37
Reach - 2	8588.6	100-Year	3285.00	255.57	267.49		267.83	0.002354	6.16	1562.64	372.92	0.34
Reach - 2	8024.2	2-Year	764.00	250.67	259.76		259.94	0.001133	3.44	256.79	52.00	0.22
Reach - 2	8024.2	10-Year	1769.00	250.67	263.39		263.58	0.000915	4.04	1097.89	447.19	0.21

HEC-RAS Plan: Prop 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 2	8024.2	25-Year	2464.00	250.67	265.28		265.39	0.000585	3.59	2146.33	591.05	0.18
Reach - 2	8024.2	50-Year	3029.00	250.67	266.61		266.69	0.000430	3.29	2988.75	657.44	0.15
Reach - 2	8024.2	100-Year	3285.00	250.67	267.26		267.32	0.000364	3.12	3417.90	693.88	0.14
Reach - 2	7524.2	2-Year	773.00	249.35	259.36		259.49	0.000700	2.93	431.97	363.89	0.18
Reach - 2	7524.2	10-Year	1797.00	249.35	263.31		263.34	0.000203	2.04	2920.91	708.22	0.10
Reach - 2	7524.2	25-Year	2508.00	249.35	265.21		265.23	0.000147	1.91	4333.64	784.13	0.09
Reach - 2	7524.2	50-Year	3083.00	249.35	266.56		266.57	0.000120	1.84	5404.05	812.36	0.08
Reach - 2	7524.2	100-Year	3374.00	249.35	267.20		267.22	0.000110	1.81	5935.38	831.42	0.08
Reach - 3	7024.2	2-Year	784.00	250.01	259.01		259.11	0.000777	2.83	686.29	427.39	0.18
Reach - 3	7024.2	10-Year	1832.00	250.01	263.22		263.24	0.000188	1.88	2791.66	557.19	0.10
Reach - 3	7024.2	25-Year	2567.00	250.01	265.14		265.16	0.000147	1.85	3906.27	606.67	0.09
Reach - 3	7024.2	50-Year	3160.00	250.01	266.49		266.51	0.000136	1.89	4885.09	760.13	0.09
Reach - 3	7024.2	100-Year	3488.00	250.01	267.14		267.16	0.000127	1.88	5385.04	773.36	0.08
Reach - 3	6790.2	2-Year	784.00	249.25	258.91		258.98	0.000384	2.09	429.32	99.41	0.13
Reach - 3	6790.2	10-Year	1832.00	249.25	263.06		263.17	0.000408	2.86	1089.45	273.00	0.15
Reach - 3	6790.2	25-Year	2567.00	249.25	264.97		265.09	0.000400	3.13	1796.99	424.18	0.15
Reach - 3	6790.2	50-Year	3160.00	249.25	266.32		266.45	0.000389	3.28	2454.59	555.22	0.15
Reach - 3	6790.2	100-Year	3488.00	249.25	266.97		267.10	0.000381	3.34	2831.72	603.64	0.15
Reach - 3	6733.5	2-Year	844.00	250.49	258.90	252.93	258.95	0.000240	1.86	457.74	213.41	0.12
Reach - 3	6733.5	10-Year	2046.00	250.49	263.02	254.55	263.15	0.000326	2.91	714.97	329.23	0.15
Reach - 3	6733.5	25-Year	2864.00	250.49	264.86	255.46	265.05	0.000390	3.51	830.32	456.65	0.17
Reach - 3	6733.5	50-Year	3501.00	250.49	266.31	256.11	266.42	0.000254	3.03	2602.35	652.47	0.14
Reach - 3	6733.5	100-Year	3899.00	250.49	266.98	256.49	267.07	0.000217	2.88	3644.12	759.29	0.13
Reach - 3	6670.0		Culvert									
Reach - 3	6606.5	2-Year	844.00	249.54	258.75	251.98	258.80	0.000171	1.68	507.89	241.47	0.10
Reach - 3	6606.5	10-Year	2046.00	249.54	262.49	253.60	262.61	0.000290	2.80	741.27	345.31	0.14
Reach - 3	6606.5	25-Year	2864.00	249.54	263.76	254.50	263.95	0.000405	3.55	820.79	447.63	0.17
Reach - 3	6606.5	50-Year	3501.00	249.54	264.57	255.17	264.82	0.000497	4.09	871.34	533.48	0.19
Reach - 3	6606.5	100-Year	3899.00	249.54	265.26	255.53	265.37	0.000281	3.17	3108.50	638.81	0.15
Reach - 3	6606.4	2-Year	844.00	249.54	258.68	252.15	258.78	0.000415	2.51	368.92	54.75	0.15
Reach - 3	6606.4	10-Year	2046.00	249.54	262.32	254.22	262.57	0.000712	4.12	1013.70	663.87	0.20

HEC-RAS Plan: Prop 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 3	6606.4	25-Year	2864.00	249.54	263.70	255.39	263.94	0.000706	4.40	2001.96	745.26	0.21
Reach - 3	6606.4	50-Year	3501.00	249.54	264.58	256.23	264.81	0.000683	4.51	2674.87	776.84	0.21
Reach - 3	6606.4	100-Year	3899.00	249.54	265.13	256.71	265.34	0.000654	4.52	3108.58	803.49	0.20
Reach - 3	6268.9		Culvert									
Reach - 3	5931.4	2-Year	844.00	249.82	258.59	252.43	258.70	0.000478	2.62	349.09	53.11	0.16
Reach - 3	5931.4	10-Year	2046.00	249.82	261.96	254.50	262.26	0.000892	4.46	682.58	363.56	0.23
Reach - 3	5931.4	25-Year	2864.00	249.82	263.16	255.67	263.53	0.001067	5.20	1403.01	712.67	0.25
Reach - 3	5931.4	50-Year	3501.00	249.82	263.89	256.51	264.27	0.001102	5.47	1937.45	742.16	0.26
Reach - 3	5931.4	100-Year	3899.00	249.82	264.37	257.01	264.73	0.001080	5.54	2292.12	759.04	0.26
Reach - 3	5454.5	2-Year	844.00	248.76	257.66		258.12	0.003071	5.63	218.18	74.71	0.39
Reach - 3	5454.5	10-Year	2046.00	248.76	260.05	257.95	261.16	0.005279	9.10	497.14	262.20	0.54
Reach - 3	5454.5	25-Year	2864.00	248.76	261.39	259.61	262.41	0.004674	9.41	910.84	357.68	0.52
Reach - 3	5454.5	50-Year	3501.00	248.76	262.67		263.34	0.003206	8.43	1801.19	896.69	0.44
Reach - 3	5454.5	100-Year	3899.00	248.76	263.70		264.06	0.001899	6.86	2767.46	970.24	0.34
Reach - 3	5024.2	2-Year	844.00	248.44	256.12		256.58	0.004247	5.94	312.07	189.02	0.45
Reach - 3	5024.2	10-Year	2046.00	248.44	258.85		259.25	0.003057	6.62	922.14	277.42	0.41
Reach - 3	5024.2	25-Year	2864.00	248.44	260.49		260.83	0.002323	6.53	1446.22	354.66	0.37
Reach - 3	5024.2	50-Year	3501.00	248.44	262.02		262.27	0.001612	5.99	2086.65	447.15	0.31
Reach - 3	5024.2	100-Year	3899.00	248.44	263.19		263.38	0.001154	5.42	2649.48	507.33	0.27
Reach - 3	4718.573	2-Year	844.00	249.06	255.93		256.02	0.000725	2.38	354.06	78.91	0.20
Reach - 3	4718.573	10-Year	2046.00	249.06	258.46		258.66	0.001112	3.54	584.27	125.06	0.26
Reach - 3	4718.573	25-Year	2864.00	249.06	260.13		260.35	0.000980	3.78	873.82	224.82	0.25
Reach - 3	4718.573	50-Year	3501.00	249.06	261.73		261.93	0.000737	3.65	1275.37	277.54	0.22
Reach - 3	4718.573	100-Year	3899.00	249.06	262.96		263.13	0.000566	3.43	1669.17	372.18	0.20
Reach - 3	4696.5	2-Year	846.00	249.91	255.93	251.97	256.00	0.000458	2.22	408.90	85.96	0.16
Reach - 3	4696.5	10-Year	1903.00	249.91	258.45	253.21	258.63	0.000668	3.43	609.61	115.54	0.21
Reach - 3	4696.5	25-Year	2633.00	249.91	260.09	253.93	260.33	0.000692	3.94	739.91	175.36	0.22
Reach - 3	4696.5	50-Year	3214.00	249.91	261.63	254.44	261.90	0.000631	4.15	862.52	214.09	0.22
Reach - 3	4696.5	100-Year	3588.00	249.91	262.82	254.75	263.09	0.000563	4.19	957.18	232.61	0.21
Reach - 3	4645.0		Culvert									

HEC-RAS Plan: Prop 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 3	4593.5	2-Year	846.00	249.19	255.75	251.25	255.81	0.000337	2.02	451.66	89.05	0.14
Reach - 3	4593.5	10-Year	1903.00	249.19	258.07	252.49	258.24	0.000583	3.29	635.94	127.43	0.20
Reach - 3	4593.5	25-Year	2633.00	249.19	259.47	253.20	259.70	0.000670	3.91	746.73	179.05	0.22
Reach - 3	4593.5	50-Year	3214.00	249.19	260.60	253.73	260.88	0.000693	4.27	837.16	209.29	0.23
Reach - 3	4593.5	100-Year	3588.00	249.19	261.48	254.04	261.78	0.000668	4.41	906.70	222.91	0.23
Reach - 3	4500.596	2-Year	846.00	248.23	255.44		255.69	0.002179	4.01	215.85	59.03	0.34
Reach - 3	4500.596	10-Year	1903.00	248.23	257.52		258.03	0.003202	5.80	403.82	116.98	0.42
Reach - 3	4500.596	25-Year	2633.00	248.23	258.94		259.49	0.002907	6.15	614.09	163.16	0.42
Reach - 3	4500.596	50-Year	3214.00	248.23	260.21		260.71	0.002366	6.00	824.68	169.64	0.38
Reach - 3	4500.596	100-Year	3588.00	248.23	261.19		261.63	0.001940	5.74	993.86	174.67	0.35
Reach - 3	4452.7	2-Year	846.00	248.28	255.43	250.94	255.59	0.000802	3.20	291.57	169.68	0.21
Reach - 3	4452.7	10-Year	1903.00	248.28	257.43	252.76	257.89	0.001705	5.52	399.83	421.03	0.32
Reach - 3	4452.7	25-Year	2633.00	248.28	258.68	253.84	259.34	0.002085	6.65	469.30	467.92	0.37
Reach - 3	4452.7	50-Year	3214.00	248.28	259.71	254.65	260.51	0.002225	7.32	527.12	607.84	0.38
Reach - 3	4452.7	100-Year	3588.00	248.28	260.57	255.11	261.41	0.002150	7.55	575.24	684.43	0.38
Reach - 3	4387.2		Culvert									
Reach - 3	4321.7	2-Year	846.00	249.27	255.20	251.93	255.44	0.001540	3.90	228.86	53.47	0.29
Reach - 3	4321.7	10-Year	1903.00	249.27	256.67	253.75	257.41	0.003591	6.93	304.71	199.38	0.45
Reach - 3	4321.7	25-Year	2633.00	249.27	257.43	254.84	258.56	0.004899	8.64	344.72	277.91	0.54
Reach - 3	4321.7	50-Year	3214.00	249.27	258.07	255.62	259.50	0.005582	9.72	379.90	403.04	0.58
Reach - 3	4321.7	100-Year	3588.00	249.27	258.93	256.10	260.38	0.005017	9.81	427.04	444.46	0.56
Reach - 3	4294.441	2-Year	846.00	246.73	255.20		255.37	0.001133	3.40	404.36	201.79	0.25
Reach - 3	4294.441	10-Year	1903.00	246.73	256.80		257.14	0.002023	5.22	872.81	329.50	0.34
Reach - 3	4294.441	25-Year	2633.00	246.73	257.71		258.11	0.002176	5.86	1175.96	335.05	0.36
Reach - 3	4294.441	50-Year	3214.00	246.73	258.50		258.90	0.002083	6.09	1442.60	339.87	0.36
Reach - 3	4294.441	100-Year	3588.00	246.73	259.41		259.75	0.001645	5.77	1755.23	345.42	0.32
Reach - 3	4000.0	2-Year	846.00	248.37	254.64		254.80	0.003965	4.67	637.13	401.79	0.41
Reach - 3	4000.0	10-Year	1903.00	248.37	256.23		256.36	0.002998	4.96	1370.59	507.06	0.37
Reach - 3	4000.0	25-Year	2633.00	248.37	257.26		257.37	0.002266	4.83	1904.47	539.65	0.33
Reach - 3	4000.0	50-Year	3214.00	248.37	258.16		258.25	0.001744	4.62	2399.90	567.08	0.30
Reach - 3	4000.0	100-Year	3588.00	248.37	259.21		259.27	0.001129	4.06	3006.88	586.16	0.25

HEC-RAS Plan: Prop 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 3	3500.0	2-Year	846.00	246.98	253.63		253.68	0.001373	2.88	1250.77	761.35	0.24
Reach - 3	3500.0	10-Year	1903.00	246.98	255.72		255.74	0.000616	2.48	2994.59	905.89	0.17
Reach - 3	3500.0	25-Year	2633.00	246.98	256.87		256.89	0.000475	2.44	4049.66	921.87	0.16
Reach - 3	3500.0	50-Year	3214.00	246.98	257.86		257.87	0.000380	2.36	4966.50	947.52	0.14
Reach - 3	3500.0	100-Year	3588.00	246.98	259.01		259.02	0.000255	2.11	6073.84	969.32	0.12
Reach - 3	3185.2	2-Year	862.00	246.10	252.88	249.97	253.12	0.001830	3.92	227.51	680.39	0.31
Reach - 3	3185.2	10-Year	1933.00	246.10	254.53	251.82	255.17	0.003415	6.49	339.04	861.02	0.45
Reach - 3	3185.2	25-Year	2682.00	246.10	255.32	252.84	256.27	0.004388	7.94	404.68	884.53	0.52
Reach - 3	3185.2	50-Year	3273.00	246.10	256.18	253.57	257.27	0.004395	8.55	479.62	903.86	0.53
Reach - 3	3185.2	100-Year	3662.00	246.10	257.66	254.03	258.56	0.003005	7.89	622.79	1069.68	0.45
Reach - 3	3157.2		Bridge									
Reach - 3	3129.2	2-Year	862.00	245.86	252.61	249.74	252.85	0.001880	3.95	225.42	667.19	0.31
Reach - 3	3129.2	10-Year	1933.00	245.86	253.38	251.58	254.27	0.005738	7.61	273.11	825.40	0.56
Reach - 3	3129.2	25-Year	2682.00	245.86	253.93	252.60	255.33	0.007997	9.57	312.09	848.68	0.68
Reach - 3	3129.2	50-Year	3273.00	245.86	254.38	253.32	256.16	0.009331	10.82	346.58	864.03	0.74
Reach - 3	3129.2	100-Year	3662.00	245.86	254.59	253.79	256.67	0.010472	11.71	363.58	871.10	0.79
Reach - 3	2957.4	2-Year	862.00	243.96	252.64		252.65	0.000221	1.51	2088.87	842.93	0.11
Reach - 3	2957.4	10-Year	1933.00	243.96	253.62		253.64	0.000452	2.38	2926.21	856.78	0.15
Reach - 3	2957.4	25-Year	2682.00	243.96	254.40		254.43	0.000484	2.64	3600.43	867.21	0.16
Reach - 3	2957.4	50-Year	3273.00	243.96	255.04		255.07	0.000476	2.75	4154.07	875.55	0.16
Reach - 3	2957.4	100-Year	3662.00	243.96	255.39		255.42	0.000484	2.85	4460.13	880.82	0.17
Reach - 3	2362.9	2-Year	862.00	243.50	252.43		252.46	0.000477	2.28	1593.60	702.69	0.16
Reach - 3	2362.9	10-Year	1933.00	243.50	253.16		253.23	0.001133	3.77	2116.41	722.87	0.25
Reach - 3	2362.9	25-Year	2682.00	243.50	253.93		254.00	0.001133	4.03	2680.35	743.48	0.25
Reach - 3	2362.9	50-Year	3273.00	243.50	254.59		254.66	0.001040	4.07	3177.63	760.41	0.24
Reach - 3	2362.9	100-Year	3662.00	243.50	254.94		255.01	0.001033	4.16	3442.85	768.38	0.24
Reach - 3	1661.6	2-Year	862.00	242.95	252.30		252.30	0.000120	1.16	2668.57	751.18	0.08
Reach - 3	1661.6	10-Year	1933.00	242.95	252.74		252.76	0.000426	2.29	3003.46	759.69	0.15
Reach - 3	1661.6	25-Year	2682.00	242.95	253.46		253.48	0.000498	2.63	3569.00	823.53	0.16
Reach - 3	1661.6	50-Year	3273.00	242.95	254.13		254.16	0.000499	2.78	4151.06	902.09	0.17
Reach - 3	1661.6	100-Year	3662.00	242.95	254.47		254.50	0.000512	2.88	4462.20	932.28	0.17

HEC-RAS Plan: Prop 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 3	920.6	2-Year	862.00	242.61	252.25	248.33	252.25	0.000042	0.75	4297.09	996.23	0.05
Reach - 3	920.6	10-Year	1933.00	242.61	252.56	248.88	252.57	0.000168	1.54	4606.72	1001.47	0.10
Reach - 3	920.6	25-Year	2682.00	242.61	253.24	249.15	253.25	0.000210	1.82	5291.71	1013.16	0.11
Reach - 3	920.6	50-Year	3273.00	242.61	253.91	249.31	253.92	0.000214	1.94	5974.25	1023.93	0.11
Reach - 3	920.6	100-Year	3662.00	242.61	254.24	249.39	254.25	0.000227	2.04	6313.41	1032.04	0.12

ALTERNATIVE CONDITIONS:

HEC-RAS OUTPUT

(PINEY MOUNTAIN ROAD FLOODPLAIN CULVERT ONLY)

HEC-RAS Plan: Piney Mt FP

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	26670.3	2-Year	176.00	470.17	472.07	472.07	472.77	0.028500	6.70	26.28	19.08	1.01
Reach - 1	26670.3	10-Year	426.00	470.17	473.98		474.59	0.009722	6.29	68.29	25.89	0.65
Reach - 1	26670.3	25-Year	585.00	470.17	475.82		476.23	0.003414	5.17	133.42	71.68	0.42
Reach - 1	26670.3	50-Year	731.00	470.17	476.91		477.28	0.002447	5.03	229.77	127.09	0.37
Reach - 1	26670.3	100-Year	891.00	470.17	478.38		478.61	0.001295	4.25	444.52	157.79	0.28
Reach - 1	26133.4	2-Year	211.00	467.03	471.03	468.62	471.11	0.000793	2.22	111.73	44.76	0.20
Reach - 1	26133.4	10-Year	449.00	467.03	473.30	469.49	473.42	0.000714	2.89	187.03	56.30	0.21
Reach - 1	26133.4	25-Year	619.00	467.03	475.43	470.00	475.55	0.000486	2.91	257.60	66.80	0.18
Reach - 1	26133.4	50-Year	764.00	467.03	476.54	470.38	476.68	0.000480	3.16	294.47	89.87	0.18
Reach - 1	26133.4	100-Year	937.00	467.03	478.05	470.82	478.21	0.000434	3.32	344.64	166.76	0.18
Reach - 1	26050.4		Culvert									
Reach - 1	25967.4	2-Year	211.00	463.47	465.57	465.06	465.91	0.009005	4.68	49.02	31.72	0.61
Reach - 1	25967.4	10-Year	447.00	463.47	466.57	465.93	467.16	0.009139	6.29	81.83	38.59	0.66
Reach - 1	25967.4	25-Year	611.00	463.47	467.13	466.42	467.88	0.009294	7.13	100.14	42.37	0.68
Reach - 1	25967.4	50-Year	750.00	463.47	467.53	466.79	468.42	0.009564	7.79	113.42	45.11	0.70
Reach - 1	25967.4	100-Year	865.00	463.47	467.82	467.08	468.83	0.009829	8.30	123.28	46.82	0.72
Reach - 1	25524.2	2-Year	211.00	456.43	458.52	458.52	459.29	0.027875	7.05	29.91	19.68	1.01
Reach - 1	25524.2	10-Year	447.00	456.43	459.55	459.55	460.70	0.025018	8.63	51.83	22.96	1.01
Reach - 1	25524.2	25-Year	611.00	456.43	460.10	460.10	461.49	0.023378	9.46	65.04	24.86	1.00
Reach - 1	25524.2	50-Year	750.00	456.43	460.53	460.53	462.09	0.021791	10.04	77.19	30.21	0.99
Reach - 1	25524.2	100-Year	865.00	456.43	460.87	460.87	462.55	0.020517	10.42	88.02	33.23	0.98
Reach - 1	24962.5	2-Year	211.00	444.33	447.17		447.50	0.008131	4.63	45.61	22.07	0.57
Reach - 1	24962.5	10-Year	447.00	444.33	448.35		448.94	0.008441	6.14	73.95	26.34	0.61
Reach - 1	24962.5	25-Year	611.00	444.33	448.74		449.60	0.010645	7.46	84.47	28.08	0.70
Reach - 1	24962.5	50-Year	750.00	444.33	449.07		450.15	0.011749	8.33	94.23	29.60	0.75
Reach - 1	24962.5	100-Year	865.00	444.33	449.31	448.75	450.57	0.012773	9.04	101.32	30.65	0.79
Reach - 1	24504.7	2-Year	328.00	437.03	439.64	439.64	440.58	0.025249	7.80	42.54	24.73	1.00
Reach - 1	24504.7	10-Year	680.00	437.03	440.77	440.77	442.26	0.022511	9.85	76.02	35.27	1.02
Reach - 1	24504.7	25-Year	916.00	437.03	441.58	441.58	443.12	0.017200	10.14	115.38	56.06	0.93
Reach - 1	24504.7	50-Year	1109.00	437.03	442.09	442.09	443.73	0.015709	10.56	146.38	64.87	0.90
Reach - 1	24504.7	100-Year	1263.00	437.03	442.47	442.47	444.16	0.014787	10.84	171.49	68.63	0.89

HEC-RAS Plan: Piney Mt FP (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	23991.1	2-Year	328.00	426.45	432.16		432.25	0.000832	2.57	265.26	198.31	0.21
Reach - 1	23991.1	10-Year	680.00	426.45	433.74		433.84	0.000803	3.06	622.99	244.58	0.21
Reach - 1	23991.1	25-Year	916.00	426.45	434.56		434.66	0.000774	3.25	828.11	258.77	0.21
Reach - 1	23991.1	50-Year	1109.00	426.45	435.17		435.27	0.000743	3.36	988.20	263.97	0.21
Reach - 1	23991.1	100-Year	1263.00	426.45	435.78		435.87	0.000664	3.34	1150.59	274.75	0.20
Reach - 1	23524.2	2-Year	328.00	425.63	431.97		432.00	0.000313	1.71	497.29	198.36	0.13
Reach - 1	23524.2	10-Year	680.00	425.63	433.52		433.56	0.000407	2.31	825.77	218.39	0.15
Reach - 1	23524.2	25-Year	916.00	425.63	434.32		434.37	0.000445	2.60	1002.25	222.24	0.16
Reach - 1	23524.2	50-Year	1109.00	425.63	434.93		434.99	0.000463	2.78	1138.32	225.16	0.17
Reach - 1	23524.2	100-Year	1263.00	425.63	435.55		435.61	0.000437	2.84	1279.41	228.16	0.17
Reach - 1	23024.2	2-Year	328.00	425.63	431.89		431.90	0.000145	1.16	927.09	325.34	0.09
Reach - 1	23024.2	10-Year	680.00	425.63	433.41		433.42	0.000184	1.53	1430.43	335.85	0.10
Reach - 1	23024.2	25-Year	916.00	425.63	434.20		434.22	0.000204	1.74	1700.20	345.89	0.11
Reach - 1	23024.2	50-Year	1109.00	425.63	434.80		434.82	0.000214	1.87	1911.26	353.86	0.11
Reach - 1	23024.2	100-Year	1263.00	425.63	435.43		435.45	0.000203	1.92	2137.94	366.29	0.11
Reach - 1	22524.2	2-Year	472.00	419.97	431.81		431.84	0.000088	1.45	635.75	95.34	0.08
Reach - 1	22524.2	10-Year	942.00	419.97	433.24		433.31	0.000221	2.49	787.83	120.92	0.12
Reach - 1	22524.2	25-Year	1225.00	419.97	433.98		434.08	0.000297	3.00	881.83	134.29	0.15
Reach - 1	22524.2	50-Year	1459.00	419.97	434.54		434.67	0.000355	3.37	960.12	144.45	0.16
Reach - 1	22524.2	100-Year	1677.00	419.97	435.14		435.30	0.000402	3.70	1054.78	168.24	0.17
Reach - 1	22396.4	2-Year	472.00	420.03	431.83	421.77	431.83	0.000000	0.08	5792.90	755.54	0.01
Reach - 1	22396.4	10-Year	942.00	420.03	433.29	422.19	433.29	0.000001	0.14	6890.06	777.58	0.01
Reach - 1	22396.4	25-Year	1225.00	420.03	434.05	422.36	434.05	0.000001	0.17	7466.89	789.02	0.01
Reach - 1	22396.4	50-Year	1459.00	420.03	434.63	422.49	434.63	0.000001	0.19	7911.45	797.77	0.01
Reach - 1	22396.4	100-Year	1677.00	420.03	435.25	422.60	435.25	0.000001	0.20	8384.81	807.04	0.01
Reach - 1	22383.4		Inl Struct									
Reach - 1	22370.4	2-Year	472.00	425.91	428.47	428.47	429.31	0.026061	7.37	64.06	38.82	1.01
Reach - 1	22370.4	10-Year	942.00	425.91	430.56		431.11	0.007479	5.97	157.85	50.94	0.60
Reach - 1	22370.4	25-Year	1225.00	425.91	431.91		432.34	0.004274	5.28	231.81	58.76	0.47
Reach - 1	22370.4	50-Year	1459.00	425.91	432.89		433.27	0.003183	4.99	292.10	64.43	0.41
Reach - 1	22370.4	100-Year	1677.00	425.91	434.43		434.71	0.001594	4.25	416.29	100.76	0.31

HEC-RAS Plan: Piney Mt FP (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	22255.4	2-Year	472.00	422.25	427.59	426.02	428.05	0.004502	5.50	93.79	27.00	0.48
Reach - 1	22255.4	10-Year	942.00	422.25	429.54	427.49	430.35	0.004802	7.35	150.85	31.82	0.53
Reach - 1	22255.4	25-Year	1225.00	422.25	430.78	428.27	431.70	0.004283	7.86	192.51	35.93	0.51
Reach - 1	22255.4	50-Year	1459.00	422.25	431.65	428.83	432.67	0.004110	8.30	226.17	41.90	0.51
Reach - 1	22255.4	100-Year	1677.00	422.25	433.45	429.36	434.30	0.002677	7.65	304.54	264.90	0.43
Reach - 1	22230.4		Bridge									
Reach - 1	22205.4	2-Year	460.00	421.56	425.28	425.28	426.51	0.022842	8.90	53.20	23.25	0.99
Reach - 1	22205.4	10-Year	842.00	421.56	426.52	426.52	428.32	0.019886	10.84	83.68	26.12	0.99
Reach - 1	22205.4	25-Year	1065.00	421.56	427.15	427.15	429.24	0.018709	11.67	100.73	27.59	0.98
Reach - 1	22205.4	50-Year	1270.00	421.56	427.69	427.69	430.01	0.017924	12.34	115.94	28.84	0.98
Reach - 1	22205.4	100-Year	1281.00	421.56	427.71	427.71	430.05	0.017965	12.39	116.57	28.89	0.98
Reach - 1	22061.4	2-Year	460.00	400.80	403.96	403.96	405.14	0.037122	8.70	52.88	22.83	1.01
Reach - 1	22061.4	10-Year	842.00	400.80	405.14	405.14	406.86	0.032402	10.51	80.38	23.94	1.00
Reach - 1	22061.4	25-Year	1065.00	400.80	405.71	405.71	407.73	0.031113	11.40	94.12	24.43	1.00
Reach - 1	22061.4	50-Year	1270.00	400.80	406.23	406.23	408.47	0.029433	12.03	106.93	24.87	1.00
Reach - 1	22061.4	100-Year	1281.00	400.80	406.25	406.25	408.51	0.029367	12.06	107.59	24.90	1.00
Reach - 1	21877	2-Year	460.00	390.67	393.01	393.01	393.65	0.028609	6.90	73.17	65.44	0.94
Reach - 1	21877	10-Year	842.00	390.67	393.78	393.78	394.58	0.026070	8.16	125.62	93.64	0.94
Reach - 1	21877	25-Year	1065.00	390.67	394.14	394.14	394.95	0.024515	8.57	172.35	144.59	0.93
Reach - 1	21877	50-Year	1270.00	390.67	394.59	394.33	395.29	0.018698	8.28	238.19	150.76	0.83
Reach - 1	21877	100-Year	1281.00	390.67	394.82	394.34	395.39	0.014105	7.55	273.96	153.51	0.73
Reach - 1	21577.4	2-Year	583.00	383.59	389.02		389.40	0.005287	5.10	167.47	105.48	0.42
Reach - 1	21577.4	10-Year	1128.00	383.59	390.27		390.83	0.006524	6.67	316.33	126.65	0.49
Reach - 1	21577.4	25-Year	1478.00	383.59	390.81		391.48	0.007470	7.57	385.42	134.75	0.53
Reach - 1	21577.4	50-Year	1750.00	383.59	391.14		391.93	0.008268	8.24	433.07	143.23	0.56
Reach - 1	21577.4	100-Year	1976.00	383.59	391.44		392.28	0.008616	8.66	475.68	147.72	0.58
Reach - 1	21329	2-Year	583.00	380.12	385.19	385.19	386.65	0.031190	9.70	60.12	20.66	1.00
Reach - 1	21329	10-Year	1128.00	380.12	387.38	387.38	388.46	0.014408	8.91	246.18	193.05	0.73
Reach - 1	21329	25-Year	1478.00	380.12	387.99	387.99	389.04	0.013106	9.24	380.38	245.69	0.71
Reach - 1	21329	50-Year	1750.00	380.12	388.33	388.33	389.37	0.012872	9.54	465.35	256.06	0.71
Reach - 1	21329	100-Year	1976.00	380.12	388.53	388.53	389.62	0.013366	9.96	517.81	260.84	0.73

HEC-RAS Plan: Piney Mt FP (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	21024.2	2-Year	583.00	375.87	381.90		382.26	0.003323	4.83	129.49	31.64	0.38
Reach - 1	21024.2	10-Year	1128.00	375.87	384.66		384.99	0.002039	5.05	562.41	314.26	0.32
Reach - 1	21024.2	25-Year	1478.00	375.87	386.39		386.55	0.001006	4.04	1182.15	386.79	0.23
Reach - 1	21024.2	50-Year	1750.00	375.87	387.36		387.47	0.000756	3.74	1561.00	394.80	0.20
Reach - 1	21024.2	100-Year	1976.00	375.87	388.00		388.10	0.000668	3.65	1815.98	400.40	0.19
Reach - 1	20803	2-Year	583.00	373.95	380.56		381.16	0.007718	6.22	95.76	31.20	0.51
Reach - 1	20803	10-Year	1128.00	373.95	383.96		384.42	0.003237	5.85	362.03	125.38	0.37
Reach - 1	20803	25-Year	1478.00	373.95	385.91		386.23	0.001973	5.28	658.04	179.20	0.30
Reach - 1	20803	50-Year	1750.00	373.95	386.93		387.22	0.001684	5.21	888.73	249.73	0.28
Reach - 1	20803	100-Year	1976.00	373.95	387.60		387.87	0.001563	5.22	1065.01	279.19	0.27
Reach - 1	20582.7	2-Year	583.00	372.04	380.48		380.61	0.000813	3.09	280.55	85.94	0.20
Reach - 1	20582.7	10-Year	1128.00	372.04	383.97		384.08	0.000517	3.17	935.16	252.29	0.17
Reach - 1	20582.7	25-Year	1478.00	372.04	385.92		386.00	0.000361	2.96	1459.15	283.50	0.14
Reach - 1	20582.7	50-Year	1750.00	372.04	386.93		387.01	0.000338	3.01	1757.82	304.67	0.14
Reach - 1	20582.7	100-Year	1976.00	372.04	387.59		387.67	0.000334	3.08	1961.62	311.66	0.14
Reach - 1	20391.6	2-Year	638.00	371.31	378.98	377.15	379.99	0.007573	8.78	124.63	64.12	0.59
Reach - 1	20391.6	10-Year	1184.00	371.31	382.65	379.55	383.60	0.004666	9.16	271.19	256.75	0.50
Reach - 1	20391.6	25-Year	1537.00	371.31	385.79	381.27	385.89	0.000751	4.37	1426.57	350.04	0.21
Reach - 1	20391.6	50-Year	1820.00	371.31	386.86	381.97	386.93	0.000539	3.89	1983.20	362.37	0.18
Reach - 1	20391.6	100-Year	2039.00	371.31	387.52	382.45	387.59	0.000493	3.83	2226.95	367.41	0.17
Reach - 1	20349.6		Mult Open									
Reach - 1	20307.6	2-Year	634.00	371.56	377.39	377.39	379.53	0.023194	12.50	76.87	22.44	0.98
Reach - 1	20307.6	10-Year	1134.00	371.56	380.10	380.10	382.00	0.013404	12.64	205.66	75.51	0.80
Reach - 1	20307.6	25-Year	1519.00	371.56	380.80	380.80	383.18	0.015839	14.56	261.89	89.80	0.88
Reach - 1	20307.6	50-Year	1804.00	371.56	382.39	382.39	383.78	0.008748	12.14	503.09	221.27	0.67
Reach - 1	20307.6	100-Year	2030.00	371.56	383.24	383.24	384.42	0.007282	11.68	714.11	275.31	0.62
Reach - 1	20223	2-Year	634.00	370.12	375.00	375.00	376.30	0.029417	9.13	69.51	28.53	1.00
Reach - 1	20223	10-Year	1134.00	370.12	376.52	376.52	377.88	0.017652	9.64	170.16	99.77	0.84
Reach - 1	20223	25-Year	1519.00	370.12	377.21	377.21	378.70	0.016650	10.39	243.96	113.15	0.84
Reach - 1	20223	50-Year	1804.00	370.12	377.65	377.65	379.22	0.016264	10.88	295.03	120.89	0.84
Reach - 1	20223	100-Year	2030.00	370.12	377.94	377.94	379.60	0.016453	11.34	330.13	125.93	0.85

HEC-RAS Plan: Piney Mt FP (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	20024.2	2-Year	634.00	366.75	371.38	370.55	372.13	0.010858	7.06	104.17	37.46	0.64
Reach - 1	20024.2	10-Year	1134.00	366.75	372.83		373.95	0.010878	8.80	166.07	51.62	0.68
Reach - 1	20024.2	25-Year	1519.00	366.75	373.46	372.69	375.00	0.012955	10.37	202.53	64.39	0.76
Reach - 1	20024.2	50-Year	1804.00	366.75	373.83	373.17	375.71	0.014611	11.47	228.71	78.33	0.81
Reach - 1	20024.2	100-Year	2030.00	366.75	374.17	373.76	376.22	0.015081	12.08	255.76	81.93	0.83
Reach - 1	19751	2-Year	634.00	361.35	366.70	366.43	367.88	0.023422	8.73	72.61	24.79	0.90
Reach - 1	19751	10-Year	1134.00	361.35	367.97	367.97	369.68	0.023638	10.52	117.31	54.87	0.95
Reach - 1	19751	25-Year	1519.00	361.35	368.90	368.90	370.70	0.019309	10.98	179.09	79.50	0.89
Reach - 1	19751	50-Year	1804.00	361.35	369.46	369.46	371.32	0.017670	11.32	226.83	88.51	0.86
Reach - 1	19751	100-Year	2030.00	361.35	369.81	369.81	371.77	0.017455	11.73	258.35	93.37	0.87
Reach - 1	19524.2	2-Year	634.00	356.87	360.62	360.62	362.03	0.028309	9.53	67.69	27.78	1.00
Reach - 1	19524.2	10-Year	1134.00	356.87	362.11	362.11	363.81	0.020410	10.71	135.48	53.78	0.91
Reach - 1	19524.2	25-Year	1519.00	356.87	362.91	362.91	364.87	0.019353	11.68	181.07	59.36	0.91
Reach - 1	19524.2	50-Year	1804.00	356.87	363.42	363.42	365.57	0.019156	12.37	211.90	62.65	0.92
Reach - 1	19524.2	100-Year	2030.00	356.87	363.83	363.83	366.09	0.018592	12.77	238.15	65.32	0.91
Reach - 1	19222	2-Year	634.00	348.54	351.92	351.92	353.06	0.027048	8.59	77.14	38.71	0.98
Reach - 1	19222	10-Year	1134.00	348.54	353.04	353.04	354.64	0.023130	10.27	125.63	46.85	0.97
Reach - 1	19222	25-Year	1519.00	348.54	353.74	353.74	355.65	0.022115	11.32	159.51	50.48	0.97
Reach - 1	19222	50-Year	1804.00	348.54	354.25	354.25	356.34	0.020791	11.86	186.20	52.62	0.96
Reach - 1	19222	100-Year	2030.00	348.54	354.61	354.61	356.85	0.020385	12.33	205.15	53.74	0.96
Reach - 1	19024.2	2-Year	634.00	343.08	348.33		348.94	0.006915	6.25	101.85	23.81	0.53
Reach - 1	19024.2	10-Year	1134.00	343.08	349.91	348.15	350.93	0.007739	8.13	155.15	55.04	0.59
Reach - 1	19024.2	25-Year	1519.00	343.08	350.83	349.14	352.07	0.008029	9.11	238.35	117.62	0.61
Reach - 1	19024.2	50-Year	1804.00	343.08	350.90	349.89	352.59	0.010898	10.68	246.32	126.39	0.72
Reach - 1	19024.2	100-Year	2030.00	343.08	351.19	350.68	353.07	0.011631	11.35	288.48	160.31	0.74
Reach - 1	18833	2-Year	634.00	339.27	344.81	344.81	346.42	0.030290	10.20	62.47	22.15	1.00
Reach - 1	18833	10-Year	1134.00	339.27	346.50	346.50	348.49	0.022271	11.53	121.65	44.46	0.92
Reach - 1	18833	25-Year	1519.00	339.27	347.59	347.59	349.72	0.018987	12.16	182.44	67.91	0.87
Reach - 1	18833	50-Year	1804.00	339.27	348.88	348.88	350.40	0.011512	10.78	348.38	158.40	0.70
Reach - 1	18833	100-Year	2030.00	339.27	349.20	349.20	350.76	0.011564	11.12	400.38	160.98	0.71
Reach - 1	18524.2	2-Year	634.00	333.12	340.33		340.61	0.001954	4.25	163.76	36.43	0.30
Reach - 1	18524.2	10-Year	1134.00	333.12	341.99		342.51	0.002763	5.91	237.00	53.26	0.37

HEC-RAS Plan: Piney Mt FP (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	18524.2	25-Year	1519.00	333.12	342.79		343.53	0.003496	7.09	302.70	102.82	0.42
Reach - 1	18524.2	50-Year	1804.00	333.12	343.33		344.19	0.003853	7.74	359.61	107.99	0.45
Reach - 1	18524.2	100-Year	2030.00	333.12	343.64		344.63	0.004245	8.31	394.02	111.81	0.47
Reach - 1	18317	2-Year	634.00	331.33	338.14	338.14	339.48	0.029379	9.40	80.27	43.69	0.92
Reach - 1	18317	10-Year	1134.00	331.33	339.58	339.58	341.14	0.023004	10.63	164.88	79.89	0.87
Reach - 1	18317	25-Year	1519.00	331.33	340.50	340.50	342.03	0.019182	10.95	251.47	103.28	0.82
Reach - 1	18317	50-Year	1804.00	331.33	340.90	340.90	342.58	0.019807	11.66	294.38	108.97	0.84
Reach - 1	18317	100-Year	2030.00	331.33	341.38	341.20	342.98	0.017747	11.62	348.35	115.73	0.81
Reach - 1	18024.2	2-Year	634.00	328.79	334.20		334.74	0.005990	5.95	117.06	35.99	0.49
Reach - 1	18024.2	10-Year	1134.00	328.79	335.44		336.44	0.008167	8.17	168.65	48.00	0.60
Reach - 1	18024.2	25-Year	1519.00	328.79	336.07	334.85	337.47	0.010049	9.72	201.60	55.30	0.68
Reach - 1	18024.2	50-Year	1804.00	328.79	336.51	335.50	338.20	0.011208	10.73	229.60	70.90	0.72
Reach - 1	18024.2	100-Year	2030.00	328.79	336.83	335.96	338.72	0.011957	11.42	252.91	77.01	0.75
Reach - 1	17810	2-Year	634.00	326.23	331.00	331.00	332.23	0.030063	8.87	71.50	29.24	1.00
Reach - 1	17810	10-Year	1134.00	326.23	332.55	332.22	333.85	0.019136	9.18	131.56	51.90	0.85
Reach - 1	17810	25-Year	1519.00	326.23	333.56	333.01	334.90	0.014433	9.40	193.96	72.63	0.77
Reach - 1	17810	50-Year	1804.00	326.23	334.22	333.51	335.57	0.012490	9.56	245.86	85.41	0.74
Reach - 1	17810	100-Year	2030.00	326.23	334.67	333.88	336.05	0.011553	9.72	287.01	93.31	0.72
Reach - 1	17524.2	2-Year	634.00	322.82	329.60		329.92	0.002438	4.54	159.27	39.33	0.33
Reach - 1	17524.2	10-Year	1134.00	322.82	331.23		331.78	0.003203	6.12	257.48	76.16	0.39
Reach - 1	17524.2	25-Year	1519.00	322.82	332.12		332.84	0.003710	7.10	330.62	89.50	0.43
Reach - 1	17524.2	50-Year	1804.00	322.82	332.68		333.53	0.004087	7.77	386.63	112.05	0.46
Reach - 1	17524.2	100-Year	2030.00	322.82	333.08		334.02	0.004324	8.23	435.34	129.02	0.47
Reach - 1	17294	2-Year	634.00	322.18	328.44		329.03	0.006400	6.41	149.91	68.64	0.51
Reach - 1	17294	10-Year	1134.00	322.18	329.88		330.70	0.007047	8.00	269.46	97.16	0.56
Reach - 1	17294	25-Year	1519.00	322.18	330.64		331.63	0.007670	9.01	347.46	108.35	0.60
Reach - 1	17294	50-Year	1804.00	322.18	331.15		332.23	0.007914	9.59	404.61	114.99	0.62
Reach - 1	17294	100-Year	2030.00	322.18	331.51		332.66	0.008132	10.03	446.90	119.51	0.63
Reach - 1	17020.0	2-Year	634.00	321.41	325.44	325.28	326.31	0.016965	7.86	121.43	76.87	0.78
Reach - 1	17020.0	10-Year	1134.00	321.41	326.31	326.31	327.62	0.020003	10.05	196.38	94.99	0.89
Reach - 1	17020.0	25-Year	1519.00	321.41	326.96	326.96	328.42	0.019295	10.91	262.47	108.48	0.89
Reach - 1	17020.0	50-Year	1804.00	321.41	327.35	327.35	328.94	0.019500	11.57	306.11	116.54	0.91

HEC-RAS Plan: Piney Mt FP (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	17020.0	100-Year	2030.00	321.41	327.65	327.65	329.32	0.019471	12.01	341.33	122.66	0.92
Reach - 1	16807	2-Year	634.00	318.05	321.79		322.60	0.017738	7.21	87.94	34.29	0.79
Reach - 1	16807	10-Year	1134.00	318.05	323.26	322.73	324.08	0.011775	7.51	213.76	117.29	0.68
Reach - 1	16807	25-Year	1519.00	318.05	324.07	323.37	324.90	0.009878	7.78	323.21	157.66	0.64
Reach - 1	16807	50-Year	1804.00	318.05	324.58		325.41	0.008832	7.91	407.83	168.05	0.62
Reach - 1	16807	100-Year	2030.00	318.05	324.94		325.77	0.008366	8.06	469.49	175.24	0.61
Reach - 1	16524.2	2-Year	675.00	313.59	319.04		319.67	0.006768	6.37	106.67	24.57	0.53
Reach - 1	16524.2	10-Year	1165.00	313.59	320.55	318.75	321.51	0.007231	7.97	201.93	108.79	0.57
Reach - 1	16524.2	25-Year	1559.00	313.59	321.41	319.89	322.49	0.007310	8.75	296.73	112.56	0.59
Reach - 1	16524.2	50-Year	1853.00	313.59	321.98	321.03	323.12	0.007243	9.18	362.04	115.07	0.59
Reach - 1	16524.2	100-Year	2075.00	313.59	322.44		323.59	0.006965	9.37	415.18	117.07	0.59
Reach - 1	16219	2-Year	675.00	307.88	314.14	314.14	315.69	0.032244	9.98	67.64	22.05	1.00
Reach - 1	16219	10-Year	1165.00	307.88	315.61	315.61	317.57	0.027083	11.25	108.28	38.25	0.97
Reach - 1	16219	25-Year	1559.00	307.88	316.62	316.62	318.75	0.022628	11.87	155.13	53.23	0.92
Reach - 1	16219	50-Year	1853.00	307.88	317.26	317.26	319.51	0.020830	12.31	191.85	61.54	0.90
Reach - 1	16219	100-Year	2075.00	307.88	317.60	317.60	320.03	0.021100	12.87	213.57	65.97	0.91
Reach - 1	16024.2	2-Year	675.00	304.23	309.99		310.53	0.005354	5.92	121.55	31.07	0.47
Reach - 1	16024.2	10-Year	1165.00	304.23	311.64		312.50	0.005823	7.50	178.42	40.52	0.52
Reach - 1	16024.2	25-Year	1559.00	304.23	312.62		313.73	0.006361	8.60	225.23	54.36	0.55
Reach - 1	16024.2	50-Year	1853.00	304.23	313.24		314.53	0.006730	9.33	261.57	62.05	0.58
Reach - 1	16024.2	100-Year	2075.00	304.23	313.67	311.39	315.09	0.006966	9.83	289.30	66.55	0.59
Reach - 1	15740	2-Year	675.00	297.95	303.37	303.37	304.88	2.445524	9.84	68.60	23.19	1.01
Reach - 1	15740	10-Year	1165.00	297.95	305.05	305.05	306.55	1.608710	9.87	118.78	39.52	0.86
Reach - 1	15740	25-Year	1559.00	297.95	305.92	305.92	307.41	1.175953	9.60	160.42	56.16	0.76
Reach - 1	15740	50-Year	1853.00	297.95	306.36	306.36	307.94	1.049711	9.60	186.77	63.90	0.73
Reach - 1	15740	100-Year	2075.00	297.95	306.61	306.61	308.32	1.000241	9.67	203.60	66.84	0.72
Reach - 1	15524.2	2-Year	675.00	293.18	300.55		300.83	0.001592	4.34	215.20	104.93	0.30
Reach - 1	15524.2	10-Year	1165.00	293.18	302.62		302.94	0.001442	4.97	507.70	190.21	0.30
Reach - 1	15524.2	25-Year	1559.00	293.18	303.30		303.72	0.001796	5.83	648.21	221.63	0.34
Reach - 1	15524.2	50-Year	1853.00	293.18	303.59		304.13	0.002193	6.58	718.46	244.77	0.38
Reach - 1	15524.2	100-Year	2075.00	293.18	303.79		304.41	0.002496	7.12	769.89	268.46	0.40

HEC-RAS Plan: Piney Mt FP (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	15291	2-Year	675.00	292.67	299.50		300.11	0.007096	6.30	107.21	24.85	0.53
Reach - 1	15291	10-Year	1165.00	292.67	302.30		302.51	0.002033	4.43	812.38	479.76	0.30
Reach - 1	15291	25-Year	1559.00	292.67	303.06		303.24	0.001727	4.39	1187.31	501.97	0.29
Reach - 1	15291	50-Year	1853.00	292.67	303.36		303.55	0.001873	4.70	1339.56	510.71	0.30
Reach - 1	15291	100-Year	2075.00	292.67	303.57		303.77	0.001981	4.92	1443.90	516.62	0.31
Reach - 1	15183.4	2-Year	675.00	292.43	299.29	296.48	299.58	0.002057	4.41	176.18	50.13	0.33
Reach - 1	15183.4	10-Year	1165.00	292.43	302.04	297.67	302.32	0.001266	4.55	524.29	263.52	0.28
Reach - 1	15183.4	25-Year	1559.00	292.43	302.57	298.49	302.98	0.001746	5.57	697.50	436.78	0.33
Reach - 1	15183.4	50-Year	1853.00	292.43	302.69	299.10	303.23	0.002269	6.41	753.34	466.22	0.38
Reach - 1	15183.4	100-Year	2075.00	292.43	302.72	299.49	303.38	0.002799	7.13	764.74	472.17	0.42
Reach - 1	15150.4		Bridge									
Reach - 1	15117.4	2-Year	675.00	292.69	298.43	296.74	298.91	0.004440	5.62	132.03	36.71	0.48
Reach - 1	15117.4	10-Year	1165.00	292.69	299.29	297.92	300.26	0.007265	8.03	167.22	46.11	0.62
Reach - 1	15117.4	25-Year	1559.00	292.69	299.84	298.75	301.23	0.009164	9.64	196.06	63.84	0.71
Reach - 1	15117.4	50-Year	1853.00	292.69	300.05	299.34	301.86	0.011373	11.00	210.14	69.33	0.80
Reach - 1	15117.4	100-Year	2075.00	292.69	300.15	299.84	302.33	0.013454	12.10	217.02	72.24	0.87
Reach - 1	15024.2	2-Year	687.00	291.44	298.38		298.58	0.001157	3.98	391.27	173.22	0.29
Reach - 1	15024.2	10-Year	1174.00	291.44	299.33		299.65	0.001676	5.27	561.57	185.30	0.35
Reach - 1	15024.2	25-Year	1570.00	291.44	299.89		300.40	0.002389	6.63	718.90	376.23	0.43
Reach - 1	15024.2	50-Year	1865.00	291.44	300.23		300.79	0.002616	7.14	850.58	393.13	0.45
Reach - 1	15024.2	100-Year	2086.00	291.44	300.46		301.05	0.002732	7.44	942.75	400.19	0.46
Reach - 1	14764	2-Year	687.00	290.94	296.83	295.80	297.41	0.006396	6.67	263.64	292.25	0.58
Reach - 1	14764	10-Year	1174.00	290.94	297.75		298.23	0.005677	6.95	589.28	421.93	0.55
Reach - 1	14764	25-Year	1570.00	290.94	298.29		298.70	0.005023	7.01	823.81	445.63	0.53
Reach - 1	14764	50-Year	1865.00	290.94	298.61		299.00	0.004851	7.16	969.29	455.18	0.53
Reach - 1	14764	100-Year	2086.00	290.94	298.83		299.22	0.004768	7.28	1070.73	461.72	0.53
Reach - 1	14524.2	2-Year	687.00	290.48	296.55		296.70	0.001258	3.74	636.06	428.25	0.29
Reach - 1	14524.2	10-Year	1174.00	290.48	297.33		297.50	0.001518	4.51	980.25	450.97	0.33
Reach - 1	14524.2	25-Year	1570.00	290.48	297.74		297.95	0.001863	5.22	1167.41	477.94	0.36
Reach - 1	14524.2	50-Year	1865.00	290.48	298.00		298.24	0.002042	5.61	1295.31	483.48	0.38
Reach - 1	14524.2	100-Year	2086.00	290.48	298.19		298.44	0.002145	5.87	1387.86	485.55	0.40

HEC-RAS Plan: Piney Mt FP (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	14034.8	2-Year	687.00	287.46	296.57		296.58	0.000056	1.07	2273.47	443.19	0.07
Reach - 1	14034.8	10-Year	1174.00	287.46	297.31		297.32	0.000113	1.61	2605.46	463.69	0.10
Reach - 1	14034.8	25-Year	1570.00	287.46	297.67		297.69	0.000172	2.04	2779.06	480.57	0.12
Reach - 1	14034.8	50-Year	1865.00	287.46	297.90		297.93	0.000218	2.34	2891.24	488.38	0.13
Reach - 1	14034.8	100-Year	2086.00	287.46	298.07		298.10	0.000254	2.55	2971.68	493.11	0.14
Reach - 1	13555.6	2-Year	687.00	287.38	296.55		296.55	0.000053	1.05	2279.10	419.77	0.06
Reach - 1	13555.6	10-Year	1174.00	287.38	297.25		297.27	0.000109	1.59	2579.50	434.34	0.09
Reach - 1	13555.6	25-Year	1570.00	287.38	297.59		297.61	0.000168	2.02	2728.73	444.85	0.12
Reach - 1	13555.6	50-Year	1865.00	287.38	297.80		297.83	0.000218	2.33	2822.08	451.62	0.13
Reach - 1	13555.6	100-Year	2086.00	287.38	297.95		297.98	0.000256	2.56	2888.28	456.20	0.15
Reach - 1	13024.2	2-Year	687.00	287.30	296.52		296.53	0.000055	1.08	2217.89	413.43	0.07
Reach - 1	13024.2	10-Year	1174.00	287.30	297.19		297.21	0.000114	1.63	2497.40	419.17	0.10
Reach - 1	13024.2	25-Year	1570.00	287.30	297.50		297.52	0.000177	2.07	2626.60	423.80	0.12
Reach - 1	13024.2	50-Year	1865.00	287.30	297.68		297.71	0.000231	2.40	2703.28	426.53	0.14
Reach - 1	13024.2	100-Year	2086.00	287.30	297.80		297.84	0.000273	2.63	2756.18	428.57	0.15
Reach - 1	12524.2	2-Year	687.00	287.22	296.50		296.50	0.000042	0.94	2639.56	493.90	0.06
Reach - 1	12524.2	10-Year	1174.00	287.22	297.15		297.15	0.000088	1.43	2966.29	509.48	0.08
Reach - 1	12524.2	25-Year	1570.00	287.22	297.43		297.44	0.000137	1.82	3109.70	511.94	0.11
Reach - 1	12524.2	50-Year	1865.00	287.22	297.58		297.60	0.000179	2.11	3190.76	513.04	0.12
Reach - 1	12524.2	100-Year	2086.00	287.22	297.69		297.71	0.000213	2.32	3245.15	513.78	0.13
Reach - 1	12024.2	2-Year	687.00	287.14	296.49		296.49	0.000015	0.56	4511.96	738.65	0.03
Reach - 1	12024.2	10-Year	1174.00	287.14	297.13		297.13	0.000031	0.86	4983.96	740.13	0.05
Reach - 1	12024.2	25-Year	1570.00	287.14	297.40		297.40	0.000049	1.10	5183.62	740.75	0.06
Reach - 1	12024.2	50-Year	1865.00	287.14	297.54		297.55	0.000065	1.27	5293.72	741.10	0.07
Reach - 1	12024.2	100-Year	2086.00	287.14	297.64		297.65	0.000077	1.40	5366.51	741.33	0.08
Reach - 1	11747.1	2-Year	687.00	284.16	296.49		296.49	0.000004	0.39	7366.75	1115.48	0.02
Reach - 1	11747.1	10-Year	1174.00	284.16	297.12		297.12	0.000010	0.60	8081.26	1131.64	0.03
Reach - 1	11747.1	25-Year	1570.00	284.16	297.39		297.39	0.000016	0.77	8385.01	1139.38	0.04
Reach - 1	11747.1	50-Year	1865.00	284.16	297.54		297.54	0.000021	0.90	8552.66	1151.24	0.05
Reach - 1	11747.1	100-Year	2086.00	284.16	297.63		297.64	0.000026	0.99	8664.07	1154.19	0.05
Reach - 1	11352.3	2-Year	823.00	273.46	296.48	277.81	296.49	0.000002	0.21	3993.25	578.59	0.01
Reach - 1	11352.3	10-Year	1773.00	273.46	297.12	279.38	297.12	0.000006	0.41	4441.90	595.37	0.02

HEC-RAS Plan: Piney Mt FP (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	11352.3	25-Year	2353.00	273.46	297.38	280.09	297.39	0.000010	0.53	4600.37	602.39	0.03
Reach - 1	11352.3	50-Year	2685.00	273.46	297.53	280.44	297.53	0.000013	0.60	4687.88	606.02	0.03
Reach - 1	11352.3	100-Year	2928.00	273.46	297.62	280.69	297.63	0.000015	0.65	4745.68	608.25	0.04
Reach - 1	11341.3		Inl Struct									
Reach - 1	11330.3	2-Year	823.00	277.80	282.25	282.25	283.72	0.012607	10.21	128.05	60.96	0.90
Reach - 1	11330.3	10-Year	1773.00	277.80	284.33	284.33	286.39	0.011298	12.80	280.99	86.14	0.92
Reach - 1	11330.3	25-Year	2353.00	277.80	285.29	285.29	287.62	0.011029	13.95	369.59	98.02	0.93
Reach - 1	11330.3	50-Year	2685.00	277.80	285.80	285.80	288.25	0.010810	14.47	421.25	104.32	0.93
Reach - 1	11330.3	100-Year	2928.00	277.80	286.17	286.17	288.68	0.010547	14.77	461.18	108.83	0.93
Reach - 1	11228.2	2-Year	823.00	274.45	279.26	279.26	280.91	0.016072	10.38	94.39	51.37	0.89
Reach - 1	11228.2	10-Year	1773.00	274.45	281.83	281.83	283.57	0.010639	11.62	308.09	119.37	0.79
Reach - 1	11228.2	25-Year	2353.00	274.45	282.68	282.68	284.59	0.010743	12.64	412.67	126.14	0.81
Reach - 1	11228.2	50-Year	2685.00	274.45	283.05	283.05	285.11	0.011248	13.35	459.66	130.13	0.83
Reach - 1	11228.2	100-Year	2928.00	274.45	283.33	283.33	285.47	0.011387	13.75	496.87	133.27	0.84
Reach - 1	10952.4	2-Year	823.00	270.52	274.54	274.54	275.79	0.015113	9.17	111.07	59.93	0.94
Reach - 1	10952.4	10-Year	1773.00	270.52	276.27	276.27	278.17	0.013212	11.67	227.14	75.37	0.95
Reach - 1	10952.4	25-Year	2353.00	270.52	276.83	276.83	279.38	0.015435	13.60	271.29	83.76	1.05
Reach - 1	10952.4	50-Year	2685.00	270.52	277.84	277.84	279.96	0.010436	12.58	380.85	123.84	0.89
Reach - 1	10952.4	100-Year	2928.00	270.52	277.86	277.86	280.36	0.012264	13.67	383.17	124.10	0.96
Reach - 1	10524.2	2-Year	823.00	263.63	268.94	268.02	269.73	0.007494	7.33	164.16	124.58	0.66
Reach - 1	10524.2	10-Year	1773.00	263.63	270.16	270.16	271.56	0.011096	10.38	339.78	167.52	0.83
Reach - 1	10524.2	25-Year	2353.00	263.63	270.85	270.85	272.42	0.011031	11.31	469.45	211.78	0.85
Reach - 1	10524.2	50-Year	2685.00	263.63	271.32	271.32	272.82	0.009897	11.31	575.39	233.69	0.81
Reach - 1	10524.2	100-Year	2928.00	263.63	271.57	271.57	273.07	0.009682	11.49	634.40	240.11	0.81
Reach - 1	10136.9	2-Year	823.00	261.02	269.01		269.07	0.000438	2.50	1210.59	612.10	0.18
Reach - 1	10136.9	10-Year	1773.00	261.02	270.14		270.24	0.000733	3.61	1947.45	694.72	0.23
Reach - 1	10136.9	25-Year	2353.00	261.02	270.85		270.95	0.000743	3.86	2456.70	735.87	0.24
Reach - 1	10136.9	50-Year	2685.00	261.02	271.65		271.73	0.000560	3.57	3065.05	780.49	0.21
Reach - 1	10136.9	100-Year	2928.00	261.02	271.89		271.97	0.000574	3.68	3250.57	792.82	0.21
Reach - 2	10024.2	2-Year	929.00	262.00	268.96		269.00	0.000811	2.59	1278.34	627.94	0.20
Reach - 2	10024.2	10-Year	2048.00	262.00	270.04		270.12	0.001326	3.73	2007.50	706.98	0.26

HEC-RAS Plan: Piney Mt FP (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 2	10024.2	25-Year	2731.00	262.00	270.76		270.83	0.001282	3.94	2526.51	749.46	0.26
Reach - 2	10024.2	50-Year	3124.00	262.00	271.58		271.64	0.000951	3.65	3173.42	844.95	0.23
Reach - 2	10024.2	100-Year	3395.00	262.00	271.82		271.88	0.000959	3.74	3378.03	887.05	0.23
Reach - 2	9691.7	2-Year	929.00	260.63	267.90	266.14	268.44	0.004010	6.34	308.48	436.78	0.47
Reach - 2	9691.7	10-Year	2048.00	260.63	269.50	268.50	269.64	0.001579	4.69	1654.51	527.43	0.31
Reach - 2	9691.7	25-Year	2731.00	260.63	270.18	268.50	270.34	0.001718	5.20	2028.27	565.11	0.32
Reach - 2	9691.7	50-Year	3124.00	260.63	271.17	268.51	271.28	0.001216	4.73	2599.94	601.15	0.28
Reach - 2	9691.7	100-Year	3395.00	260.63	271.39	268.51	271.51	0.001273	4.92	2733.46	615.90	0.29
Reach - 2	9676.2		Bridge									
Reach - 2	9660.7	2-Year	929.00	260.97	266.57	266.47	268.20	0.016822	10.29	101.21	256.44	0.91
Reach - 2	9660.7	10-Year	2048.00	260.97	269.19	268.01	269.42	0.002678	5.75	1325.30	488.87	0.39
Reach - 2	9660.7	25-Year	2731.00	260.97	270.09	268.23	270.29	0.002337	5.84	1786.12	540.14	0.38
Reach - 2	9660.7	50-Year	3124.00	260.97	270.58	268.48	270.77	0.002167	5.86	2058.67	568.26	0.37
Reach - 2	9660.7	100-Year	3395.00	260.97	270.91	268.62	271.11	0.002132	5.98	2251.56	577.89	0.36
Reach - 2	9524.2	2-Year	929.00	259.17	265.89		266.41	0.005611	5.98	226.91	125.45	0.47
Reach - 2	9524.2	10-Year	2048.00	259.17	268.56		268.95	0.003418	6.13	1009.15	467.54	0.39
Reach - 2	9524.2	25-Year	2731.00	259.17	269.63		269.93	0.002586	5.82	1523.49	494.22	0.35
Reach - 2	9524.2	50-Year	3124.00	259.17	270.19		270.45	0.002263	5.68	1802.35	500.56	0.33
Reach - 2	9524.2	100-Year	3395.00	259.17	270.57		270.81	0.002089	5.60	1993.28	508.21	0.32
Reach - 2	9024.2	2-Year	929.00	256.05	264.15		264.49	0.002657	4.78	253.31	87.82	0.33
Reach - 2	9024.2	10-Year	2048.00	256.05	266.63		267.23	0.003395	6.73	549.11	154.43	0.40
Reach - 2	9024.2	25-Year	2731.00	256.05	267.62		268.34	0.003732	7.58	709.58	166.49	0.43
Reach - 2	9024.2	50-Year	3124.00	256.05	268.21		268.96	0.003751	7.90	808.64	171.93	0.43
Reach - 2	9024.2	100-Year	3395.00	256.05	268.58		269.37	0.003807	8.14	874.72	181.77	0.44
Reach - 2	8588.6	2-Year	929.00	255.57	261.44		262.35	0.011114	7.62	122.98	37.30	0.65
Reach - 2	8588.6	10-Year	2048.00	255.57	264.72		265.40	0.005257	7.45	634.99	273.34	0.48
Reach - 2	8588.6	25-Year	2731.00	255.57	266.21		266.70	0.003503	6.87	1099.25	347.17	0.41
Reach - 2	8588.6	50-Year	3124.00	255.57	267.11		267.49	0.002646	6.37	1421.64	367.02	0.36
Reach - 2	8588.6	100-Year	3395.00	255.57	267.62		267.95	0.002346	6.20	1609.14	374.23	0.34
Reach - 2	8024.2	2-Year	929.00	250.67	260.27		260.50	0.001317	3.88	284.00	54.81	0.24
Reach - 2	8024.2	10-Year	2048.00	250.67	264.08		264.26	0.000864	4.09	1457.66	559.38	0.21

HEC-RAS Plan: Piney Mt FP (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 2	8024.2	25-Year	2731.00	250.67	265.87		265.97	0.000520	3.49	2508.48	629.62	0.17
Reach - 2	8024.2	50-Year	3124.00	250.67	266.85		266.92	0.000405	3.22	3144.32	661.40	0.15
Reach - 2	8024.2	100-Year	3395.00	250.67	267.38		267.45	0.000366	3.14	3505.20	732.31	0.14
Reach - 2	7524.2	2-Year	941.00	249.35	259.85		259.99	0.000745	3.14	654.09	508.05	0.19
Reach - 2	7524.2	10-Year	2077.00	249.35	264.02		264.04	0.000183	2.01	3428.74	736.76	0.10
Reach - 2	7524.2	25-Year	2777.00	249.35	265.81		265.83	0.000135	1.89	4804.17	793.30	0.09
Reach - 2	7524.2	50-Year	3203.00	249.35	266.79		266.81	0.000117	1.83	5596.72	818.15	0.08
Reach - 2	7524.2	100-Year	3470.00	249.35	267.33		267.34	0.000111	1.83	6037.37	839.13	0.08
Reach - 3	7024.2	2-Year	956.00	250.01	259.52		259.61	0.000716	2.84	911.94	461.73	0.18
Reach - 3	7024.2	10-Year	2116.00	250.01	263.93		263.95	0.000174	1.89	3194.12	572.86	0.10
Reach - 3	7024.2	25-Year	2836.00	250.01	265.73		265.75	0.000153	1.94	4316.28	738.61	0.09
Reach - 3	7024.2	50-Year	3294.00	250.01	266.73		266.75	0.000134	1.90	5066.19	765.64	0.09
Reach - 3	7024.2	100-Year	3576.00	250.01	267.26		267.28	0.000127	1.89	5479.41	774.70	0.08
Reach - 3	6790.2	2-Year	956.00	249.25	259.39		259.47	0.000460	2.37	478.54	106.59	0.15
Reach - 3	6790.2	10-Year	2116.00	249.25	263.76		263.88	0.000420	3.02	1319.04	352.13	0.15
Reach - 3	6790.2	25-Year	2836.00	249.25	265.56		265.69	0.000400	3.22	2060.85	479.99	0.15
Reach - 3	6790.2	50-Year	3294.00	249.25	266.56		266.68	0.000390	3.32	2587.29	567.82	0.15
Reach - 3	6790.2	100-Year	3576.00	249.25	267.09		267.22	0.000385	3.37	2904.61	610.93	0.15
Reach - 3	6733.5	2-Year	966.00	250.49	259.38	253.12	259.44	0.000256	2.00	487.80	238.63	0.13
Reach - 3	6733.5	10-Year	2334.00	250.49	263.70	254.88	263.85	0.000350	3.13	757.84	357.30	0.16
Reach - 3	6733.5	25-Year	3132.00	250.49	265.43	255.76	265.64	0.000406	3.68	866.04	526.87	0.17
Reach - 3	6733.5	50-Year	3639.00	250.49	266.56	256.25	266.65	0.000217	2.83	3341.57	682.23	0.13
Reach - 3	6733.5	100-Year	3999.00	250.49	267.09	256.57	267.19	0.000230	2.98	3732.52	761.09	0.13
Reach - 3	6670.0		Culvert									
Reach - 3	6606.5	2-Year	966.00	249.54	259.21	252.17	259.26	0.000187	1.83	536.30	247.94	0.11
Reach - 3	6606.5	10-Year	2334.00	249.54	262.99	253.94	263.14	0.000328	3.07	773.02	369.96	0.15
Reach - 3	6606.5	25-Year	3132.00	249.54	264.10	254.81	264.32	0.000446	3.78	841.86	470.34	0.18
Reach - 3	6606.5	50-Year	3639.00	249.54	264.75	255.29	265.02	0.000514	4.19	882.81	546.40	0.20
Reach - 3	6606.5	100-Year	3999.00	249.54	265.42	255.60	265.54	0.000280	3.19	3215.80	660.80	0.15
Reach - 3	6606.4	2-Year	966.00	249.54	259.12	252.39	259.24	0.000461	2.73	393.14	56.71	0.16
Reach - 3	6606.4	10-Year	2334.00	249.54	262.86	254.65	263.11	0.000716	4.25	1389.27	711.76	0.21

HEC-RAS Plan: Piney Mt FP (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 3	6606.4	25-Year	3132.00	249.54	264.08	255.75	264.31	0.000699	4.46	2286.88	758.79	0.21
Reach - 3	6606.4	50-Year	3639.00	249.54	264.78	256.41	265.00	0.000674	4.51	2825.13	785.45	0.20
Reach - 3	6606.4	100-Year	3999.00	249.54	265.31	256.86	265.51	0.000634	4.48	3250.40	812.37	0.20
Reach - 3	6268.9		Culvert									
Reach - 3	5931.4	2-Year	966.00	249.82	259.02	252.67	259.15	0.000532	2.86	372.08	55.00	0.17
Reach - 3	5931.4	10-Year	2334.00	249.82	262.44	254.93	262.78	0.000977	4.79	910.60	610.59	0.24
Reach - 3	5931.4	25-Year	3132.00	249.82	263.47	256.03	263.85	0.001090	5.33	1629.55	727.06	0.26
Reach - 3	5931.4	50-Year	3639.00	249.82	264.06	256.69	264.43	0.001096	5.50	2060.77	748.07	0.26
Reach - 3	5931.4	100-Year	3999.00	249.82	264.54	257.14	264.89	0.001043	5.49	2425.02	765.27	0.25
Reach - 3	5454.5	2-Year	966.00	248.76	257.97		258.50	0.003356	6.07	241.91	77.97	0.41
Reach - 3	5454.5	10-Year	2334.00	248.76	260.49	258.48	261.63	0.005287	9.41	622.66	296.91	0.54
Reach - 3	5454.5	25-Year	3132.00	248.76	261.94	260.74	262.80	0.004019	9.03	1194.89	675.89	0.48
Reach - 3	5454.5	50-Year	3639.00	248.76	262.96		263.56	0.002900	8.15	2064.47	928.87	0.42
Reach - 3	5454.5	100-Year	3999.00	248.76	263.94		264.25	0.001667	6.51	3003.87	975.97	0.32
Reach - 3	5024.2	2-Year	966.00	248.44	256.46		256.90	0.004018	6.02	376.62	193.86	0.44
Reach - 3	5024.2	10-Year	2334.00	248.44	259.37		259.76	0.002898	6.72	1072.23	307.37	0.40
Reach - 3	5024.2	25-Year	3132.00	248.44	261.06		261.39	0.002209	6.61	1665.37	420.94	0.36
Reach - 3	5024.2	50-Year	3639.00	248.44	262.35		262.58	0.001488	5.87	2236.48	462.65	0.30
Reach - 3	5024.2	100-Year	3999.00	248.44	263.47		263.64	0.001064	5.28	2790.63	514.03	0.26
Reach - 3	4718.573	2-Year	966.00	249.06	256.23		256.33	0.000795	2.56	377.65	81.09	0.21
Reach - 3	4718.573	10-Year	2334.00	249.06	258.97		259.18	0.001135	3.71	656.08	159.68	0.26
Reach - 3	4718.573	25-Year	3132.00	249.06	260.73		260.95	0.000897	3.78	1014.22	244.24	0.24
Reach - 3	4718.573	50-Year	3639.00	249.06	262.07		262.27	0.000695	3.61	1372.58	293.44	0.22
Reach - 3	4718.573	100-Year	3999.00	249.06	263.25		263.41	0.000535	3.38	1778.73	393.12	0.19
Reach - 3	4696.5	2-Year	955.00	249.91	256.22	252.13	256.31	0.000492	2.38	432.35	87.42	0.17
Reach - 3	4696.5	10-Year	2132.00	249.91	258.95	253.44	259.15	0.000687	3.62	649.39	133.13	0.22
Reach - 3	4696.5	25-Year	2860.00	249.91	260.67	254.14	260.92	0.000673	4.04	785.99	197.99	0.22
Reach - 3	4696.5	50-Year	3336.00	249.91	261.96	254.55	262.23	0.000617	4.18	888.83	219.24	0.22
Reach - 3	4696.5	100-Year	3706.00	249.91	263.17	254.86	263.39	0.000476	3.92	1549.76	237.95	0.19
Reach - 3	4645.0		Culvert									

HEC-RAS Plan: Piney Mt FP (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 3	4593.5	2-Year	955.00	249.19	256.03	251.41	256.10	0.000370	2.19	473.57	91.63	0.15
Reach - 3	4593.5	10-Year	2132.00	249.19	258.51	252.72	258.70	0.000617	3.50	671.03	142.96	0.21
Reach - 3	4593.5	25-Year	2860.00	249.19	259.91	253.41	260.16	0.000682	4.06	782.13	196.46	0.22
Reach - 3	4593.5	50-Year	3336.00	249.19	260.84	253.83	261.13	0.000695	4.34	855.83	212.95	0.23
Reach - 3	4593.5	100-Year	3706.00	249.19	261.71	254.13	262.01	0.000669	4.47	924.78	226.45	0.23
Reach - 3	4500.596	2-Year	955.00	248.23	255.68		255.96	0.002403	4.29	230.20	62.41	0.35
Reach - 3	4500.596	10-Year	2132.00	248.23	257.95		258.49	0.003180	5.99	456.26	126.11	0.43
Reach - 3	4500.596	25-Year	2860.00	248.23	259.44		259.97	0.002681	6.10	695.56	165.70	0.40
Reach - 3	4500.596	50-Year	3336.00	248.23	260.47		260.96	0.002273	5.97	868.98	170.97	0.38
Reach - 3	4500.596	100-Year	3706.00	248.23	261.44		261.87	0.001874	5.71	1037.35	175.94	0.35
Reach - 3	4452.7	2-Year	955.00	248.28	255.66	251.16	255.85	0.000914	3.49	303.79	197.65	0.23
Reach - 3	4452.7	10-Year	2132.00	248.28	257.84	253.11	258.37	0.001837	5.89	422.57	439.63	0.34
Reach - 3	4452.7	25-Year	2860.00	248.28	259.08	254.16	259.79	0.002152	6.93	491.78	505.38	0.37
Reach - 3	4452.7	50-Year	3336.00	248.28	259.92	254.80	260.75	0.002245	7.45	539.16	631.89	0.39
Reach - 3	4452.7	100-Year	3706.00	248.28	260.78	255.24	261.65	0.002161	7.66	587.03	699.06	0.38
Reach - 3	4387.2		Culvert									
Reach - 3	4321.7	2-Year	955.00	249.27	255.39	252.15	255.67	0.001760	4.26	238.35	60.21	0.31
Reach - 3	4321.7	10-Year	2132.00	249.27	256.95	254.10	257.80	0.003973	7.47	319.06	220.29	0.48
Reach - 3	4321.7	25-Year	2860.00	249.27	257.67	255.14	258.93	0.005203	9.09	358.12	351.65	0.56
Reach - 3	4321.7	50-Year	3336.00	249.27	258.21	255.79	259.70	0.005704	9.92	387.24	409.59	0.59
Reach - 3	4321.7	100-Year	3706.00	249.27	259.08	256.24	260.58	0.005063	9.96	435.50	449.41	0.56
Reach - 3	4294.441	2-Year	955.00	246.73	255.39		255.59	0.001283	3.68	446.87	240.57	0.26
Reach - 3	4294.441	10-Year	2132.00	246.73	257.11		257.48	0.002059	5.42	978.06	331.44	0.35
Reach - 3	4294.441	25-Year	2860.00	246.73	258.01		258.42	0.002154	5.97	1277.98	336.90	0.36
Reach - 3	4294.441	50-Year	3336.00	246.73	258.66		259.07	0.002059	6.13	1498.32	340.86	0.36
Reach - 3	4294.441	100-Year	3706.00	246.73	259.59		259.93	0.001616	5.79	1816.30	346.50	0.32
Reach - 3	4000.0	2-Year	955.00	248.37	254.80		254.96	0.004026	4.80	702.39	411.54	0.41
Reach - 3	4000.0	10-Year	2132.00	248.37	256.61		256.72	0.002589	4.82	1564.29	513.16	0.35
Reach - 3	4000.0	25-Year	2860.00	248.37	257.61		257.71	0.002038	4.75	2094.53	548.47	0.32
Reach - 3	4000.0	50-Year	3336.00	248.37	258.34		258.43	0.001666	4.59	2503.96	574.63	0.29
Reach - 3	4000.0	100-Year	3706.00	248.37	259.39		259.46	0.001083	4.04	3117.60	588.67	0.24

HEC-RAS Plan: Piney Mt FP (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 3	3500.0	2-Year	955.00	246.98	253.85		253.89	0.001264	2.83	1414.11	771.15	0.24
Reach - 3	3500.0	10-Year	2132.00	246.98	256.17		256.19	0.000533	2.42	3404.29	915.57	0.16
Reach - 3	3500.0	25-Year	2860.00	246.98	257.26		257.28	0.000431	2.40	4407.31	927.69	0.15
Reach - 3	3500.0	50-Year	3336.00	246.98	258.05		258.07	0.000365	2.35	5151.44	954.62	0.14
Reach - 3	3500.0	100-Year	3706.00	246.98	259.20		259.22	0.000247	2.10	6263.56	971.00	0.12
Reach - 3	3185.2	2-Year	971.00	246.10	253.02	250.21	253.31	0.002113	4.29	235.61	721.65	0.34
Reach - 3	3185.2	10-Year	2165.00	246.10	254.93	252.14	255.64	0.003474	6.81	371.64	874.58	0.45
Reach - 3	3185.2	25-Year	2909.00	246.10	255.67	253.11	256.67	0.004384	8.17	433.97	892.45	0.52
Reach - 3	3185.2	50-Year	3396.00	246.10	256.35	253.71	257.46	0.004398	8.66	494.93	907.51	0.53
Reach - 3	3185.2	100-Year	3779.00	246.10	257.84	254.15	258.76	0.002981	7.96	641.69	1072.19	0.45
Reach - 3	3157.2		Bridge									
Reach - 3	3129.2	2-Year	971.00	245.86	252.68	249.97	252.97	0.002271	4.39	229.51	689.09	0.35
Reach - 3	3129.2	10-Year	2165.00	245.86	253.48	251.91	254.56	0.006761	8.37	280.13	830.26	0.61
Reach - 3	3129.2	25-Year	2909.00	245.86	253.98	252.88	255.60	0.009167	10.29	315.54	850.48	0.72
Reach - 3	3129.2	50-Year	3396.00	245.86	254.39	253.47	256.30	0.010010	11.22	347.11	864.25	0.77
Reach - 3	3129.2	100-Year	3779.00	245.86	254.58	253.93	256.80	0.011206	12.10	362.81	870.78	0.81
Reach - 3	2957.4	2-Year	971.00	243.96	252.72		252.73	0.000258	1.65	2159.40	844.11	0.11
Reach - 3	2957.4	10-Year	2165.00	243.96	253.80		253.82	0.000494	2.53	3075.46	859.23	0.16
Reach - 3	2957.4	25-Year	2909.00	243.96	254.54		254.57	0.000518	2.76	3719.12	868.39	0.17
Reach - 3	2957.4	50-Year	3396.00	243.96	255.10		255.13	0.000494	2.81	4208.62	876.49	0.17
Reach - 3	2957.4	100-Year	3779.00	243.96	255.44		255.47	0.000500	2.90	4508.92	882.06	0.17
Reach - 3	2362.9	2-Year	971.00	243.50	252.47		252.51	0.000576	2.52	1624.81	703.90	0.17
Reach - 3	2362.9	10-Year	2165.00	243.50	253.28		253.37	0.001275	4.04	2205.40	729.79	0.26
Reach - 3	2362.9	25-Year	2909.00	243.50	254.03		254.11	0.001238	4.25	2752.81	747.48	0.26
Reach - 3	2362.9	50-Year	3396.00	243.50	254.63		254.71	0.001087	4.17	3210.50	761.40	0.25
Reach - 3	2362.9	100-Year	3779.00	243.50	254.97		255.05	0.001074	4.25	3471.89	769.25	0.25
Reach - 3	1661.6	2-Year	971.00	242.95	252.31		252.32	0.000151	1.31	2677.79	751.36	0.09
Reach - 3	1661.6	10-Year	2165.00	242.95	252.78		252.81	0.000518	2.53	3036.37	760.55	0.16
Reach - 3	1661.6	25-Year	2909.00	242.95	253.50		253.52	0.000572	2.83	3599.07	825.81	0.17
Reach - 3	1661.6	50-Year	3396.00	242.95	254.15		254.18	0.000532	2.87	4165.62	903.14	0.17
Reach - 3	1661.6	100-Year	3779.00	242.95	254.49		254.51	0.000541	2.97	4475.54	933.89	0.17

HEC-RAS Plan: Piney Mt FP (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 3	920.6	2-Year	971.00	242.61	252.25	248.37	252.25	0.000053	0.84	4297.09	996.23	0.05
Reach - 3	920.6	10-Year	2165.00	242.61	252.56	248.99	252.57	0.000211	1.73	4606.72	1001.47	0.11
Reach - 3	920.6	25-Year	2909.00	242.61	253.24	249.20	253.25	0.000248	1.98	5291.71	1013.16	0.12
Reach - 3	920.6	50-Year	3396.00	242.61	253.91	249.34	253.92	0.000231	2.01	5974.25	1023.93	0.12
Reach - 3	920.6	100-Year	3779.00	242.61	254.24	249.43	254.25	0.000241	2.11	6313.41	1032.04	0.12

EXISTING CONDITIONS:

HYDRAFLOW STORM SEWERS (10-YEAR EVENT)

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	10.000	-75.030	Hdwl	0.00	0.05	0.50	5.0	311.00	1.30	311.13	24	Cir	0.013	0.68	316.43	OUT
2	1	22.740	0.000	Curb	0.00	0.99	0.56	10.0	311.23	4.13	312.17	24	Cir	0.013	0.50	319.27	EL0131
3	2	39.270	5.519	Curb	0.00	0.85	0.52	5.0	312.27	2.88	313.40	24	Cir	0.013	1.10	319.90	EL0130
4	3	51.920	-43.720	Curb	0.00	1.73	0.61	15.0	316.30	2.66	317.68	24	Cir	0.013	0.50	321.88	EL0134
5	4	40.740	14.750	Curb	0.00	3.02	0.54	30.0	317.88	4.74	319.81	18	Cir	0.013	1.00	323.41	EL0135
6	1	30.280	-23.464	None	0.00	0.00	0.00	0.0	312.43	3.93	313.62	18	Cir	0.013	0.41	319.62	EL0136
7	6	223.050	-20.694	MH	0.00	0.00	0.00	0.0	316.82	7.18	332.84	18	Cir	0.013	0.49	337.24	EL0143
8	7	137.640	-25.945	Curb	0.00	0.35	0.56	5.0	334.44	8.67	346.37	24	Cir	0.013	1.18	349.57	EL0139
9	8	76.040	-8.212	Curb	0.00	0.50	0.58	5.0	346.57	3.89	349.53	15	Cir	0.013	1.16	355.03	EL0138
10	9	36.330	46.920	Comb	0.00	0.30	0.57	5.0	349.83	7.05	352.39	15	Cir	0.013	1.00	358.69	EL0137
11	8	38.160	48.669	Curb	0.00	1.55	0.51	15.0	346.47	8.46	349.70	18	Cir	0.013	0.50	353.20	EL0140
12	11	38.920	-15.600	Curb	0.00	3.07	0.53	30.0	350.10	13.16	355.22	18	Cir	0.013	0.83	358.62	EL0141
13	12	31.870	-29.628	Curb	0.00	1.68	0.56	15.0	355.32	5.08	356.94	15	Cir	0.013	1.00	360.24	EL0142
14	End	43.224	-0.150	MH	0.00	0.21	0.50	5.0	296.58	0.67	296.87	24	Cir	0.020	0.15	302.47	EL0005
15	14	31.000	1.950	MH	0.00	0.21	0.50	5.0	296.97	-0.13	296.93	24	Cir	0.020	0.15	303.63	EL0006
16	15	136.000	0.860	Curb	0.00	1.51	0.50	15.0	297.33	0.21	297.62	24	Cir	0.013	0.50	301.82	EL0007
17	16	83.000	0.430	Curb	0.00	0.89	0.50	10.0	297.72	1.94	299.33	24	Cir	0.013	0.50	302.93	EL0008
18	17	224.000	-0.150	Curb	0.00	0.40	0.50	5.0	299.43	0.88	301.41	24	Cir	0.013	1.00	304.51	EL0011

Rock Creek - Existing | Number of lines: 18 | Date: 10/25/2018

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	OUT	28.02	24	Cir	10.000	311.00	311.13	1.300	313.00	313.13	0.84	313.97	End	OpenHeadwall
2	EL0131	13.50	24	Cir	22.740	311.23	312.17	4.134	313.97	314.03	0.15	314.18	1	Curb-Horiz
3	EL0130	11.50	24	Cir	39.270	312.27	313.40	2.878	314.18	314.62	n/a	314.62 j	2	Curb-Horiz
4	EL0134	9.93	24	Cir	51.920	316.30	317.68	2.658	317.01	318.81	0.23	318.81	3	Curb-Horiz
5	EL0135	6.05	18	Cir	40.740	317.88	319.81	4.737	318.81	320.76	n/a	320.76	4	Curb-Horiz
6	EL0136	14.59	18	Cir	30.280	312.43	313.62	3.930	313.97	315.02	n/a	315.02 j	1	None
7	EL0143	14.71	18	Cir	223.050	316.82	332.84	7.182	317.59	334.24	n/a	334.24	6	Manhole
8	EL0139	14.84	24	Cir	137.640	334.44	346.37	8.668	335.08	347.76	0.75	347.76	7	Curb-Horiz
9	EL0138	3.25	15	Cir	76.040	346.57	349.53	3.893	347.76	350.26	n/a	350.26 j	8	Curb-Horiz
10	EL0137	1.23	15	Cir	36.330	349.83	352.39	7.047	350.26	352.83	0.16	352.83	9	Combination
11	EL0140	12.43	18	Cir	38.160	346.47	349.70	8.464	347.76	351.03	0.44	351.03	8	Curb-Horiz
12	EL0141	9.53	18	Cir	38.920	350.10	355.22	13.155	351.03	356.41	0.52	356.41	11	Curb-Horiz
13	EL0142	4.89	15	Cir	31.870	355.32	356.94	5.083	356.41	357.84	n/a	357.84 j	12	Curb-Horiz
14	EL0005	8.10	24	Cir	43.224	296.58	296.87	0.671	301.33*	301.46*	0.02	301.48	End	Manhole
15	EL0006	7.61	24	Cir	31.000	296.97	296.93	-0.129	301.48*	301.56*	0.01	301.57	14	Manhole
16	EL0007	7.27	24	Cir	136.000	297.33	297.62	0.213	301.57*	301.71*	0.04	301.76	15	Curb-Horiz
17	EL0008	3.53	24	Cir	83.000	297.72	299.33	1.940	301.76*	301.78*	0.01	301.79	16	Curb-Horiz
18	EL0011	1.44	24	Cir	224.000	299.43	301.41	0.884	301.79	301.93	0.08	302.00	17	Curb-Horiz

Rock Creek - Existing | Number of lines: 18 | Run Date: 10/25/2018

NOTES: Return period = 10 Yrs. ; *Surcharged (HGL above crown). ; j - Line contains hyd. jump.

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q Byp (cfs)	Junc Type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp Line No
							Ht (in)	L (ft)	Area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	PE_EL0132	0.18	20.48	20.66	0.00	Hdwl	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
2	CB_EL0131	3.34	19.84	2.70	20.48	Curb	6.0	4.00	0.00	0.00	0.00	0.020	2.00	0.050	0.030	0.013	0.48	14.67	0.46	14.00	0.0	1
3	CB_EL0130	3.19	17.33	2.52	17.99	Curb	6.0	4.00	0.00	0.00	0.00	0.020	2.00	0.050	0.030	0.013	0.46	14.00	0.44	13.33	0.0	2
4	CB_EL0134	5.48	14.78	2.94	17.33	Curb	6.0	4.00	0.00	0.00	0.00	0.020	2.00	0.050	0.048	0.013	0.51	10.48	0.48	9.92	0.0	3
5	CB_EL0135	6.05	0.00	1.43	4.62	Curb	6.0	4.00	0.00	0.00	0.00	0.020	2.00	0.050	0.048	0.013	0.32	6.65	0.30	6.17	0.0	4
6	UGPJ_EL036	0.00	0.00	0.00	0.00	None	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
7	JB_EL0143	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
8	CB_EL0139	1.41	1.33	0.90	1.84	Curb	6.0	4.00	0.00	0.00	0.00	0.020	2.00	0.050	0.057	0.013	0.25	4.54	0.21	3.93	0.0	2
9	CB_EL0138	2.09	0.00	0.76	1.33	Curb	6.0	4.00	0.00	0.00	0.00	0.020	2.00	0.050	0.057	0.013	0.22	4.12	0.19	3.58	0.0	8
10	CB_EL0137	1.23	0.00	1.14	0.09	Comb	6.0	3.00	0.00	3.00	2.00	0.020	2.00	0.050	0.050	0.013	0.18	3.60	0.07	1.40	0.0	11
11	CB_EL0140	4.11	8.37	2.31	10.16	Curb	6.0	4.00	0.00	0.00	0.00	0.020	2.00	0.050	0.057	0.013	0.44	7.91	0.41	7.44	0.0	4
12	CB_EL0141	6.04	4.23	1.99	8.27	Curb	6.0	4.00	0.00	0.00	0.00	0.020	2.00	0.050	0.051	0.013	0.40	7.84	0.37	7.29	0.0	11
13	CB_EL0142	4.89	0.00	0.66	4.23	Curb	6.0	4.00	0.00	0.00	0.00	0.200	2.00	0.050	0.051	0.013	0.20	3.88	0.19	3.76	0.0	12
14	JB_EL0005	0.76	0.00	0.00	0.76	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
15	JB_EL0006	0.76	0.00	0.00	0.76	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
16	CB_EL0007	3.92	2.54	1.43	5.03	Curb	6.0	4.00	0.00	0.00	0.00	0.020	2.00	0.050	0.040	0.013	0.32	7.55	0.30	7.00	0.0	Off
17	CB_EL0008	2.68	0.86	1.00	2.54	Curb	6.0	4.00	0.00	0.00	0.00	0.020	2.00	0.050	0.040	0.013	0.26	6.00	0.23	5.25	0.0	16
18	CB_EL0011	1.44	0.00	0.59	0.86	Curb	6.0	4.00	0.00	0.00	0.00	0.020	2.00	0.050	0.040	0.013	0.19	4.20	0.16	3.50	0.0	17

Rock Creek - Existing | Number of lines: 18 | Run Date: 10/25/2018

NOTES: Inlet N-Values = 0.016; Intensity = 105.70 / (Inlet time + 16.80) ^ 0.87; Return period = 10 Yrs. ; * Indicates Known Q added. All curb inlets are Horiz throat.

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf		Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf	Ave Sf	Enrgy loss		
(1)	(in) (2)	(cfs) (3)	(ft) (4)	(ft) (5)	(ft) (6)	(sqft) (7)	(ft/s) (8)	(ft) (9)	(ft) (10)	(%) (11)	(ft) (12)	(ft) (13)	(ft) (14)	(ft) (15)	(sqft) (16)	(ft/s) (17)	(ft) (18)	(ft) (19)	(%) (20)	(%) (21)	(ft) (22)	(K) (23)	(ft) (24)
1	24	28.02	311.00	313.00	2.00	3.14	8.92	1.24	314.24	1.536	10.000	311.13	313.13	2.00	3.14	8.92	1.24	314.37	1.509	1.522	0.152	0.68	0.84
2	24	13.50	311.23	313.97	2.00	3.14	4.30	0.29	314.26	0.356	22.740	312.17	314.03	1.86	3.04	4.44	0.31	314.33	0.308	0.332	0.076	0.50	0.15
3	24	11.50	312.27	314.18	1.91	2.00	3.72	0.51	314.69	0.000	39.270	313.40	314.62 j	1.22**	2.00	5.75	0.51	315.13	0.000	0.000	n/a	1.10	n/a
4	24	9.93	316.30	317.01	0.71*	1.00	9.96	0.46	317.47	0.000	51.920	317.68	318.81	1.13**	1.82	5.45	0.46	319.27	0.000	0.000	n/a	0.50	0.23
5	18	6.05	317.88	318.81	0.93	1.15	5.28	0.41	319.22	0.000	40.740	319.81	320.76	0.95**	1.18	5.13	0.41	321.17	0.000	0.000	n/a	1.00	n/a
6	18	14.59	312.43	313.97	1.50	1.71	8.26	1.06	315.03	1.930	30.280	313.62	315.02 j	1.40**	1.71	8.51	1.13	316.14	1.669	1.799	n/a	0.41	n/a
7	18	14.71	316.82	317.59	0.77*	0.91	16.10	1.14	318.73	0.000	223.050	332.84	334.24	1.40**	1.72	8.57	1.14	335.38	0.000	0.000	n/a	0.49	n/a
8	24	14.84	334.44	335.08	0.64*	0.87	17.05	0.63	335.71	0.000	137.640	346.37	347.76	1.39**	2.33	6.38	0.63	348.39	0.000	0.000	n/a	1.18	0.75
9	15	3.25	346.57	347.76	1.19	0.74	2.70	0.30	348.06	0.000	76.040	349.53	350.26 j	0.73**	0.74	4.40	0.30	350.56	0.000	0.000	n/a	1.16	0.35
10	15	1.23	349.83	350.26	0.43	0.37	3.35	0.16	350.42	0.000	36.330	352.39	352.83	0.44**	0.38	3.22	0.16	352.99	0.000	0.000	n/a	1.00	0.16
11	18	12.43	346.47	347.76	1.29	1.61	7.70	0.88	348.63	0.000	38.160	349.70	351.03	1.33**	1.66	7.50	0.88	351.91	0.000	0.000	n/a	0.50	0.44
12	18	9.53	350.10	351.03	0.93	1.15	8.27	0.62	351.65	0.000	38.920	355.22	356.41	1.19**	1.51	6.33	0.62	357.03	0.000	0.000	n/a	0.83	0.52
13	15	4.89	355.32	356.41	1.09	0.94	4.30	0.42	356.83	0.000	31.870	356.94	357.84 j	0.90**	0.94	5.19	0.42	358.26	0.000	0.000	n/a	1.00	0.42
14	24	8.10	296.58	301.33	2.00	3.14	2.58	0.10	301.43	0.304	43.224	296.87	301.46	2.00	3.14	2.58	0.10	301.56	0.304	0.304	0.131	0.15	0.02
15	24	7.61	296.97	301.48	2.00	3.14	2.42	0.09	301.57	0.268	31.000	296.93	301.56	2.00	3.14	2.42	0.09	301.65	0.268	0.268	0.083	0.15	0.01
16	24	7.27	297.33	301.57	2.00	3.14	2.32	0.08	301.66	0.103	136.000	297.62	301.71	2.00	3.14	2.31	0.08	301.80	0.103	0.103	0.141	0.50	0.04
17	24	3.53	297.72	301.76	2.00	3.14	1.12	0.02	301.78	0.024	83.000	299.33	301.78	2.00	3.14	1.12	0.02	301.80	0.024	0.024	0.020	0.50	0.01
18	24	1.44	299.43	301.79	2.00	3.14	0.46	0.00	301.79	0.004	224.000	301.41	301.93	0.52	0.64	2.25	0.08	302.00	0.191	0.098	0.219	1.00	0.08

Rock Creek - Existing | Number of lines: 18 | Run Date: 10/25/2018

Notes: * Normal depth assumed; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

EXISTING CONDITIONS:
SWMM OUTPUT

Existing Conditions - Shady Lawn (10-Year)

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.021)
--------------------------------------------------------------

Existing Conditions - Shady Lawn (10-Year)
Starting WSELs interpolated between HEC-RAS XS 13024 and 13556
2-Year = 296.25'

******************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
******************************************************

***************
Analysis Options
***************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... CURVE_NUMBER
Flow Routing Method ...... DYNWAVE
Starting Date ............ MAY-05-2016 00:00:00
Ending Date .............. MAY-06-2016 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:15:00
Wet Time Step ............ 00:10:00
Dry Time Step ............ 00:10:00
Routing Time Step ........ 10.00 sec

WARNING 02: maximum depth increased for Node 8_EL0186_PE

*************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
*************************     ---------       -------
Total Precipitation ......         5.004         5.385
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         1.852         1.993
Surface Runoff ...........         3.107         3.344
Final Surface Storage ....         0.054         0.058
Continuity Error (%) .....        -0.193


*************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
*************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         3.102         1.011
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         3.094         1.008
Internal Outflow .........         0.000         0.000
Storage Losses ...........         0.000         0.000
Initial Stored Volume ....         0.016         0.005
Final Stored Volume ......         0.025         0.008
Continuity Error (%) .....        -0.003


**************************
Time-Step Critical Elements
**************************
Link 15_RCP_EL0187 (12.76%)
Link 15_RCP_EL0180 (1.21%)


******************************
Highest Flow Instability Indexes
******************************
All links are stable.
```

Existing Conditions - Shady Lawn (10-Year)

```
************************
Routing Time Step Summary
************************
Minimum Time Step           :     0.50 sec
Average Time Step           :     9.63 sec
Maximum Time Step           :    10.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.00


**************************
Subcatchment Runoff Summary
**************************

-----------------------------------------------------------------------------------------------------------
                         Total      Total      Total      Total      Total       Total     Peak  Runoff
                        Precip      Runon       Evap      Infil     Runoff      Runoff   Runoff   Coeff
Subcatchment                in         in         in         in         in    10^6 gal      CFS
-----------------------------------------------------------------------------------------------------------
Shadylawn_10              5.38       0.00       0.00       1.95       3.38        0.26     6.04   0.628
Shadylawn_20              5.39       0.00       0.00       1.07       4.28        0.06     1.39   0.794
Shadylawn_30              5.38       0.00       0.00       2.21       3.12        0.16     3.67   0.580
Shadylawn_40              5.38       0.00       0.00       2.59       2.75        0.01     0.20   0.511
Shadylawn_50              5.38       0.00       0.00       2.15       3.19        0.12     2.71   0.592
Shadylawn_60              5.39       0.00       0.00       1.86       3.49        0.04     0.91   0.647
Shadylawn_70              5.38       0.00       0.00       1.96       3.38        0.11     2.47   0.627
Shadylawn_80              5.39       0.00       0.00       2.22       3.12        0.06     1.40   0.579
Shadylawn_90              5.39       0.00       0.00       2.07       3.27        0.14     3.26   0.608
Shadylawn_100             5.39       0.00       0.00       1.53       3.82        0.06     1.25   0.709


******************
Node Depth Summary
******************

-----------------------------------------------------------------------
                           Average  Maximum  Maximum  Time of Max
                             Depth    Depth      HGL   Occurrence
Node                 Type     Feet     Feet     Feet  days hr:min
-----------------------------------------------------------------------
1_EL0610_DI          JUNCTION     0.07     0.31   347.12     0  13:00
2_EL611_SI*          JUNCTION     0.08     0.35   339.65     0  13:00
3_EL0612_PE          JUNCTION     0.05     0.30   320.30     0  13:00
4_EL0181_PE          JUNCTION     0.28     1.83   306.23     0  13:01
5_EL0182_CB          JUNCTION     0.20     1.71   306.04     0  13:00
6_EL0183_CB          JUNCTION     0.24     1.68   305.33     0  13:00
7_EL0184_PE          JUNCTION     0.09     0.50   303.84     0  13:00
1_EL0188_PE          JUNCTION     0.28     0.61   401.99     0  13:00
2_EL0189_DI          JUNCTION     0.40     0.93   382.24     0  13:00
3_EL0190_CB*         JUNCTION     0.17     1.17   375.77     0  13:00
4_EL0191_PE          JUNCTION     0.13     0.69   371.92     0  13:00
5_EL0179_PE          JUNCTION     0.31     2.54   307.82     0  13:01
6_EL0180_CB          JUNCTION     0.70     2.96   307.64     0  13:01
7_EL0187_DA*         JUNCTION     0.23     2.09   307.03     0  13:03
8_EL0186_PE          JUNCTION     0.10     0.53   300.67     0  13:03
SHADYLAWN_1          OUTFALL      9.80     9.80   297.15     0  00:00
SHADYLAWN_2          OUTFALL      9.80     9.80   297.15     0  00:00


******************
Node Inflow Summary
******************

-------------------------------------------------------------------------------------
                           Maximum  Maximum                  Lateral       Total
                           Lateral    Total  Time of Max      Inflow      Inflow
                            Inflow   Inflow   Occurrence      Volume      Volume
Node                 Type      CFS      CFS  days hr:min    10^6 gal    10^6 gal
-------------------------------------------------------------------------------------
1_EL0610_DI          JUNCTION     2.47     2.47     0  12:59       0.105       0.105
2_EL611_SI*          JUNCTION     1.40     3.87     0  13:00       0.061       0.166
3_EL0612_PE          JUNCTION     0.00     3.87     0  13:00       0.000       0.166
4_EL0181_PE          JUNCTION     0.00     3.86     0  13:00       0.000       0.166
```

5_EL0182_CB	JUNCTION	3.26	6.85	0	12:59	0.143	0.309
6_EL0183_CB	JUNCTION	0.00	6.85	0	13:00	0.000	0.309
7_EL0184_PE	JUNCTION	1.25	8.10	0	13:00	0.056	0.365
1_EL0188_PE	JUNCTION	6.04	6.04	0	13:00	0.257	0.257
2_EL0189_DI	JUNCTION	1.39	7.43	0	13:00	0.063	0.320
3_EL0190_CB*	JUNCTION	3.66	11.08	0	13:00	0.158	0.477
4_EL0191_PE	JUNCTION	0.20	11.24	0	13:00	0.008	0.486
5_EL0179_PE	JUNCTION	0.00	11.22	0	13:00	0.000	0.486
6_EL0180_CB	JUNCTION	2.71	13.42	0	13:01	0.119	0.603
7_EL0187_DA*	JUNCTION	0.00	13.45	0	13:02	0.000	0.603
8_EL0186_PE	JUNCTION	0.91	14.05	0	13:03	0.041	0.644
SHADYLAWN_1	OUTFALL	0.00	8.09	0	13:00	0.000	0.364
SHADYLAWN_2	OUTFALL	0.00	14.05	0	13:03	0.000	0.644

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Feet	Min. Depth Below Rim Feet
6_EL0183_CB	JUNCTION	0.40	0.335	1.615

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq. Pcnt.	Avg. Flow CFS	Max. Flow CFS	Total Volume 10^6 gal
SHADYLAWN_1	95.02	0.74	8.09	0.364
SHADYLAWN_2	93.92	1.30	14.05	0.644
System	94.47	2.04	21.76	1.008

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days	hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
15_RCP_EL0610	CONDUIT	2.47	0	13:00	9.60	0.12	0.26
18_RCP_EL0611	CONDUIT	3.87	0	13:00	13.61	0.10	0.22
SHADYLAWN_DITCH_1	CONDUIT	3.86	0	13:00	2.24	0.12	0.65
15_RCP_EL0181	CONDUIT	4.08	0	13:03	3.33	1.80	1.00
OVER_15_RCP_EL0181	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
15_RCP_EL0182	CONDUIT	6.85	0	13:00	5.58	0.77	1.00
15_RCP_EL0183	CONDUIT	6.85	0	13:00	7.44	0.47	0.70
SHADYLAWN_CHANNEL_1	CONDUIT	8.09	0	13:00	3.91	0.28	0.75
15_RCP_0188	CONDUIT	6.04	0	13:00	9.04	0.23	0.53
15_RCP_EL0189	CONDUIT	7.42	0	13:00	8.18	0.51	0.72
15_RCP_EL0190	CONDUIT	11.05	0	13:00	11.60	0.58	0.74
OVER_15_RCP_EL0190	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
SHADYLAWN_DITCH_2	CONDUIT	11.22	0	13:00	4.34	0.20	0.73
15_RCP_EL0179	CONDUIT	6.50	0	13:17	5.30	0.77	1.00
OVER_15_RCP_EL0179	CONDUIT	7.74	0	13:02	1.88	0.00	0.13
15_RCP_EL0187	CONDUIT	9.61	0	12:53	7.95	2.23	1.00

OVER_15_RCP_EL0187	CONDUIT	6.98	0	13:02	4.84	0.00	0.05
15_RCP_EL0180	CONDUIT	10.89	0	13:03	12.04	0.68	0.71
OVER_15_RCP_EL0180	CONDUIT	2.48	0	13:03	5.60	0.00	0.02
SHADYLAWN_CHANNEL_2	CONDUIT	14.05	0	13:03	3.27	0.14	0.68

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change
15_RCP_EL0610	2.86	0.04	0.00	0.00	0.00	0.96	0.00	0.00	2.65	0.0000
18_RCP_EL0611	1.85	0.04	0.00	0.00	0.00	0.96	0.00	0.00	5.14	0.0000
SHADYLAWN_DITCH_1	1.00	0.04	0.00	0.00	0.95	0.01	0.00	0.00	0.22	0.0000
15_RCP_EL0181	4.82	0.04	0.03	0.00	0.04	0.00	0.89	0.00	0.48	0.0004
OVER_15_RCP_EL0181	45.25	0.99	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
15_RCP_EL0182	4.54	0.04	0.00	0.00	0.04	0.17	0.00	0.75	1.50	0.0002
15_RCP_EL0183	30.53	0.04	0.00	0.00	0.00	0.96	0.00	0.00	2.26	0.0001
SHADYLAWN_CHANNEL_1	1.00	0.00	0.04	0.00	0.96	0.00	0.00	0.00	0.11	0.0001
15_RCP_0188	2.27	0.04	0.02	0.00	0.75	0.19	0.00	0.00	0.56	0.0001
15_RCP_EL0189	1.33	0.04	0.08	0.00	0.00	0.88	0.00	0.00	2.04	0.0001
15_RCP_EL0190	5.60	0.04	0.00	0.00	0.00	0.96	0.00	0.00	3.56	0.0001
OVER_15_RCP_EL0190	10.48	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
SHADYLAWN_DITCH_2	1.00	0.04	0.00	0.00	0.41	0.54	0.00	0.00	0.95	0.0000
15_RCP_EL0179	4.57	0.04	0.00	0.00	0.95	0.00	0.00	0.01	0.35	0.0002
OVER_15_RCP_EL0179	14.50	0.95	0.02	0.00	0.01	0.00	0.02	0.00	0.01	0.0000
15_RCP_EL0187	2.74	0.05	0.04	0.00	0.88	0.03	0.00	0.00	0.50	0.0007
OVER_15_RCP_EL0187	9.61	0.98	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.0000
15_RCP_EL0180	2.49	0.04	0.05	0.00	0.00	0.91	0.00	0.00	3.75	0.0002
OVER_15_RCP_EL0180	8.68	0.99	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.0000
SHADYLAWN_CHANNEL_2	1.27	0.00	0.04	0.00	0.96	0.00	0.00	0.00	0.08	0.0000

****
Conduit Surcharge Summary
****

Conduit	Hours Full: Both Ends	Upstream	Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
15_RCP_EL0181	0.31	0.31	0.31	0.50	0.01
15_RCP_EL0182	0.35	0.35	0.35	0.01	0.28
15_RCP_EL0179	0.85	0.85	0.85	0.01	0.23
15_RCP_EL0187	0.30	0.30	0.30	0.97	0.01

Analysis begun on: Thu Oct 25 13:39:54 2018
Analysis ended on: Thu Oct 25 13:39:54 2018
Total elapsed time: < 1 sec

Existing Conditions - Arlington 1 and 2 (10-Year)

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.021)
--------------------------------------------------------------

Existing Conditions - Arlington 1 and 2 (10-Year)
Starting WSELs from HEC-RAS XS 13556 (Arlington 1) and XS 14035 (Arlington 2)
2-Year = 296.26', 296.27'

***********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
***********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... CURVE_NUMBER
Flow Routing Method ...... DYNWAVE
Starting Date ............ MAY-05-2016 00:00:00
Ending Date .............. MAY-06-2016 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:15:00
Wet Time Step ............ 00:10:00
Dry Time Step ............ 00:10:00
Routing Time Step ........ 15.00 sec

WARNING 02: maximum depth increased for Node 3_EL0166_PE
WARNING 02: maximum depth increased for Node 10_EL0175_PE
WARNING 02: maximum depth increased for Node 14_EL0177_PE

*************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
*************************     ---------       -------
Total Precipitation ......        11.955         5.385
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         4.759         2.144
Surface Runoff ...........         7.082         3.190
Final Surface Storage ....         0.135         0.061
Continuity Error (%) .....        -0.180


*************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
*************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         7.072         2.305
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         7.057         2.300
Internal Outflow .........         0.000         0.000
Storage Losses ...........         0.000         0.000
Initial Stored Volume ....         0.118         0.038
Final Stored Volume ......         0.210         0.068
Continuity Error (%) .....        -1.071


***************************
Time-Step Critical Elements
***************************
Link 24_RCP_EL0172 (9.71%)
```

Existing Conditions - Arlington 1 and 2 (10-Year)

```
*******************************
Highest Flow Instability Indexes
*******************************
All links are stable.


************************
Routing Time Step Summary
************************
Minimum Time Step           :     0.53 sec
Average Time Step           :    14.64 sec
Maximum Time Step           :    15.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.00


**************************
Subcatchment Runoff Summary
**************************
```

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
Arlington1_10	5.39	0.00	0.00	1.44	3.91	0.06	1.44	0.725
Arlington1_20	5.38	0.00	0.00	2.75	2.57	0.70	16.21	0.477
Arlington1_30	5.39	0.00	0.00	2.44	2.90	0.06	1.40	0.538
Arlington1_40	5.39	0.00	0.00	2.10	3.24	0.02	0.50	0.602
Arlington1_50	5.38	0.00	0.00	0.73	4.62	0.02	0.32	0.857
Arlington1_60	5.38	0.00	0.00	1.76	3.58	0.02	0.52	0.665
Arlington1_70	5.39	0.00	0.00	1.75	3.60	0.19	4.46	0.668
Arlington1_80	5.39	0.00	0.00	1.15	4.19	0.08	1.84	0.779
Arlington1_90	5.38	0.00	0.00	1.09	4.25	0.09	2.10	0.789
Arlington2_10	5.39	0.00	0.00	1.87	3.47	0.09	2.00	0.645
Arlington2_20	5.38	0.00	0.00	2.14	3.20	0.08	1.72	0.594
Arlington2_30	5.39	0.00	0.00	2.06	3.28	0.08	1.72	0.609
Arlington2_40	5.38	0.00	0.00	2.02	3.32	0.18	4.10	0.616
Arlington2_50	5.38	0.00	0.00	2.11	3.23	0.04	1.02	0.599
Arlington2_60	5.38	0.00	0.00	2.32	3.02	0.08	1.88	0.562
Arlington2_70	5.39	0.00	0.00	0.80	4.55	0.09	1.91	0.844
Arlington2_80	5.38	0.00	0.00	1.57	3.77	0.05	1.18	0.701
Arlington2_90	5.38	0.00	0.00	1.82	3.52	0.30	7.19	0.654
Arlington2_100	5.38	0.00	0.00	1.16	4.18	0.07	1.59	0.776

```
******************
Node Depth Summary
******************
```

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min
1_EL0164_CB	JUNCTION	0.03	0.17	327.20	0 12:59
2_EL0165_JB*	JUNCTION	0.06	0.31	323.66	0 13:00
3_EL0166_PE	JUNCTION	0.03	0.17	320.08	0 13:01
4_EL0170_PE	JUNCTION	0.06	0.33	309.66	0 13:02
5_EL0171_DI	JUNCTION	0.20	1.16	308.77	0 13:00
6_EL0178_DI	JUNCTION	0.25	2.30	307.80	0 13:01
7_EL0172_JB	JUNCTION	0.47	2.78	307.11	0 13:01
8_EL0173_CB	JUNCTION	0.36	3.26	306.61	0 13:01
9_EL0174_CB	JUNCTION	0.43	3.16	306.09	0 13:02
10_EL0175_PE	JUNCTION	0.10	0.54	303.26	0 13:02
11_EL0167_PE	JUNCTION	0.10	0.49	307.89	0 12:59
12_EL0168_DI	JUNCTION	0.16	0.85	305.73	0 13:00
13_EL0169_CB	JUNCTION	0.11	0.50	304.98	0 13:00
14_EL0177_PE	JUNCTION	0.13	0.65	300.04	0 13:01
1_EL0153_CB	JUNCTION	0.06	0.26	396.59	0 12:59

2_EL0154_CB	JUNCTION	0.10	0.56	391.56	0	12:59
3_EL0155_PE	JUNCTION	0.04	0.23	387.76	0	13:00
4_EL0163_DA*	JUNCTION	0.10	0.50	360.25	0	13:00
5_EL0156_CB	JUNCTION	0.17	1.10	346.06	0	12:59
6_EL0157_PDST	JUNCTION	0.07	0.37	340.22	0	13:00
7_EL0159_DI	JUNCTION	0.06	0.29	355.10	0	12:59
8_EL0160_CB	JUNCTION	0.07	0.30	349.62	0	12:59
9_EL0161_CB	JUNCTION	0.11	0.56	343.04	0	13:00
10_EL0162_PDST	JUNCTION	0.04	0.22	338.26	0	13:00
11_JUNCTION_1	JUNCTION	0.12	0.58	330.08	0	13:00
12_EL0615_PE	JUNCTION	0.26	1.41	310.69	0	13:00
13_EL0616_DA*	JUNCTION	0.31	1.49	308.49	0	13:00
14_EL0617_PE	JUNCTION	0.11	0.56	303.73	0	13:01
ARLINGTON1*	OUTFALL	9.77	9.77	297.17	0	00:00
ARLINGTON2*	OUTFALL	9.72	9.72	297.22	0	00:00

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal
1_EL0164_CB	JUNCTION	1.44	1.44	0 12:59	0.064	0.064
2_EL0165_JB*	JUNCTION	0.00	1.44	0 13:00	0.000	0.064
3_EL0166_PE	JUNCTION	0.00	1.44	0 13:00	0.000	0.064
4_EL0170_PE	JUNCTION	0.00	1.44	0 13:01	0.000	0.064
5_EL0171_DI	JUNCTION	16.20	17.62	0 12:59	0.699	0.762
6_EL0178_DI	JUNCTION	1.40	18.83	0 13:00	0.060	0.822
7_EL0172_JB	JUNCTION	0.00	18.43	0 13:00	0.000	0.822
8_EL0173_CB	JUNCTION	0.50	18.72	0 13:01	0.022	0.843
9_EL0174_CB	JUNCTION	0.32	18.95	0 13:01	0.015	0.858
10_EL0175_PE	JUNCTION	0.52	19.31	0 13:02	0.023	0.881
11_EL0167_PE	JUNCTION	4.46	4.46	0 12:59	0.190	0.190
12_EL0168_DI	JUNCTION	1.84	6.29	0 12:59	0.082	0.272
13_EL0169_CB	JUNCTION	0.00	6.27	0 13:00	0.000	0.272
14_EL0177_PE	JUNCTION	2.10	27.31	0 13:01	0.093	1.246
1_EL0153_CB	JUNCTION	2.00	2.00	0 12:59	0.089	0.089
2_EL0154_CB	JUNCTION	1.72	3.72	0 12:59	0.075	0.165
3_EL0155_PE	JUNCTION	0.00	3.71	0 13:00	0.000	0.165
4_EL0163_DA*	JUNCTION	1.72	5.42	0 12:59	0.076	0.240
5_EL0156_CB	JUNCTION	4.10	9.48	0 12:59	0.181	0.421
6_EL0157_PDST	JUNCTION	0.00	9.47	0 13:00	0.000	0.421
7_EL0159_DI	JUNCTION	1.88	1.88	0 12:59	0.080	0.080
8_EL0160_CB	JUNCTION	1.91	3.78	0 12:59	0.089	0.169
9_EL0161_CB	JUNCTION	0.00	3.78	0 13:00	0.000	0.169
10_EL0162_PDST	JUNCTION	0.00	3.77	0 13:00	0.000	0.169
11_JUNCTION_1	JUNCTION	2.20	15.40	0 12:59	0.092	0.682
12_EL0615_PE	JUNCTION	7.18	22.50	0 12:59	0.304	0.985
13_EL0616_DA*	JUNCTION	1.59	24.00	0 12:59	0.070	1.055
14_EL0617_PE	JUNCTION	0.00	23.94	0 13:00	0.000	1.056
ARLINGTON1*	OUTFALL	0.00	27.20	0 13:01	0.000	1.244
ARLINGTON2*	OUTFALL	0.00	23.94	0 13:01	0.000	1.055

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

Existing Conditions - Arlington 1 and 2 (10-Year)

****
Outfall Loading Summary
****

Outfall Node	Flow Freq. Pcnt.	Avg. Flow CFS	Max. Flow CFS	Total Volume 10^6 gal
ARLINGTON1*	93.92	2.50	27.20	1.244
ARLINGTON2*	93.80	2.14	23.94	1.055
System	93.86	4.64	51.08	2.299

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
15_RCP_EL0164	CONDUIT	1.44	0 13:00	8.82	0.03	0.19
15_RCP_EL0165	CONDUIT	1.44	0 13:00	8.82	0.08	0.19
ARLINGTON1_CHANNEL_1	CONDUIT	1.44	0 13:01	2.63	0.01	0.12
24_RCP_EL0170	CONDUIT	1.43	0 13:02	5.26	0.03	0.14
24_RCP_EL0171	CONDUIT	17.45	0 13:00	8.44	0.43	0.79
24_RCP_EL0178	CONDUIT	18.43	0 13:00	5.87	0.56	1.00
OVER_24_RCP_EL0178	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
24_RCP_EL0172	CONDUIT	18.27	0 13:01	5.81	2.68	1.00
OVER_24_RCP_EL0172	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
24_RCP_EL0173	CONDUIT	18.67	0 13:01	5.94	0.95	1.00
OVER_24_RCP_EL0173	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
24_RCP_EL0174	CONDUIT	18.87	0 13:02	8.99	0.55	0.63
ARLINGTON1_CHANNEL_2	CONDUIT	19.30	0 13:02	5.67	0.01	0.15
24_RCP_EL0167	CONDUIT	4.45	0 12:59	6.95	0.11	0.26
24_RCP_EL0168	CONDUIT	6.27	0 13:00	6.04	0.21	0.37
24_RCP_EL0169	CONDUIT	6.28	0 13:00	9.14	0.12	0.29
ARLINGTON1_CHANNEL_3	CONDUIT	27.20	0 13:01	0.84	0.02	0.58
15_RCP_EL0153	CONDUIT	2.00	0 13:00	11.78	0.07	0.20
15_RCP_EL0154	CONDUIT	3.71	0 13:00	11.46	0.17	0.31
ARLINGTON2_CHANNEL_1*	CONDUIT	3.71	0 13:00	2.98	0.02	0.24
15_RCP_EL0163	CONDUIT	5.40	0 13:00	13.04	0.25	0.37
15_RCP_EL0156	CONDUIT	9.47	0 13:00	13.16	0.48	0.59
ARLINGTON2_CHANNEL_2*	CONDUIT	9.46	0 13:00	5.11	0.05	0.32
15_RCP_EL0159	CONDUIT	1.87	0 13:00	9.45	0.10	0.22
15_RCP_EL0160	CONDUIT	3.78	0 13:00	12.07	0.11	0.30
15_RCP_EL0161	CONDUIT	3.77	0 13:00	11.51	0.21	0.31
ARLINGTON2_CHANNEL_3	CONDUIT	3.77	0 13:00	2.68	0.02	0.27
ARLINGTON2_CHANNEL_4	CONDUIT	15.35	0 13:00	2.59	0.12	0.66
15_RCP_1*	CONDUIT	10.75	0 12:39	8.79	0.75	1.00
OVER_15_RCP_1*	CONDUIT	11.89	0 13:00	5.73	0.01	0.10
15_RCP_2*	CONDUIT	10.46	0 13:01	11.36	0.62	0.73
OVER_15_RCP_2*	CONDUIT	13.47	0 13:00	5.34	0.03	0.12
ARLINGTON2_CHANNEL_5*	CONDUIT	23.94	0 13:01	3.79	0.11	0.69

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change
15_RCP_EL0164	131.83	0.04	0.00	0.00	0.00	0.96	0.00	0.00	3.79	0.0000

15_RCP_EL0165	6.97	0.04	0.00	0.00	0.00	0.96	0.00	0.00	4.07	0.0000
ARLINGTON1_CHANNEL_1	3.33	0.04	0.00	0.00	0.90	0.05	0.00	0.00	0.71	0.0000
24_RCP_EL0170	42.06	0.04	0.00	0.00	0.00	0.00	0.00	0.96	2.01	0.0000
24_RCP_EL0171	5.08	0.04	0.00	0.00	0.01	0.12	0.00	0.83	2.12	0.0001
24_RCP_EL0178	5.43	0.04	0.00	0.00	0.09	0.67	0.00	0.20	1.23	0.0002
OVER_24_RCP_EL0178	10.44	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
24_RCP_EL0172	6.95	0.04	0.01	0.00	0.03	0.00	0.93	0.00	0.56	0.0009
OVER_24_RCP_EL0172	17.98	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
24_RCP_EL0173	7.39	0.04	0.00	0.00	0.13	0.06	0.00	0.77	1.01	0.0003
OVER_24_RCP_EL0173	19.02	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
24_RCP_EL0174	31.71	0.04	0.00	0.00	0.00	0.96	0.00	0.00	1.71	0.0002
ARLINGTON1_CHANNEL_2	8.80	0.04	0.00	0.00	0.34	0.61	0.00	0.00	1.11	0.0000
24_RCP_EL0167	4.39	0.04	0.00	0.00	0.00	0.03	0.00	0.92	2.03	0.0000
24_RCP_EL0168	22.85	0.04	0.00	0.00	0.00	0.00	0.00	0.96	1.47	0.0001
24_RCP_EL0169	3.90	0.04	0.00	0.00	0.00	0.96	0.00	0.00	2.43	0.0000
ARLINGTON1_CHANNEL_3	2.24	0.00	0.05	0.00	0.95	0.00	0.00	0.00	0.01	0.0000
15_RCP_EL0153	16.14	0.04	0.00	0.00	0.00	0.00	0.00	0.96	4.28	0.0000
15_RCP_EL0154	12.73	0.04	0.00	0.00	0.00	0.96	0.00	0.00	5.15	0.0001
ARLINGTON2_CHANNEL_1*	1.62	0.04	0.00	0.00	0.88	0.07	0.00	0.00	0.70	0.0000
15_RCP_EL0163	7.10	0.04	0.00	0.00	0.00	0.00	0.00	0.96	3.59	0.0001
15_RCP_EL0156	6.19	0.04	0.00	0.00	0.00	0.96	0.00	0.00	4.80	0.0002
ARLINGTON2_CHANNEL_2*	4.03	0.04	0.00	0.00	0.05	0.91	0.00	0.00	1.19	0.0000
15_RCP_EL0159	6.06	0.04	0.00	0.00	0.00	0.00	0.00	0.96	3.14	0.0000
15_RCP_EL0160	19.39	0.04	0.00	0.00	0.00	0.06	0.00	0.90	5.26	0.0000
15_RCP_EL0161	5.68	0.04	0.00	0.00	0.00	0.96	0.00	0.00	4.63	0.0001
ARLINGTON2_CHANNEL_3	5.74	0.04	0.00	0.00	0.94	0.01	0.00	0.00	0.66	0.0000
ARLINGTON2_CHANNEL_4	1.00	0.04	0.00	0.00	0.96	0.00	0.00	0.00	0.62	0.0000
15_RCP_1*	5.89	0.04	0.00	0.00	0.05	0.90	0.00	0.00	2.02	0.0003
OVER_15_RCP_1*	13.08	0.95	0.01	0.00	0.00	0.04	0.00	0.00	0.08	0.0000
15_RCP_2*	5.39	0.04	0.00	0.00	0.00	0.96	0.00	0.00	3.98	0.0002
OVER_15_RCP_2*	8.37	0.95	0.00	0.00	0.00	0.00	0.00	0.05	0.09	0.0000
ARLINGTON2_CHANNEL_5*	3.41	0.00	0.05	0.00	0.95	0.00	0.00	0.00	0.09	0.0000

****
Conduit Surcharge Summary
****

Conduit	Hours Full: Both Ends	Hours Full: Upstream	Hours Full: Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
24_RCP_EL0178	0.09	0.09	0.10	0.01	0.01
24_RCP_EL0172	0.12	0.12	0.13	0.73	0.01
24_RCP_EL0173	0.38	0.38	0.38	0.01	0.37
15_RCP_1*	0.53	0.53	0.53	0.01	0.01

Analysis begun on: Thu Oct 25 13:42:12 2018
Analysis ended on: Thu Oct 25 13:42:13 2018
Total elapsed time: 00:00:01

Existing Conditions - South Lakeshore: d,e,f,g,h (10-Year)

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.021)
--------------------------------------------------------------

Existing Conditions - South Lakeshore: d,e,f,g,h (10-Year)
ALLARD Starting WSELs from HEC-RAS XS 14764
2-Year = 296.42'

***********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
***********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... CURVE_NUMBER
Flow Routing Method ...... DYNWAVE
Starting Date ............ MAY-05-2016 00:00:00
Ending Date .............. MAY-06-2016 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:15:00
Wet Time Step ............ 00:10:00
Dry Time Step ............ 00:10:00
Routing Time Step ........ 10.00 sec

WARNING 02: maximum depth increased for Node 3_EL0120_PE
WARNING 02: maximum depth increased for Node JUNCTION_1
WARNING 02: maximum depth increased for Node 4_EL0126_PE
WARNING 02: maximum depth increased for Node 4_EL0090_PE
WARNING 02: maximum depth increased for Node 7_EL0048_PE

**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Total Precipitation ......        39.530         5.385
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........        17.551         2.391
Surface Runoff ...........        21.551         2.936
Final Surface Storage ....         0.496         0.068
Continuity Error (%) .....        -0.171


**************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......        21.513         7.010
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.104         0.034
External Outflow .........        21.565         7.027
Internal Outflow .........         0.000         0.000
Storage Losses ...........         0.000         0.000
Initial Stored Volume ....         0.359         0.117
Final Stored Volume ......         0.569         0.185
Continuity Error (%) .....        -0.718


************************
Highest Continuity Errors
************************
```

Existing Conditions - South Lakeshore: d,e,f,g,h (10-Year)

Node 3_EL0083_PE (1.95%)

****
Time-Step Critical Elements
****
Link 24_HDPVC_EL0089 (19.77%)

****
Highest Flow Instability Indexes
****
Link S_LAKESHORE_CHANNEL (10)
Link 24_RCP_EL0086 (2)
Link S_LAKESHORE_ROLLING_CHANNEL_1 (2)
Link S_LAKESHORE_ROLLING_CHANNEL_2 (2)
Link 24_HDPVC_EL0089 (2)

****
Routing Time Step Summary
****
Minimum Time Step : 1.76 sec
Average Time Step : 9.54 sec
Maximum Time Step : 10.00 sec
Percent in Steady State : 0.00
Average Iterations per Step : 2.01

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
S_Lakeshore_Ridgecrest_10	5.39	0.00	0.00	2.76	2.57	0.75	16.89	0.477
S_Lakeshore_Ridgecrest_20	5.39	0.00	0.00	2.39	2.95	0.81	18.30	0.547
S_Lakeshore_Ridgecrest_30	5.38	0.00	0.00	2.35	2.99	0.16	3.61	0.556
S_Lakeshore_Woodhaven_10	5.38	0.00	0.00	2.49	2.83	0.41	9.09	0.526
S_Lakeshore_Woodhaven_20	5.38	0.00	0.00	2.20	3.15	0.03	0.64	0.584
S_Lakeshore_Woodhaven_30	5.39	0.00	0.00	2.20	3.14	0.04	0.83	0.583
S_Lakeshore_Woodhaven_40	5.39	0.00	0.00	2.24	3.10	0.16	3.56	0.575
S_Lakeshore_Woodhaven_50	5.39	0.00	0.00	1.13	4.22	0.02	0.44	0.783
S_Lakeshore_Woodhaven_60	5.39	0.00	0.00	2.78	2.56	0.01	0.28	0.475
S_Lakeshore_Woodhaven_70	5.38	0.00	0.00	2.42	2.92	0.21	4.91	0.541
S_Lakeshore_Rolling_10	5.39	0.00	0.00	2.38	2.94	1.55	33.85	0.546
S_Lakeshore_Rolling_20	5.39	0.00	0.00	2.28	3.05	1.43	31.74	0.566
S_Lakeshore_Rolling_30	5.38	0.00	0.00	2.10	3.24	0.03	0.74	0.601
S_Lakeshore_Rolling_40	5.39	0.00	0.00	1.80	3.54	0.06	1.42	0.658
S_Lakeshore_10	5.39	0.00	0.00	1.85	3.49	0.16	3.66	0.649
Allard_10	5.39	0.00	0.00	2.41	2.92	1.03	23.05	0.542
Allard_20	5.38	0.00	0.00	2.36	2.98	0.05	1.17	0.553
Allard_30	5.39	0.00	0.00	2.05	3.29	0.11	2.48	0.611

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min
1_EL0123_PE*	JUNCTION	0.30	2.11	324.82	0 13:00
2_EL0122_PE	JUNCTION	0.09	0.54	322.02	0 13:00
3_EL0120_PE	JUNCTION	0.18	1.03	322.11	0 13:01
4_EL0118_PE	JUNCTION	0.10	0.54	317.44	0 13:01

Existing Conditions - South Lakeshore: d,e,f,g,h (10-Year)

1_EL0112_PE	JUNCTION	0.09	0.44	332.32	0	13:00
2_EL0113_JB	JUNCTION	0.08	0.39	327.37	0	13:00
3_EL0114_DI	JUNCTION	0.08	0.32	324.33	0	13:00
JUNCTION_1	JUNCTION	0.13	0.70	308.84	0	13:00
1_EL0590_PE	JUNCTION	0.24	1.57	345.16	0	13:00
2_EL0591_PE	JUNCTION	0.08	0.43	330.02	0	13:00
3_EL0125_DA*	JUNCTION	0.15	0.75	318.07	0	13:00
4_EL0126_PE	JUNCTION	0.20	0.95	309.07	0	13:00
JUNCTION_2*	JUNCTION	0.18	0.88	308.63	0	13:00
1_EL0086_SI*	JUNCTION	0.36	2.57	318.07	0	12:58
2_EL0087_PE	JUNCTION	0.26	2.18	315.62	0	13:00
3_EL0089_PE	JUNCTION	0.64	2.87	315.65	0	13:01
4_EL0090_PE	JUNCTION	0.18	1.00	313.69	0	13:02
5_EL0092_PE	JUNCTION	0.75	2.74	306.81	0	12:59
6_EL0094_PE	JUNCTION	0.20	1.00	304.05	0	13:00
1_EL0081_DA*	JUNCTION	0.09	0.47	299.47	0	13:00
2_EL0082_CB	JUNCTION	0.14	0.80	298.53	0	13:00
3_EL0083_PE	JUNCTION	0.37	0.56	297.84	0	00:01
1_EL0043_PE	JUNCTION	0.27	1.55	329.73	0	13:00
2_EL0044_CB	JUNCTION	0.24	1.28	328.78	0	13:00
3_EL0045_CB	JUNCTION	0.25	1.35	327.61	0	13:00
4_EL0046_JB	JUNCTION	0.20	0.91	320.89	0	13:01
6_EL0047_JB	JUNCTION	0.15	0.84	306.85	0	13:01
7_EL0048_PE	JUNCTION	0.16	0.83	302.25	0	13:01
3A_EL0115_DA*	JUNCTION	0.03	0.11	331.17	0	12:59
S_LAKESHORE_WOODHAVEN	OUTFALL	9.72	9.72	297.22	0	00:00
S_LAKESHORE_RIDGECREST	OUTFALL	9.82	9.82	297.12	0	00:00
S_LAKESHORE_ROLLING	OUTFALL	6.29	6.29	297.24	0	00:00
S_LAKESHORE	OUTFALL	6.71	6.71	297.65	0	00:00
S_LAKESHORE_ALLARD	OUTFALL	6.68	6.68	297.62	0	00:00

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal
1_EL0123_PE*	JUNCTION	9.08	9.08	0 12:59	0.406	0.406
2_EL0122_PE	JUNCTION	0.00	9.05	0 13:00	0.000	0.406
3_EL0120_PE	JUNCTION	0.64	9.56	0 13:00	0.028	0.434
4_EL0118_PE	JUNCTION	0.83	10.20	0 13:00	0.037	0.470
1_EL0112_PE	JUNCTION	3.55	3.55	0 12:59	0.158	0.158
2_EL0113_JB	JUNCTION	0.00	3.55	0 13:00	0.000	0.158
3_EL0114_DI	JUNCTION	0.00	3.98	0 13:00	0.000	0.178
JUNCTION_1	JUNCTION	5.19	19.31	0 13:00	0.224	0.873
1_EL0590_PE	JUNCTION	18.29	18.29	0 12:59	0.812	0.812
2_EL0591_PE	JUNCTION	0.00	18.19	0 13:00	0.000	0.812
3_EL0125_DA*	JUNCTION	16.87	16.87	0 12:59	0.750	0.750
4_EL0126_PE	JUNCTION	0.00	16.86	0 13:00	0.000	0.750
JUNCTION_2*	JUNCTION	3.61	38.51	0 13:00	0.157	1.718
1_EL0086_SI*	JUNCTION	31.71	31.71	0 12:59	1.428	1.428
2_EL0087_PE	JUNCTION	0.00	53.65	0 12:47	0.000	1.544
3_EL0089_PE	JUNCTION	0.74	76.57	0 12:49	0.033	1.573
4_EL0090_PE	JUNCTION	0.00	39.24	0 13:02	0.000	1.454
5_EL0092_PE	JUNCTION	35.23	73.62	0 12:59	1.611	3.065
6_EL0094_PE	JUNCTION	0.00	71.48	0 13:00	0.000	3.063
1_EL0081_DA*	JUNCTION	3.66	3.66	0 12:59	0.159	0.159
2_EL0082_CB	JUNCTION	0.00	3.66	0 13:00	0.000	0.159
3_EL0083_PE	JUNCTION	0.00	12.89	0 00:00	0.000	0.193
1_EL0043_PE	JUNCTION	23.04	23.04	0 12:59	1.030	1.030
2_EL0044_CB	JUNCTION	0.00	23.02	0 13:00	0.000	1.030
3_EL0045_CB	JUNCTION	1.17	24.14	0 13:00	0.050	1.080
4_EL0046_JB	JUNCTION	0.00	24.14	0 13:01	0.000	1.080
6_EL0047_JB	JUNCTION	0.00	24.14	0 13:01	0.000	1.080
7_EL0048_PE	JUNCTION	2.48	26.38	0 13:01	0.107	1.187
3A_EL0115_DA*	JUNCTION	0.44	0.44	0 12:59	0.021	0.021

Existing Conditions - South Lakeshore: d,e,f,g,h (10-Year)

```
S_LAKESHORE_WOODHAVEN OUTFALL       0.00    19.28     0  13:00       0.000       0.873
S_LAKESHORE_RIDGECREST OUTFALL       0.00    38.27     0  13:00       0.000       1.716
S_LAKESHORE_ROLLING  OUTFALL       0.00    70.85     0  13:00       0.000       3.062
S_LAKESHORE          OUTFALL       0.00    12.89     0  00:00       0.000       0.223
S_LAKESHORE_ALLARD   OUTFALL       0.00    26.36     0  13:01       0.000       1.186


**********************
Node Surcharge Summary
**********************

No nodes were surcharged.


**********************
Node Flooding Summary
**********************

No nodes were flooded.


***********************
Outfall Loading Summary
***********************

-------------------------------------------------------------
                      Flow       Avg.       Max.       Total
                      Freq.      Flow       Flow      Volume
Outfall Node          Pcnt.       CFS        CFS    10^6 gal
-------------------------------------------------------------
S_LAKESHORE_WOODHAVEN  95.33      1.80      19.28       0.873
S_LAKESHORE_RIDGECREST  94.77      3.56      38.27       1.716
S_LAKESHORE_ROLLING   94.64      6.33     70.85       3.062
S_LAKESHORE           99.89      0.41     12.89       0.223
S_LAKESHORE_ALLARD    95.08      2.45     26.36       1.186
-------------------------------------------------------------
System                95.94     14.54    158.29       7.061


*******************
Link Flow Summary
*******************

-------------------------------------------------------------------------------
                               Maximum  Time of Max   Maximum    Max/    Max/
                                |Flow|   Occurrence   |Veloc|    Full    Full
Link                 Type          CFS  days hr:min    ft/sec    Flow   Depth
-------------------------------------------------------------------------------
12_CLAY_EL0123       CONDUIT      5.74     0  13:00      8.86    0.77    0.77
OVER_12_CLAY_EL0123  CONDUIT      3.32     0  13:00      3.07    0.01    0.05
S_LAKESHORE_WOODHAVEN_CHANNEL_1 CONDUIT      8.95     0  13:00      2.59    0.02    0.26
15_RCP_EL0120        CONDUIT      9.44     0  13:01     11.67    0.53    0.63
S_LAKESHORE_WOODHAVEN_CHANNEL_2 CONDUIT     10.20     0  13:01      5.92    0.15    0.41
15_RCP_EL0112        CONDUIT      3.55     0  13:00     10.33    0.19    0.32
15_RCP_EL0113        CONDUIT      3.55     0  13:00     12.19    0.15    0.29
15_RCP_EL0114        CONDUIT      3.98     0  13:00      8.41    0.15    0.41
S_LAKESHORE_WOODHAVEN_CHANNEL_3 CONDUIT     19.28     0  13:00      5.11    0.23    0.73
15_RCP_EL0590        CONDUIT     13.61     0  13:00     17.84    0.63    0.67
OVER_15_RCP_EL0590   CONDUIT      4.58     0  13:00      6.44    0.00    0.04
S_LAKESHORE_RIDGECREST_CHANNEL_1* CONDUIT     18.17     0  13:00      5.20    0.02    0.22
24_RCP_EL0125        CONDUIT     16.86     0  13:00     13.33    0.22    0.42
S_LAKESHORE_RIDGECREST_CHANNEL_2 CONDUIT     16.82     0  13:00      2.94    0.08    0.30
S_LAKESHORE_RIDGECREST_CHANNEL_3 CONDUIT     38.27     0  13:00      1.98    0.06    0.65
24_RCP_EL0086        CONDUIT     29.15     0  12:56     10.04    0.60    1.00
OVER_24_RCP_EL0086   CONDUIT      3.06     0  12:58      4.55    0.00    0.11
S_LAKESHORE_ROLLING_CHANNEL_1 CONDUIT     75.87     0  12:49      3.34    0.06    0.68
24_HDPVC_EL0089      CONDUIT     18.65     0  13:02      7.40    2.28    0.75
OVER_24_HDPVC_EL0089 CONDUIT     20.60     0  13:01      2.46    0.13    0.37
S_LAKESHORE_ROLLING_CHANNEL_2 CONDUIT     38.94     0  13:02      4.26    0.23    0.75
24_RCP_EL0092        CONDUIT     23.02     0  13:00      9.18    0.71    0.75
OVER_24_RCP_EL0092   CONDUIT     48.46     0  13:00     12.07    0.06    0.21
```

Existing Conditions - South Lakeshore: d,e,f,g,h (10-Year)

```
S_LAKESHORE_ROLLING_CHANNEL_3 CONDUIT     70.85     0  13:00      2.42    0.06    0.64
18_RCP_EL0081         CONDUIT      3.66     0  13:00      7.77    0.11    0.36
18_RCP_EL0082         CONDUIT      3.65     0  13:00      5.74    0.29    0.39
S_LAKESHORE_CHANNEL   CONDUIT     12.89     0  00:00      0.88    0.03    0.59
30_RCP_EL0043         CONDUIT     23.02     0  13:00      8.51    0.31    0.55
30_RCP_EL0044         CONDUIT     23.02     0  13:00      9.31    0.30    0.51
30_RCP_EL0045         CONDUIT     24.14     0  13:01     11.01    0.31    0.46
TWIN_18_RCP_EL0047    CONDUIT     24.14     0  13:01     11.95    0.38    0.56
30_RCP_EL0046         CONDUIT     24.14     0  13:01     15.40    0.26    0.36
S_LAKESHORE_ALLARD_CHANNEL CONDUIT     26.36     0  13:01      3.04    0.17    0.71
15_CLAY_EL0115        CONDUIT      0.44     0  13:00      3.36    0.02    0.17


**************************
Flow Classification Summary
**************************

-------------------------------------------------------------------------------------------
                    Adjusted    --- Fraction of Time in Flow Class ----    Avg.     Avg.
                     /Actual         Up    Down  Sub   Sup   Up    Down   Froude   Flow
Conduit               Length    Dry  Dry   Dry   Crit  Crit  Crit  Crit   Number   Change
-------------------------------------------------------------------------------------------
12_CLAY_EL0123          5.42   0.04  0.00  0.00  0.00  0.96  0.00  0.00     2.94   0.0002
OVER_12_CLAY_EL0123     9.02   0.96  0.00  0.00  0.00  0.00  0.00  0.04     0.06   0.0000
S_LAKESHORE_WOODHAVEN_CHANNEL_1   21.31   0.04  0.00  0.00  0.96  0.00  0.00  0.00     0.51   0.0000
15_RCP_EL0120           3.70   0.04  0.00  0.00  0.01  0.95  0.00  0.00     3.88   0.0001
S_LAKESHORE_WOODHAVEN_CHANNEL_2    1.36   0.04  0.00  0.00  0.19  0.77  0.00  0.00     1.09   0.0000
15_RCP_EL0112           6.32   0.04  0.00  0.00  0.00  0.00  0.00  0.96     3.11   0.0000
15_RCP_EL0113          12.83   0.04  0.00  0.00  0.00  0.00  0.00  0.96     3.87   0.0000
15_RCP_EL0114           3.04   0.04  0.00  0.00  0.00  0.96  0.00  0.00     2.98   0.0000
S_LAKESHORE_WOODHAVEN_CHANNEL_3    1.00   0.00  0.04  0.00  0.95  0.01  0.00  0.00     0.12   0.0001
15_RCP_EL0590           1.88   0.04  0.00  0.00  0.00  0.96  0.00  0.00     5.86   0.0001
OVER_15_RCP_EL0590      4.47   0.97  0.00  0.00  0.00  0.00  0.00  0.03     0.13   0.0000
S_LAKESHORE_RIDGECREST_CHANNEL_1*    2.66   0.04  0.00  0.00  0.29  0.67  0.00  0.00     1.09   0.0000
24_RCP_EL0125           4.07   0.04  0.00  0.00  0.00  0.96  0.00  0.00     3.13   0.0000
S_LAKESHORE_RIDGECREST_CHANNEL_2    2.12   0.04  0.00  0.00  0.96  0.00  0.00  0.00     0.46   0.0000
S_LAKESHORE_RIDGECREST_CHANNEL_3    1.00   0.00  0.04  0.00  0.96  0.00  0.00  0.00     0.04   0.0000
24_RCP_EL0086           5.21   0.04  0.00  0.00  0.04  0.92  0.00  0.00     2.89   0.0003
OVER_24_RCP_EL0086      9.74   0.97  0.01  0.00  0.01  0.00  0.00  0.00     0.02   0.0000
S_LAKESHORE_ROLLING_CHANNEL_1   36.14   0.04  0.00  0.00  0.95  0.01  0.00  0.00     0.31   0.0003
24_HDPVC_EL0089         3.67   0.04  0.00  0.00  0.06  0.90  0.00  0.00     1.07   0.0044
OVER_24_HDPVC_EL0089    4.33   0.94  0.01  0.00  0.00  0.00  0.05  0.00     0.02   0.0002
S_LAKESHORE_ROLLING_CHANNEL_2    1.00   0.04  0.01  0.00  0.95  0.00  0.00  0.00     0.28   0.0004
24_RCP_EL0092           3.76   0.04  0.00  0.00  0.00  0.96  0.00  0.00     2.03   0.0003
OVER_24_RCP_EL0092     12.50   0.90  0.00  0.00  0.00  0.00  0.00  0.10     0.27   0.0000
S_LAKESHORE_ROLLING_CHANNEL_3    1.21   0.00  0.05  0.00  0.95  0.00  0.00  0.00     0.04   0.0000
18_RCP_EL0081          23.21   0.04  0.00  0.00  0.00  0.00  0.04  0.00  0.92     3.14   0.0000
18_RCP_EL0082           4.46   0.00  0.00  0.00  0.90  0.10  0.00  0.00     0.39   0.0001
S_LAKESHORE_CHANNEL     1.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00     0.00   0.0001
30_RCP_EL0043          13.32   0.04  0.00  0.00  0.00  0.05  0.00  0.91     2.00   0.0001
30_RCP_EL0044           7.43   0.04  0.00  0.00  0.00  0.10  0.00  0.86     2.22   0.0001
30_RCP_EL0045           8.79   0.04  0.00  0.00  0.00  0.00  0.00  0.96     2.23   0.0001
TWIN_18_RCP_EL0047      5.00   0.04  0.00  0.00  0.00  0.96  0.00  0.00     3.35   0.0002
30_RCP_EL0046           1.05   0.04  0.00  0.00  0.00  0.00  0.00  0.96     2.89   0.0001
S_LAKESHORE_ALLARD_CHANNEL    1.00   0.00  0.04  0.00  0.96  0.00  0.00  0.00     0.07   0.0000
15_CLAY_EL0115          6.47   0.04  0.00  0.00  0.05  0.91  0.00  0.00     1.24   0.0000


************************
Conduit Surcharge Summary
************************

-------------------------------------------------------------------------
                                                    Hours        Hours
                      --------- Hours Full --------   Above Full   Capacity
Conduit               Both Ends  Upstream  Dnstream   Normal Flow   Limited
-------------------------------------------------------------------------
24_RCP_EL0086              0.12      0.12      0.13      0.01         0.11
24_HDPVC_EL0089            0.01      0.01      0.01      1.40         0.01
```

Existing Conditions - South Lakeshore: d,e,f,g,h (10-Year)

```
Analysis begun on:  Thu Oct 25 13:45:18 2018
Analysis ended on:  Thu Oct 25 13:45:18 2018
Total elapsed time: < 1 sec
```

Existing Conditions - Curtis (10-Year)

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.021)
--------------------------------------------------------------

Existing Conditions - Curtis (10-Year)
Starting WSELs from HEC-RAS XS 15024
2-Year = 297.42'

***********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
***********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... CURVE_NUMBER
Flow Routing Method ...... DYNWAVE
Starting Date ............ MAY-05-2016 00:00:00
Ending Date .............. MAY-06-2016 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:15:00
Wet Time Step ............ 00:10:00
Dry Time Step ............ 00:10:00
Routing Time Step ........ 10.00 sec

WARNING 02: maximum depth increased for Node 10_EL0019_PE
WARNING 02: maximum depth increased for Node 11_EL0017_PE

**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Total Precipitation ......        10.837         5.385
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         4.745         2.358
Surface Runoff ...........         5.984         2.974
Final Surface Storage ....         0.125         0.062
Continuity Error (%) .....        -0.157


**************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         5.975         1.947
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.204         0.067
External Outflow .........         6.080         1.981
Internal Outflow .........         0.000         0.000
Storage Losses ...........         0.000         0.000
Initial Stored Volume ....         0.024         0.008
Final Stored Volume ......         0.102         0.033
Continuity Error (%) .....         0.361


************************
Highest Continuity Errors
************************
Node 13_EL0017_PE (1.43%)
```

Existing Conditions - Curtis (10-Year)

****
Time-Step Critical Elements
****
None

****
Highest Flow Instability Indexes
****
Link CURTIS_CHANNEL_2 (4)

****
Routing Time Step Summary
****
Minimum Time Step : 1.18 sec
Average Time Step : 9.97 sec
Maximum Time Step : 10.00 sec
Percent in Steady State : 0.00
Average Iterations per Step : 2.00

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
Curtis_10	5.38	0.00	0.00	2.02	3.32	0.06	1.32	0.616
Curtis_20	5.39	0.00	0.00	1.54	3.81	0.04	0.86	0.707
Curtis_30	5.39	0.00	0.00	2.57	2.77	0.09	2.11	0.514
Curtis_40	5.39	0.00	0.00	2.34	3.00	0.13	3.00	0.557
Curtis_50	5.39	0.00	0.00	2.31	3.03	0.08	1.79	0.563
Curtis_60	5.38	0.00	0.00	2.07	3.27	0.03	0.78	0.607
Curtis_70	5.39	0.00	0.00	2.14	3.20	0.01	0.34	0.593
Curtis_80	5.38	0.00	0.00	2.08	3.26	0.12	2.65	0.605
Curtis_90	5.39	0.00	0.00	1.92	3.42	0.05	1.15	0.635
Curtis_100	5.38	0.00	0.00	2.49	2.84	1.17	25.92	0.527
Curtis_110	5.39	0.00	0.00	2.12	3.22	0.04	0.92	0.599
Curtis_120	5.38	0.00	0.00	2.17	3.17	0.03	0.62	0.589
Curtis_130	5.39	0.00	0.00	1.64	3.70	0.09	2.12	0.688

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min
1_EL0029_CB	JUNCTION	0.05	0.22	407.37	0 12:59
2_EL0028_CB	JUNCTION	0.06	0.27	395.83	0 12:59
3_EL0027_CB	JUNCTION	0.11	0.54	371.17	0 13:00
4_EL0026_CB	JUNCTION	0.11	0.57	353.42	0 13:00
5_EL0025_CB	JUNCTION	0.12	0.63	339.50	0 13:00
6_EL0023_CB	JUNCTION	0.15	0.76	328.46	0 13:00
7_EL0022_CB	JUNCTION	0.26	3.78	316.56	0 13:00
8_EL0021_CB	JUNCTION	0.33	2.96	314.36	0 13:00
9_EL0020_CB	JUNCTION	0.30	2.87	313.13	0 13:00
10_EL0019_PE	JUNCTION	0.13	0.71	308.28	0 13:01
11_EL0017_PE	JUNCTION	0.33	1.96	302.22	0 13:03
12_EL0016_JB	JUNCTION	0.21	0.98	300.48	0 13:03
13_EL0017_PE	JUNCTION	2.51	2.93	299.49	0 13:03
CURTIS	OUTFALL	7.56	7.56	299.06	0 00:00

Existing Conditions - Curtis (10-Year)

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal
1_EL0029_CB	JUNCTION	1.32	1.32	0 12:59	0.058	0.058
2_EL0028_CB	JUNCTION	0.86	2.18	0 12:59	0.039	0.098
3_EL0027_CB	JUNCTION	5.10	7.28	0 12:59	0.220	0.318
4_EL0026_CB	JUNCTION	1.78	9.05	0 12:59	0.078	0.396
5_EL0025_CB	JUNCTION	0.78	9.82	0 13:00	0.035	0.431
6_EL0023_CB	JUNCTION	2.99	12.78	0 13:00	0.131	0.562
7_EL0022_CB	JUNCTION	1.15	13.93	0 13:00	0.051	0.613
8_EL0021_CB	JUNCTION	25.89	39.46	0 12:59	1.172	1.785
9_EL0020_CB	JUNCTION	0.92	40.18	0 13:00	0.041	1.825
10_EL0019_PE	JUNCTION	0.00	39.87	0 13:01	0.000	1.825
11_EL0017_PE	JUNCTION	0.00	39.81	0 13:01	0.000	1.825
12_EL0016_JB	JUNCTION	0.00	39.17	0 13:03	0.000	1.822
13_EL0017_PE	JUNCTION	2.74	49.77	0 00:01	0.121	2.010
CURTIS	OUTFALL	0.00	49.77	0 00:01	0.000	2.048

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq. Pcnt.	Avg. Flow CFS	Max. Flow CFS	Total Volume 10^6 gal
CURTIS	99.98	3.25	49.77	2.048
System	99.98	3.25	49.77	2.048

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
15_RCP_EL0029	CONDUIT	1.32	0 13:00	9.40	0.06	0.17
15_RCP_EL0028	CONDUIT	2.18	0 13:00	9.76	0.10	0.24
18_RCP_EL0027	CONDUIT	7.27	0 13:00	12.99	0.26	0.35
18_RCP_EL0026	CONDUIT	9.04	0 13:00	15.18	0.28	0.37
18_RCP_EL0025	CONDUIT	9.81	0 13:00	14.97	0.30	0.40
18_RCP_EL0023	CONDUIT	12.78	0 13:00	9.58	0.51	0.75
18_RCP_EL0022	CONDUIT	13.88	0 13:01	7.85	0.93	1.00
OVER_18_RCP_EL0022	CONDUIT	0.00	0 00:00	0.00	0.00	0.00

30_RCP_EL0021	CONDUIT	39.27	0	13:00	8.00	0.54	1.00
OVER_30_RCP_EL0021	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
30_RCP_EL0020	CONDUIT	39.87	0	13:01	12.59	0.23	0.64
CURTIS_CHANNEL_1	CONDUIT	39.81	0	13:01	2.68	0.00	0.13
36_RCP_EL0017	CONDUIT	39.17	0	13:03	10.13	0.37	0.54
36_RCP_EL0016	CONDUIT	39.18	0	13:03	4.02	0.23	0.65
OVER_36_RCP_EL0016	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
CURTIS_CHANNEL_2	CONDUIT	49.77	0	00:01	3.74	0.35	1.00

****
Flow Classification Summary
****

	Adjusted	--- Fraction of Time in Flow Class ----						Avg.	Avg.
	/Actual		Up	Down	Sub	Sup	Up	Down	Froude	Flow
Conduit	Length	Dry	Dry	Dry	Crit	Crit	Crit	Crit	Number	Change
15_RCP_EL0029	2.40	0.04	0.00	0.00	0.00	0.00	0.00	0.96	3.39	0.0000
15_RCP_EL0028	1.05	0.04	0.00	0.00	0.00	0.02	0.00	0.94	3.50	0.0000
18_RCP_EL0027	1.00	0.04	0.00	0.00	0.00	0.00	0.00	0.96	3.10	0.0001
18_RCP_EL0026	1.77	0.04	0.00	0.00	0.00	0.00	0.00	0.96	3.57	0.0001
18_RCP_EL0025	3.24	0.04	0.00	0.00	0.00	0.00	0.00	0.96	3.55	0.0001
18_RCP_EL0023	1.00	0.04	0.00	0.00	0.00	0.05	0.00	0.91	2.78	0.0001
18_RCP_EL0022	2.45	0.04	0.00	0.00	0.03	0.30	0.00	0.63	1.54	0.0002
OVER_18_RCP_EL0022	5.61	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
30_RCP_EL0021	7.22	0.04	0.00	0.00	0.02	0.09	0.00	0.85	2.03	0.0001
OVER_30_RCP_EL0021	8.76	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
30_RCP_EL0020	29.77	0.04	0.00	0.00	0.00	0.96	0.00	0.00	4.65	0.0001
CURTIS_CHANNEL_1	2.25	0.04	0.00	0.00	0.95	0.01	0.00	0.00	0.46	0.0000
36_RCP_EL0017	11.31	0.04	0.00	0.00	0.00	0.00	0.00	0.96	1.82	0.0001
36_RCP_EL0016	1.21	0.00	0.05	0.00	0.95	0.00	0.00	0.00	0.06	0.0001
OVER_36_RCP_EL0016	2.40	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
CURTIS_CHANNEL_2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.03	0.0005

****
Conduit Surcharge Summary
****

				Hours	Hours
	--- Hours Full ---			Above Full	Capacity
Conduit	Both Ends	Upstream	Dnstream	Normal Flow	Limited
18_RCP_EL0022	0.43	0.43	0.44	0.01	0.42
30_RCP_EL0021	0.11	0.11	0.11	0.01	0.10
CURTIS_CHANNEL_2	23.98	23.98	23.98	0.01	0.01

Analysis begun on: Thu Oct 25 13:46:09 2018
Analysis ended on: Thu Oct 25 13:46:09 2018
Total elapsed time: < 1 sec

Existing Conditions - Woodshire & Huntington (10-Year)

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.021)
--------------------------------------------------------------

Existing Conditions - Woodshire & Huntington (10-Year)
Starting WSELs from HEC-RAS XS 20583
2-Year = 379.27'

***********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
***********************************************************

***************
Analysis Options
***************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... CURVE_NUMBER
Flow Routing Method ...... DYNWAVE
Starting Date ............ MAY-05-2016 00:00:00
Ending Date .............. MAY-06-2016 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:15:00
Wet Time Step ............ 00:10:00
Dry Time Step ............ 00:10:00
Routing Time Step ........ 10.00 sec

WARNING 02: maximum depth increased for Node 8_EL0530_PE
WARNING 02: maximum depth increased for Node 9_EL0529_PE

*************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
*************************     ---------       -------
Total Precipitation ......        30.259         5.385
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         9.012         1.604
Surface Runoff ...........        20.906         3.720
Final Surface Storage ....         0.420         0.075
Continuity Error (%) .....        -0.263


*************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
*************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......        20.868         6.800
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........        20.776         6.770
Internal Outflow .........         0.000         0.000
Storage Losses ...........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.080         0.026
Continuity Error (%) .....         0.059


**************************
Time-Step Critical Elements
**************************
Link 24_RCP_EL0530 (6.67%)
Link 24_RCP_EL0531 (3.21%)


******************************
Highest Flow Instability Indexes
******************************
```

All links are stable.

****
Routing Time Step Summary
****

Minimum Time Step	:	7.39 sec
Average Time Step	:	9.89 sec
Maximum Time Step	:	10.00 sec
Percent in Steady State	:	0.00
Average Iterations per Step	:	2.00

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
Woodshire&Huntington_10	5.39	0.00	0.00	1.32	4.00	3.30	70.04	0.743
Woodshire&Huntington_20	5.39	0.00	0.00	1.85	3.47	0.34	7.73	0.645
Woodshire&Huntington_30	5.38	0.00	0.00	2.34	2.98	0.24	5.71	0.554
Woodshire&Huntington_40	5.39	0.00	0.00	2.13	3.20	0.25	5.68	0.594
Woodshire&Huntington_50	5.38	0.00	0.00	1.98	3.36	0.40	8.86	0.623
Woodshire&Huntington_60	5.39	0.00	0.00	1.78	3.56	0.35	7.99	0.660
Woodshire&Huntington_70	5.39	0.00	0.00	1.73	3.58	1.48	31.23	0.665
Woodshire&Huntington_80	5.39	0.00	0.00	1.53	3.80	0.46	10.57	0.706

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min
1_EL0329_JB	JUNCTION	0.61	3.27	429.46	0 13:00
2_EL0330_PE	JUNCTION	0.24	1.33	426.93	0 13:00
3_EL0332_PE	JUNCTION	0.72	4.09	426.37	0 13:00
4_EL0333_PE	JUNCTION	0.21	1.12	423.05	0 13:01
5_EL0531_PE	JUNCTION	0.55	4.36	420.22	0 13:01
6_EL0534_PE	JUNCTION	0.25	1.32	416.48	0 13:00
7_JUNCTION*	JUNCTION	0.25	1.34	408.34	0 13:00
8_EL0530_PE	JUNCTION	0.99	2.69	388.41	0 13:00
9_EL0529_PE	JUNCTION	0.17	0.86	383.50	0 13:01
Outfall*	OUTFALL	0.17	0.86	372.86	0 13:01

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal
1_EL0329_JB	JUNCTION	70.03	70.03	0 13:00	3.291	3.290
2_EL0330_PE	JUNCTION	7.73	77.66	0 13:00	0.341	3.631
3_EL0332_PE	JUNCTION	5.71	83.13	0 13:00	0.243	3.873
4_EL0333_PE	JUNCTION	0.00	81.36	0 13:01	0.000	3.868
5_EL0531_PE	JUNCTION	5.68	86.57	0 13:01	0.250	4.117
6_EL0534_PE	JUNCTION	8.86	94.65	0 13:00	0.399	4.513
7_JUNCTION*	JUNCTION	39.21	133.48	0 13:00	1.820	6.331
8_EL0530_PE	JUNCTION	10.56	143.18	0 13:00	0.457	6.784
9_EL0529_PE	JUNCTION	0.00	143.21	0 13:01	0.000	6.772
Outfall*	OUTFALL	0.00	143.41	0 13:01	0.000	6.770

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq. Pcnt.	Avg. Flow CFS	Max. Flow CFS	Total Volume 10^6 gal
Outfall*	92.65	12.28	143.41	6.770
System	92.65	12.28	143.41	6.770

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
48_RCP_EL0329	CONDUIT	69.95	0 13:00	9.40	0.60	0.57
CHANNEL_1	CONDUIT	77.49	0 13:00	1.98	0.22	0.72
48_RCP_EL0332	CONDUIT	81.36	0 13:01	9.58	0.55	0.64
OVER_48_RCP_EL0332	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
CHANNEL_2	CONDUIT	81.34	0 13:01	3.26	0.21	0.72
24_RCP_EL0531	CONDUIT	64.41	0 13:01	11.57	0.87	0.83
OVER_24_RCP_EL0531	CONDUIT	22.07	0 13:01	4.30	0.03	0.13
CHANNEL_3	CONDUIT	94.61	0 13:01	5.84	0.28	0.53
CHANNEL_4	CONDUIT	132.86	0 13:00	4.89	0.29	0.77
24_RCP_EL0530	CONDUIT	26.93	0 13:01	11.22	0.62	0.71
OVER_24_RCP_EL0530	CONDUIT	116.29	0 13:01	12.60	0.01	0.09
CHANNEL_5	CONDUIT	143.41	0 13:01	19.25	0.00	0.09

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	--- Fraction of Time in Flow Class ---- Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change
48_RCP_EL0329	2.32	0.04	0.00	0.00	0.01	0.95	0.00	0.00	1.55	0.0001
CHANNEL_1	1.00	0.04	0.00	0.00	0.96	0.00	0.00	0.00	0.15	0.0000
48_RCP_EL0332	7.01	0.04	0.00	0.00	0.02	0.94	0.00	0.00	1.54	0.0001
OVER_48_RCP_EL0332	4.42	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
CHANNEL_2	1.00	0.04	0.01	0.00	0.95	0.00	0.00	0.00	0.37	0.0000
24_RCP_EL0531	7.63	0.04	0.00	0.00	0.02	0.94	0.00	0.00	1.94	0.0004
OVER_24_RCP_EL0531	6.94	0.98	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.0000
CHANNEL_3	1.00	0.04	0.00	0.00	0.93	0.03	0.00	0.00	0.74	0.0001
CHANNEL_4	1.00	0.04	0.00	0.00	0.96	0.00	0.00	0.00	0.25	0.0001
24_RCP_EL0530	2.60	0.04	0.00	0.00	0.00	0.96	0.00	0.00	2.39	0.0001
OVER_24_RCP_EL0530	7.51	0.81	0.00	0.00	0.00	0.00	0.00	0.19	0.51	0.0000
CHANNEL_5	5.79	0.04	0.00	0.00	0.05	0.91	0.00	0.00	3.21	0.0000

****

Conduit Surcharge Summary
****

Conduit	Hours Full: Both Ends	Hours Full: Upstream	Hours Full: Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
24_RCP_EL0531	0.01	0.01	0.01	0.69	0.01

Analysis begun on: Thu Oct 25 13:36:57 2018
Analysis ended on: Thu Oct 25 13:36:57 2018
Total elapsed time: < 1 sec

ALTERNATIVE:
SWMM OUTPUT

Alternative - Shady Lawn (10-Year)

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.021)
--------------------------------------------------------------

Alternative - Shady Lawn (10-Year)
Starting WSELs interpolated between HEC-RAS XS 13024 and 13556
2-Year = 296.25'

***********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
***********************************************************

***************
Analysis Options
***************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... CURVE_NUMBER
Flow Routing Method ...... DYNWAVE
Starting Date ............ MAY-05-2016 00:00:00
Ending Date .............. MAY-06-2016 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:15:00
Wet Time Step ............ 00:10:00
Dry Time Step ............ 00:10:00
Routing Time Step ........ 10.00 sec


*************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
*************************     ---------       -------
Total Precipitation ......         5.004         5.385
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         1.852         1.993
Surface Runoff ...........         2.979         3.206
Final Surface Storage ....         0.181         0.194
Continuity Error (%) .....        -0.169


*************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
*************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         2.972         0.968
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         2.961         0.965
Internal Outflow .........         0.000         0.000
Storage Losses ...........         0.000         0.000
Initial Stored Volume ....         0.016         0.005
Final Stored Volume ......         0.026         0.008
Continuity Error (%) .....         0.037


**************************
Time-Step Critical Elements
**************************
Link 15_RCP_EL0181 (1.94%)
Link PROP_18_RCP_EL0187 (1.10%)


******************************
Highest Flow Instability Indexes
******************************
All links are stable.
```

```
************************
Routing Time Step Summary
************************
Minimum Time Step           :     0.50 sec
Average Time Step           :     9.90 sec
Maximum Time Step           :    10.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.00


**************************
Subcatchment Runoff Summary
**************************
```

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
Shadylawn_10	5.38	0.00	0.00	1.95	2.84	0.22	1.69	0.527
Shadylawn_20	5.39	0.00	0.00	1.07	4.28	0.06	1.39	0.794
Shadylawn_30	5.38	0.00	0.00	2.21	3.12	0.16	3.67	0.580
Shadylawn_40	5.38	0.00	0.00	2.59	2.75	0.01	0.20	0.511
Shadylawn_50	5.38	0.00	0.00	2.15	3.19	0.12	2.71	0.592
Shadylawn_60	5.39	0.00	0.00	1.86	3.49	0.04	0.91	0.647
Shadylawn_70	5.38	0.00	0.00	1.96	3.38	0.11	2.47	0.627
Shadylawn_80	5.39	0.00	0.00	2.22	3.12	0.06	1.40	0.579
Shadylawn_90	5.39	0.00	0.00	2.07	3.27	0.14	3.26	0.608
Shadylawn_100	5.39	0.00	0.00	1.53	3.82	0.06	1.25	0.709

```
******************
Node Depth Summary
******************
```

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min
1_EL0610_DI	JUNCTION	0.06	0.31	347.12	0 12:59
2_EL611_SI*	JUNCTION	0.08	0.35	339.65	0 12:59
3_EL0612_PE	JUNCTION	0.05	0.30	320.30	0 13:00
4_EL0181_PE	JUNCTION	0.27	1.83	306.23	0 13:01
5_EL0182_CB	JUNCTION	0.19	1.72	306.04	0 12:59
6_EL0183_CB	JUNCTION	0.23	1.69	305.34	0 12:59
7_EL0184_PE	JUNCTION	0.08	0.50	303.84	0 13:00
1_EL0188_PE	JUNCTION	0.26	0.41	401.79	0 13:00
2_EL0189_DI	JUNCTION	0.39	0.69	382.00	0 13:00
3_EL0190_CB*	JUNCTION	0.15	0.72	375.32	0 13:00
4_EL0191_PE	JUNCTION	0.12	0.53	371.76	0 13:00
5_EL0179_PE	JUNCTION	0.19	1.55	306.33	0 13:01
6_EL0180_CB	JUNCTION	0.95	2.32	306.00	0 13:00
7_EL0187_DA*	JUNCTION	0.18	0.87	305.31	0 13:02
8_EL0186_PE	JUNCTION	0.09	0.44	300.08	0 13:00
SHADYLAWN_1	OUTFALL	9.80	9.80	297.15	0 00:00
SHADYLAWN_2	OUTFALL	9.80	9.80	297.15	0 00:00

```
******************
Node Inflow Summary
******************
```

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal
1_EL0610_DI	JUNCTION	2.47	2.47	0 12:59	0.105	0.105
2_EL611_SI*	JUNCTION	1.40	3.87	0 12:59	0.061	0.166
3_EL0612_PE	JUNCTION	0.00	3.87	0 13:00	0.000	0.166
4_EL0181_PE	JUNCTION	0.00	3.86	0 13:00	0.000	0.166
5_EL0182_CB	JUNCTION	3.26	6.86	0 12:59	0.143	0.309

6_EL0183_CB	JUNCTION	0.00	6.85	0	13:00	0.000	0.309
7_EL0184_PE	JUNCTION	1.25	8.10	0	12:59	0.056	0.365
1_EL0188_PE	JUNCTION	1.68	1.68	0	12:59	0.214	0.214
2_EL0189_DI	JUNCTION	1.39	3.07	0	12:59	0.063	0.277
3_EL0190_CB*	JUNCTION	3.66	6.72	0	12:59	0.158	0.435
4_EL0191_PE	JUNCTION	0.20	6.90	0	13:00	0.008	0.443
5_EL0179_PE	JUNCTION	0.00	6.87	0	13:00	0.000	0.443
6_EL0180_CB	JUNCTION	2.71	9.04	0	12:59	0.119	0.561
7_EL0187_DA*	JUNCTION	0.00	9.04	0	13:00	0.000	0.560
8_EL0186_PE	JUNCTION	0.91	9.90	0	13:00	0.041	0.601
SHADYLAWN_1	OUTFALL	0.00	8.09	0	13:00	0.000	0.365
SHADYLAWN_2	OUTFALL	0.00	9.90	0	13:00	0.000	0.600

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Feet	Min. Depth Below Rim Feet
6_EL0183_CB	JUNCTION	0.40	0.336	1.614

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq. Pcnt.	Avg. Flow CFS	Max. Flow CFS	Total Volume 10^6 gal
SHADYLAWN_1	94.88	0.66	8.09	0.365
SHADYLAWN_2	93.76	1.07	9.90	0.600
System	94.32	1.73	17.98	0.965

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days	hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
15_RCP_EL0610	CONDUIT	2.47	0	12:59	9.60	0.12	0.26
18_RCP_EL0611	CONDUIT	3.87	0	13:00	13.61	0.10	0.22
SHADYLAWN_DITCH_1	CONDUIT	3.86	0	13:00	2.24	0.12	0.65
15_RCP_EL0181	CONDUIT	4.09	0	13:03	3.33	1.80	1.00
OVER_15_RCP_EL0181	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
15_RCP_EL0182	CONDUIT	6.85	0	13:00	5.58	0.77	1.00
15_RCP_EL0183	CONDUIT	6.85	0	13:00	7.45	0.47	0.70
SHADYLAWN_CHANNEL_1	CONDUIT	8.09	0	13:00	3.93	0.28	0.75
15_RCP_0188	CONDUIT	1.68	0	13:00	4.22	0.06	0.36
15_RCP_EL0189	CONDUIT	3.06	0	13:00	6.14	0.21	0.44
15_RCP_EL0190	CONDUIT	6.71	0	13:00	10.99	0.35	0.50
OVER_15_RCP_EL0190	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
SHADYLAWN_DITCH_2	CONDUIT	6.87	0	13:00	5.02	0.12	0.68
PROP_18_RCP_EL0179	CONDUIT	6.73	0	13:03	3.81	0.33	1.00
OVER_15_RCP_EL0179	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
PROP_18_RCP_EL0187	CONDUIT	9.04	0	13:00	6.05	0.59	0.79
OVER_15_RCP_EL0187	CONDUIT	0.00	0	00:00	0.00	0.00	0.00

PROP_18_RCP_EL0180	CONDUIT	9.04	0	13:00	12.23	0.35	0.44
OVER_15_RCP_EL0180	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
SHADYLAWN_CHANNEL_2	CONDUIT	9.90	0	13:00	2.46	0.10	0.65

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change
15_RCP_EL0610	2.86	0.04	0.00	0.00	0.00	0.96	0.00	0.00	2.62	0.0000
18_RCP_EL0611	1.85	0.04	0.00	0.00	0.00	0.96	0.00	0.00	5.13	0.0000
SHADYLAWN_DITCH_1	1.00	0.04	0.00	0.00	0.95	0.01	0.00	0.00	0.22	0.0000
15_RCP_EL0181	4.82	0.04	0.03	0.00	0.04	0.00	0.89	0.00	0.47	0.0004
OVER_15_RCP_EL0181	45.25	0.99	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
15_RCP_EL0182	4.54	0.04	0.00	0.00	0.03	0.15	0.00	0.77	1.51	0.0002
15_RCP_EL0183	30.53	0.04	0.00	0.00	0.00	0.96	0.00	0.00	2.27	0.0001
SHADYLAWN_CHANNEL_1	1.00	0.00	0.04	0.00	0.96	0.00	0.00	0.00	0.10	0.0001
15_RCP_0188	2.27	0.04	0.07	0.00	0.70	0.20	0.00	0.00	0.53	0.0000
15_RCP_EL0189	1.33	0.04	0.10	0.00	0.00	0.85	0.00	0.00	2.00	0.0000
15_RCP_EL0190	5.60	0.04	0.00	0.00	0.00	0.96	0.00	0.00	3.57	0.0001
OVER_15_RCP_EL0190	10.48	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
SHADYLAWN_DITCH_2	1.00	0.04	0.00	0.00	0.19	0.76	0.00	0.00	1.26	0.0000
PROP_18_RCP_EL0179	6.39	0.04	0.00	0.00	0.96	0.00	0.00	0.00	0.17	0.0001
OVER_15_RCP_EL0179	7.92	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
PROP_18_RCP_EL0187	4.33	0.04	0.13	0.00	0.83	0.00	0.00	0.00	0.22	0.0001
OVER_15_RCP_EL0187	5.27	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
PROP_18_RCP_EL0180	2.78	0.04	0.13	0.00	0.00	0.83	0.00	0.00	3.45	0.0001
OVER_15_RCP_EL0180	8.68	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
SHADYLAWN_CHANNEL_2	1.25	0.00	0.04	0.00	0.96	0.00	0.00	0.00	0.07	0.0000

****
Conduit Surcharge Summary
****

Conduit	Hours Full: Both Ends	Upstream	Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
15_RCP_EL0181	0.31	0.31	0.31	0.50	0.01
15_RCP_EL0182	0.35	0.35	0.35	0.01	0.28
PROP_18_RCP_EL0179	0.09	0.09	0.09	0.01	0.01

Analysis begun on: Thu Oct 25 13:49:15 2018
Analysis ended on: Thu Oct 25 13:49:15 2018
Total elapsed time: < 1 sec

Alternative - Arlington 1 and 2 (10-Year)

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.021)
--------------------------------------------------------------

Alternative - Arlington 1 and 2 (10-Year)
Starting WSELs from HEC-RAS XS 13556 (Arlington 1) and XS 14035 (Arlington 2)
2-Year = 296.26', 296.27'

***********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
***********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... CURVE_NUMBER
Flow Routing Method ...... DYNWAVE
Starting Date ............ MAY-05-2016 00:00:00
Ending Date .............. MAY-06-2016 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:15:00
Wet Time Step ............ 00:10:00
Dry Time Step ............ 00:10:00
Routing Time Step ........ 10.00 sec

WARNING 02: maximum depth increased for Node 3_EL0166_PE
WARNING 02: maximum depth increased for Node 10_EL0175_PE
WARNING 02: maximum depth increased for Node 14_EL0177_PE

*************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
*************************     ---------       -------
Total Precipitation ......        11.955         5.385
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         4.759         2.144
Surface Runoff ...........         7.082         3.190
Final Surface Storage ....         0.135         0.061
Continuity Error (%) .....        -0.180


*************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
*************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         7.072         2.305
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         7.060         2.301
Internal Outflow .........         0.000         0.000
Storage Losses ...........         0.000         0.000
Initial Stored Volume ....         0.118         0.038
Final Stored Volume ......         0.210         0.068
Continuity Error (%) .....        -1.109


***************************
Time-Step Critical Elements
***************************
Link 24_RCP_EL0172 (9.71%)
```

Alternative - Arlington 1 and 2 (10-Year)

```
*******************************
Highest Flow Instability Indexes
*******************************
All links are stable.


************************
Routing Time Step Summary
************************
Minimum Time Step           :     0.50 sec
Average Time Step           :     9.77 sec
Maximum Time Step           :    10.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.01


**************************
Subcatchment Runoff Summary
**************************
```

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
Arlington1_10	5.39	0.00	0.00	1.44	3.91	0.06	1.44	0.725
Arlington1_20	5.38	0.00	0.00	2.75	2.57	0.70	16.21	0.477
Arlington1_30	5.39	0.00	0.00	2.44	2.90	0.06	1.40	0.538
Arlington1_40	5.39	0.00	0.00	2.10	3.24	0.02	0.50	0.602
Arlington1_50	5.38	0.00	0.00	0.73	4.62	0.02	0.32	0.857
Arlington1_60	5.38	0.00	0.00	1.76	3.58	0.02	0.52	0.665
Arlington1_70	5.39	0.00	0.00	1.75	3.60	0.19	4.46	0.668
Arlington1_80	5.39	0.00	0.00	1.15	4.19	0.08	1.84	0.779
Arlington1_90	5.38	0.00	0.00	1.09	4.25	0.09	2.10	0.789
Arlington2_10	5.39	0.00	0.00	1.87	3.47	0.09	2.00	0.645
Arlington2_20	5.38	0.00	0.00	2.14	3.20	0.08	1.72	0.594
Arlington2_30	5.39	0.00	0.00	2.06	3.28	0.08	1.72	0.609
Arlington2_40	5.38	0.00	0.00	2.02	3.32	0.18	4.10	0.616
Arlington2_50	5.38	0.00	0.00	2.11	3.23	0.04	1.02	0.599
Arlington2_60	5.38	0.00	0.00	2.32	3.02	0.08	1.88	0.562
Arlington2_70	5.39	0.00	0.00	0.80	4.55	0.09	1.91	0.844
Arlington2_80	5.38	0.00	0.00	1.57	3.77	0.05	1.18	0.701
Arlington2_90	5.38	0.00	0.00	1.82	3.52	0.30	7.19	0.654
Arlington2_100	5.38	0.00	0.00	1.16	4.18	0.07	1.59	0.776

```
******************
Node Depth Summary
******************
```

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min
1_EL0164_CB	JUNCTION	0.03	0.17	327.20	0 13:00
2_EL0165_JB*	JUNCTION	0.06	0.31	323.66	0 13:00
3_EL0166_PE	JUNCTION	0.03	0.17	320.08	0 13:00
4_EL0170_PE	JUNCTION	0.06	0.33	309.66	0 13:01
5_EL0171_DI	JUNCTION	0.20	1.20	308.81	0 13:00
6_EL0178_DI	JUNCTION	0.25	2.45	307.95	0 13:00
7_EL0172_JB	JUNCTION	0.47	2.90	307.23	0 13:01
8_EL0173_CB	JUNCTION	0.36	3.36	306.71	0 13:01
9_EL0174_CB	JUNCTION	0.43	3.24	306.17	0 13:01
10_EL0175_PE	JUNCTION	0.10	0.54	303.26	0 13:01
11_EL0167_PE	JUNCTION	0.10	0.49	307.89	0 13:00
12_EL0168_DI	JUNCTION	0.16	0.85	305.73	0 13:00
13_EL0169_CB	JUNCTION	0.11	0.50	304.98	0 13:00
14_EL0177_PE	JUNCTION	0.13	0.65	300.04	0 13:01
1_EL0153_CB	JUNCTION	0.06	0.26	396.59	0 13:00

2_EL0154_CB	JUNCTION	0.10	0.56	391.56	0	13:00
3_EL0155_PE	JUNCTION	0.04	0.23	387.76	0	13:00
4_EL0163_DA*	JUNCTION	0.10	0.50	360.25	0	13:00
5_EL0156_CB	JUNCTION	0.17	1.10	346.06	0	13:00
6_EL0157_PDST	JUNCTION	0.07	0.37	340.22	0	13:00
7_EL0159_DI	JUNCTION	0.06	0.29	355.10	0	13:00
8_EL0160_CB	JUNCTION	0.07	0.30	349.62	0	13:00
9_EL0161_CB	JUNCTION	0.11	0.56	343.04	0	13:00
10_EL0162_PDST	JUNCTION	0.04	0.22	338.26	0	13:00
11_JUNCTION_1	JUNCTION	0.12	0.57	330.07	0	13:00
12_EL0615_PE	JUNCTION	0.22	1.34	309.87	0	13:00
13_EL0616_DA*	JUNCTION	0.26	1.82	308.07	0	13:00
14_EL0617_PE	JUNCTION	0.11	0.57	302.99	0	13:01
ARLINGTON1*	OUTFALL	9.77	9.77	297.17	0	00:00
ARLINGTON2*	OUTFALL	9.72	9.72	297.22	0	00:00

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal
1_EL0164_CB	JUNCTION	1.44	1.44	0 12:59	0.064	0.064
2_EL0165_JB*	JUNCTION	0.00	1.44	0 13:00	0.000	0.064
3_EL0166_PE	JUNCTION	0.00	1.44	0 13:00	0.000	0.064
4_EL0170_PE	JUNCTION	0.00	1.44	0 13:00	0.000	0.064
5_EL0171_DI	JUNCTION	16.18	17.61	0 13:00	0.699	0.762
6_EL0178_DI	JUNCTION	1.40	18.88	0 13:00	0.060	0.822
7_EL0172_JB	JUNCTION	0.00	18.60	0 13:00	0.000	0.822
8_EL0173_CB	JUNCTION	0.50	18.99	0 13:00	0.022	0.843
9_EL0174_CB	JUNCTION	0.32	19.24	0 13:01	0.015	0.858
10_EL0175_PE	JUNCTION	0.52	19.72	0 13:01	0.023	0.881
11_EL0167_PE	JUNCTION	4.46	4.46	0 12:59	0.190	0.190
12_EL0168_DI	JUNCTION	1.84	6.29	0 12:59	0.082	0.272
13_EL0169_CB	JUNCTION	0.00	6.28	0 13:00	0.000	0.272
14_EL0177_PE	JUNCTION	2.10	27.89	0 13:00	0.093	1.247
1_EL0153_CB	JUNCTION	2.00	2.00	0 12:59	0.089	0.089
2_EL0154_CB	JUNCTION	1.72	3.72	0 12:59	0.075	0.165
3_EL0155_PE	JUNCTION	0.00	3.72	0 13:00	0.000	0.165
4_EL0163_DA*	JUNCTION	1.72	5.43	0 13:00	0.076	0.240
5_EL0156_CB	JUNCTION	4.10	9.50	0 12:59	0.181	0.421
6_EL0157_PDST	JUNCTION	0.00	9.49	0 13:00	0.000	0.421
7_EL0159_DI	JUNCTION	1.88	1.88	0 12:59	0.080	0.080
8_EL0160_CB	JUNCTION	1.91	3.78	0 12:59	0.089	0.169
9_EL0161_CB	JUNCTION	0.00	3.78	0 13:00	0.000	0.169
10_EL0162_PDST	JUNCTION	0.00	3.78	0 13:00	0.000	0.169
11_JUNCTION_1	JUNCTION	2.19	15.44	0 13:00	0.092	0.682
12_EL0615_PE	JUNCTION	7.18	22.55	0 13:00	0.304	0.986
13_EL0616_DA*	JUNCTION	1.59	23.88	0 13:00	0.070	1.055
14_EL0617_PE	JUNCTION	0.00	23.86	0 13:00	0.000	1.055
ARLINGTON1*	OUTFALL	0.00	27.82	0 13:01	0.000	1.245
ARLINGTON2*	OUTFALL	0.00	23.86	0 13:01	0.000	1.055

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Feet	Min. Depth Below Rim Feet
9_EL0174_CB	JUNCTION	0.36	1.037	1.263

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq. Pcnt.	Avg. Flow CFS	Max. Flow CFS	Total Volume 10^6 gal
ARLINGTON1*	94.37	2.48	27.82	1.245
ARLINGTON2*	94.32	2.11	23.86	1.055
System	94.35	4.59	51.69	2.300

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days	hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
15_RCP_EL0164	CONDUIT	1.44	0	13:00	8.80	0.03	0.19
15_RCP_EL0165	CONDUIT	1.44	0	13:00	8.82	0.08	0.19
ARLINGTON1_CHANNEL_1	CONDUIT	1.44	0	13:00	2.57	0.01	0.13
24_RCP_EL0170	CONDUIT	1.44	0	13:01	5.24	0.03	0.14
24_RCP_EL0171	CONDUIT	17.49	0	13:00	8.34	0.43	0.80
24_RCP_EL0178	CONDUIT	18.60	0	13:00	5.92	0.57	1.00
OVER_24_RCP_EL0178	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
24_RCP_EL0172	CONDUIT	18.51	0	13:00	5.89	2.71	1.00
OVER_24_RCP_EL0172	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
24_RCP_EL0173	CONDUIT	18.96	0	13:01	6.03	0.96	1.00
24_RCP_EL0174	CONDUIT	19.25	0	13:01	9.14	0.56	0.64
ARLINGTON1_CHANNEL_2	CONDUIT	19.71	0	13:01	5.69	0.01	0.15
24_RCP_EL0167	CONDUIT	4.45	0	13:00	6.95	0.11	0.26
24_RCP_EL0168	CONDUIT	6.28	0	13:00	6.01	0.21	0.37
24_RCP_EL0169	CONDUIT	6.28	0	13:00	8.92	0.12	0.29
ARLINGTON1_CHANNEL_3	CONDUIT	27.82	0	13:01	0.86	0.02	0.58
15_RCP_EL0153	CONDUIT	2.00	0	13:00	11.77	0.07	0.20
15_RCP_EL0154	CONDUIT	3.72	0	13:00	11.41	0.17	0.31
ARLINGTON2_CHANNEL_1*	CONDUIT	3.72	0	13:00	2.98	0.02	0.24
15_RCP_EL0163	CONDUIT	5.41	0	13:00	13.05	0.25	0.37
15_RCP_EL0156	CONDUIT	9.49	0	13:00	13.08	0.48	0.59
ARLINGTON2_CHANNEL_2*	CONDUIT	9.49	0	13:00	5.16	0.05	0.32
15_RCP_EL0159	CONDUIT	1.88	0	13:00	9.45	0.10	0.22
15_RCP_EL0160	CONDUIT	3.78	0	13:00	12.05	0.11	0.30
15_RCP_EL0161	CONDUIT	3.78	0	13:00	11.49	0.21	0.31
ARLINGTON2_CHANNEL_3	CONDUIT	3.78	0	13:00	2.68	0.02	0.27
ARLINGTON2_CHANNEL_4	CONDUIT	15.40	0	13:00	3.13	0.12	0.64
PROP_24_RCP_1*	CONDUIT	22.35	0	13:00	8.54	0.44	0.79
OVER_15_RCP_1*	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
PROP_24_RCP_2*	CONDUIT	23.86	0	13:00	12.76	0.40	0.60
OVER_15_RCP_2*	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
ARLINGTON2_CHANNEL_5*	CONDUIT	23.86	0	13:01	3.76	0.12	0.69

****
Flow Classification Summary
****

Alternative - Arlington 1 and 2 (10-Year)

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change
15_RCP_EL0164	87.88	0.04	0.00	0.00	0.00	0.96	0.00	0.00	3.78	0.0000
15_RCP_EL0165	4.65	0.04	0.00	0.00	0.00	0.96	0.00	0.00	4.07	0.0000
ARLINGTON1_CHANNEL_1	2.22	0.04	0.00	0.00	0.91	0.04	0.00	0.00	0.70	0.0000
24_RCP_EL0170	28.04	0.04	0.00	0.00	0.00	0.00	0.00	0.96	2.02	0.0000
24_RCP_EL0171	3.39	0.04	0.00	0.00	0.01	0.12	0.00	0.83	2.12	0.0001
24_RCP_EL0178	3.62	0.04	0.00	0.00	0.09	0.67	0.00	0.20	1.23	0.0001
OVER_24_RCP_EL0178	6.96	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
24_RCP_EL0172	4.63	0.04	0.01	0.00	0.02	0.00	0.93	0.00	0.56	0.0006
OVER_24_RCP_EL0172	11.98	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
24_RCP_EL0173	4.93	0.04	0.00	0.00	0.13	0.06	0.00	0.77	1.01	0.0002
24_RCP_EL0174	21.14	0.04	0.00	0.00	0.00	0.96	0.00	0.00	1.71	0.0001
ARLINGTON1_CHANNEL_2	5.87	0.04	0.00	0.00	0.34	0.61	0.00	0.00	1.10	0.0000
24_RCP_EL0167	2.92	0.04	0.00	0.00	0.00	0.03	0.00	0.92	2.03	0.0000
24_RCP_EL0168	15.24	0.04	0.00	0.00	0.00	0.00	0.00	0.96	1.47	0.0000
24_RCP_EL0169	2.60	0.04	0.00	0.00	0.00	0.96	0.00	0.00	2.41	0.0000
ARLINGTON1_CHANNEL_3	1.49	0.00	0.05	0.00	0.95	0.00	0.00	0.00	0.01	0.0000
15_RCP_EL0153	10.76	0.04	0.00	0.00	0.00	0.00	0.00	0.96	4.28	0.0000
15_RCP_EL0154	8.49	0.04	0.00	0.00	0.00	0.96	0.00	0.00	5.15	0.0000
ARLINGTON2_CHANNEL_1*	1.08	0.04	0.00	0.00	0.88	0.07	0.00	0.00	0.70	0.0000
15_RCP_EL0163	4.74	0.04	0.00	0.00	0.00	0.00	0.00	0.96	3.60	0.0001
15_RCP_EL0156	4.13	0.04	0.00	0.00	0.00	0.96	0.00	0.00	4.80	0.0001
ARLINGTON2_CHANNEL_2*	2.69	0.04	0.00	0.00	0.05	0.91	0.00	0.00	1.20	0.0000
15_RCP_EL0159	4.04	0.04	0.00	0.00	0.00	0.00	0.00	0.96	3.15	0.0000
15_RCP_EL0160	12.93	0.04	0.00	0.00	0.00	0.06	0.00	0.90	5.26	0.0000
15_RCP_EL0161	3.78	0.04	0.00	0.00	0.00	0.96	0.00	0.00	4.64	0.0000
ARLINGTON2_CHANNEL_3	3.83	0.04	0.00	0.00	0.94	0.01	0.00	0.00	0.66	0.0000
ARLINGTON2_CHANNEL_4	1.00	0.04	0.00	0.00	0.96	0.00	0.00	0.00	0.74	0.0000
PROP_24_RCP_1*	5.23	0.04	0.00	0.00	0.01	0.95	0.00	0.00	2.24	0.0001
OVER_15_RCP_1*	8.72	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
PROP_24_RCP_2*	4.80	0.04	0.00	0.00	0.00	0.96	0.00	0.00	3.98	0.0001
OVER_15_RCP_2*	5.58	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
ARLINGTON2_CHANNEL_5*	2.23	0.00	0.05	0.00	0.95	0.00	0.00	0.00	0.09	0.0000

****
Conduit Surcharge Summary
****

Conduit	Hours Full: Both Ends	Upstream	Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
24_RCP_EL0178	0.11	0.11	0.12	0.01	0.01
24_RCP_EL0172	0.14	0.14	0.14	0.73	0.01
24_RCP_EL0173	0.36	0.36	0.36	0.01	0.36

Analysis begun on: Thu Oct 25 13:50:23 2018
Analysis ended on: Thu Oct 25 13:50:24 2018
Total elapsed time: 00:00:01

Alternative - South Lakeshore: Rolling & Ridgecrest (10-Year)

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.021)
--------------------------------------------------------------

Alternative - South Lakeshore: Rolling & Ridgecrest (10-Year)
ALLARD Starting WSELs from HEC-RAS XS 14764
2-Year = 296.42'

***********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
***********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... CURVE_NUMBER
Flow Routing Method ...... DYNWAVE
Starting Date ............ MAY-05-2016 00:00:00
Ending Date .............. MAY-06-2016 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:15:00
Wet Time Step ............ 00:10:00
Dry Time Step ............ 00:10:00
Routing Time Step ........ 10.00 sec

WARNING 02: maximum depth increased for Node 3_EL0120_PE
WARNING 02: maximum depth increased for Node JUNCTION_1
WARNING 02: maximum depth increased for Node 4_EL0126_PE
WARNING 02: maximum depth increased for Node 1_EL0086_SI*
WARNING 02: maximum depth increased for Node 2_EL0087_PE
WARNING 02: maximum depth increased for Node 4_EL0090_PE
WARNING 02: maximum depth increased for Node 7_EL0048_PE

*************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
*************************     ---------       -------
Total Precipitation ......        39.530         5.385
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........        17.551         2.391
Surface Runoff ...........        21.551         2.936
Final Surface Storage ....         0.496         0.068
Continuity Error (%) .....        -0.171


*************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
*************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......        21.512         7.010
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.104         0.034
External Outflow .........        21.575         7.031
Internal Outflow .........         0.000         0.000
Storage Losses ...........         0.000         0.000
Initial Stored Volume ....         0.359         0.117
Final Stored Volume ......         0.568         0.185
Continuity Error (%) .....        -0.762


************************
```

Highest Continuity Errors
****
Node 3_EL0083_PE (1.95%)

****
Time-Step Critical Elements
****
Link 12_CLAY_EL0123 (2.76%)
Link PROP_36_EL0089 (1.02%)

****
Highest Flow Instability Indexes
****
Link S_LAKESHORE_CHANNEL (10)

****
Routing Time Step Summary
****
Minimum Time Step : 6.76 sec
Average Time Step : 9.93 sec
Maximum Time Step : 10.00 sec
Percent in Steady State : 0.00
Average Iterations per Step : 2.00

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
S_Lakeshore_Ridgecrest_10	5.39	0.00	0.00	2.76	2.57	0.75	16.89	0.477
S_Lakeshore_Ridgecrest_20	5.39	0.00	0.00	2.39	2.95	0.81	18.30	0.547
S_Lakeshore_Ridgecrest_30	5.38	0.00	0.00	2.35	2.99	0.16	3.61	0.556
S_Lakeshore_Woodhaven_10	5.38	0.00	0.00	2.49	2.83	0.41	9.09	0.526
S_Lakeshore_Woodhaven_20	5.38	0.00	0.00	2.20	3.15	0.03	0.64	0.584
S_Lakeshore_Woodhaven_30	5.39	0.00	0.00	2.20	3.14	0.04	0.83	0.583
S_Lakeshore_Woodhaven_40	5.39	0.00	0.00	2.24	3.10	0.16	3.56	0.575
S_Lakeshore_Woodhaven_50	5.39	0.00	0.00	1.13	4.22	0.02	0.44	0.783
S_Lakeshore_Woodhaven_60	5.39	0.00	0.00	2.78	2.56	0.01	0.28	0.475
S_Lakeshore_Woodhaven_70	5.38	0.00	0.00	2.42	2.92	0.21	4.91	0.541
S_Lakeshore_Rolling_10	5.39	0.00	0.00	2.38	2.94	1.55	33.85	0.546
S_Lakeshore_Rolling_20	5.39	0.00	0.00	2.28	3.05	1.43	31.74	0.566
S_Lakeshore_Rolling_30	5.38	0.00	0.00	2.10	3.24	0.03	0.74	0.601
S_Lakeshore_Rolling_40	5.39	0.00	0.00	1.80	3.54	0.06	1.42	0.658
S_Lakeshore_10	5.39	0.00	0.00	1.85	3.49	0.16	3.66	0.649
Allard_10	5.39	0.00	0.00	2.41	2.92	1.03	23.05	0.542
Allard_20	5.38	0.00	0.00	2.36	2.98	0.05	1.17	0.553
Allard_30	5.39	0.00	0.00	2.05	3.29	0.11	2.48	0.611

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min
1_EL0123_PE*	JUNCTION	0.27	2.11	324.82	0 13:00
2_EL0122_PE	JUNCTION	0.08	0.54	322.02	0 13:00
3_EL0120_PE	JUNCTION	0.16	1.03	322.11	0 13:01
4_EL0118_PE	JUNCTION	0.09	0.54	317.44	0 13:01
1_EL0112_PE	JUNCTION	0.08	0.44	332.32	0 12:59

2_EL0113_JB	JUNCTION	0.08	0.39	327.37	0	13:00
3_EL0114_DI	JUNCTION	0.07	0.32	324.33	0	13:00
JUNCTION_1	JUNCTION	0.12	0.70	308.84	0	13:00
1_EL0590_PE	JUNCTION	0.20	1.26	344.60	0	12:59
2_EL0591_PE	JUNCTION	0.08	0.43	330.02	0	13:00
3_EL0125_DA*	JUNCTION	0.13	0.75	318.07	0	12:59
4_EL0126_PE	JUNCTION	0.18	0.95	309.07	0	13:00
JUNCTION_2*	JUNCTION	0.17	0.88	308.63	0	13:00
1_EL0086_SI*	JUNCTION	0.27	1.61	316.11	0	12:59
2_EL0087_PE	JUNCTION	0.18	2.23	314.67	0	13:02
3_EL0089_PE	JUNCTION	0.48	2.98	314.76	0	13:01
4_EL0090_PE	JUNCTION	0.17	0.98	312.67	0	13:01
5_EL0092_PE	JUNCTION	0.54	3.75	306.32	0	12:59
6_EL0094_PE	JUNCTION	0.19	0.99	302.54	0	13:00
1_EL0081_DA*	JUNCTION	0.08	0.47	299.47	0	12:59
2_EL0082_CB	JUNCTION	0.12	0.80	298.53	0	13:00
3_EL0083_PE	JUNCTION	0.37	0.56	297.84	0	00:01
1_EL0043_PE	JUNCTION	0.25	1.55	329.73	0	12:59
2_EL0044_CB	JUNCTION	0.22	1.28	328.78	0	13:00
3_EL0045_CB	JUNCTION	0.23	1.35	327.61	0	13:00
4_EL0046_JB	JUNCTION	0.19	0.91	320.89	0	13:01
6_EL0047_JB	JUNCTION	0.14	0.84	306.85	0	13:01
7_EL0048_PE	JUNCTION	0.15	0.83	302.25	0	13:01
3A_EL0115_DA*	JUNCTION	0.03	0.11	331.17	0	12:59
S_LAKESHORE_WOODHAVEN	OUTFALL	9.72	9.72	297.22	0	00:00
S_LAKESHORE_RIDGECREST	OUTFALL	9.82	9.82	297.12	0	00:00
S_LAKESHORE_ROLLING	OUTFALL	6.29	6.29	297.24	0	00:00
S_LAKESHORE	OUTFALL	6.71	6.71	297.65	0	00:00
S_LAKESHORE_ALLARD	OUTFALL	6.71	6.71	297.65	0	00:00

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal
1_EL0123_PE*	JUNCTION	9.09	9.09	0 12:59	0.406	0.406
2_EL0122_PE	JUNCTION	0.00	9.05	0 13:00	0.000	0.406
3_EL0120_PE	JUNCTION	0.64	9.56	0 13:00	0.028	0.434
4_EL0118_PE	JUNCTION	0.83	10.20	0 13:00	0.037	0.470
1_EL0112_PE	JUNCTION	3.55	3.55	0 12:59	0.158	0.158
2_EL0113_JB	JUNCTION	0.00	3.55	0 13:00	0.000	0.158
3_EL0114_DI	JUNCTION	0.00	3.98	0 13:00	0.000	0.178
JUNCTION_1	JUNCTION	5.19	19.31	0 12:59	0.224	0.873
1_EL0590_PE	JUNCTION	18.30	18.30	0 12:59	0.812	0.812
2_EL0591_PE	JUNCTION	0.00	18.27	0 13:00	0.000	0.812
3_EL0125_DA*	JUNCTION	16.88	16.88	0 12:59	0.750	0.750
4_EL0126_PE	JUNCTION	0.00	16.86	0 13:00	0.000	0.750
JUNCTION_2*	JUNCTION	3.61	38.60	0 13:00	0.157	1.718
1_EL0086_SI*	JUNCTION	31.73	31.73	0 12:59	1.428	1.428
2_EL0087_PE	JUNCTION	0.00	71.92	0 13:02	0.000	1.509
3_EL0089_PE	JUNCTION	0.74	97.89	0 13:00	0.033	1.544
4_EL0090_PE	JUNCTION	0.00	38.99	0 13:01	0.000	1.458
5_EL0092_PE	JUNCTION	35.25	72.58	0 12:59	1.611	3.069
6_EL0094_PE	JUNCTION	0.00	65.50	0 13:00	0.000	3.067
1_EL0081_DA*	JUNCTION	3.66	3.66	0 12:59	0.159	0.159
2_EL0082_CB	JUNCTION	0.00	3.66	0 13:00	0.000	0.159
3_EL0083_PE	JUNCTION	0.00	12.89	0 00:00	0.000	0.193
1_EL0043_PE	JUNCTION	23.05	23.05	0 12:59	1.030	1.030
2_EL0044_CB	JUNCTION	0.00	23.02	0 13:00	0.000	1.030
3_EL0045_CB	JUNCTION	1.17	24.14	0 13:00	0.050	1.080
4_EL0046_JB	JUNCTION	0.00	24.14	0 13:01	0.000	1.080
6_EL0047_JB	JUNCTION	0.00	24.14	0 13:01	0.000	1.080
7_EL0048_PE	JUNCTION	2.48	26.38	0 13:01	0.107	1.187
3A_EL0115_DA*	JUNCTION	0.44	0.44	0 12:59	0.021	0.021
S_LAKESHORE_WOODHAVEN	OUTFALL	0.00	19.28	0 13:00	0.000	0.873

```
S_LAKESHORE_RIDGECREST OUTFALL       0.00    38.35     0  13:00       0.000       1.716
S_LAKESHORE_ROLLING  OUTFALL       0.00    65.31     0  13:00       0.000       3.066
S_LAKESHORE          OUTFALL       0.00    12.89     0  00:00       0.000       0.223
S_LAKESHORE_ALLARD   OUTFALL       0.00    26.37     0  13:01       0.000       1.186


**********************
Node Surcharge Summary
**********************

No nodes were surcharged.


*********************
Node Flooding Summary
*********************

No nodes were flooded.


***********************
Outfall Loading Summary
***********************

-------------------------------------------------------------
                     Flow       Avg.      Max.       Total
                     Freq.      Flow      Flow      Volume
Outfall Node         Pcnt.       CFS       CFS    10^6 gal
-------------------------------------------------------------
S_LAKESHORE_WOODHAVEN  95.14      1.53     19.28       0.873
S_LAKESHORE_RIDGECREST  94.57      3.02     38.35       1.716
S_LAKESHORE_ROLLING   94.60      5.37     65.31       3.066
S_LAKESHORE           99.89      0.36     12.89       0.223
S_LAKESHORE_ALLARD    94.88      2.08     26.37       1.186
-------------------------------------------------------------
System               95.81     12.36    152.86       7.064


*******************
Link Flow Summary
*******************

-------------------------------------------------------------------------------
                              Maximum  Time of Max   Maximum    Max/    Max/
                               |Flow|   Occurrence   |Veloc|    Full    Full
Link                 Type         CFS  days hr:min    ft/sec    Flow   Depth
-------------------------------------------------------------------------------
12_CLAY_EL0123       CONDUIT      5.74     0  13:00      8.85    0.77    0.77
OVER_12_CLAY_EL0123  CONDUIT      3.32     0  13:00      3.07    0.01    0.05
S_LAKESHORE_WOODHAVEN_CHANNEL_1 CONDUIT      8.95     0  13:00      2.61    0.02    0.26
15_RCP_EL0120        CONDUIT      9.44     0  13:01     11.67    0.53    0.63
S_LAKESHORE_WOODHAVEN_CHANNEL_2 CONDUIT     10.20     0  13:01      5.93    0.15    0.41
15_RCP_EL0112        CONDUIT      3.55     0  13:00     10.33    0.19    0.32
15_RCP_EL0113        CONDUIT      3.55     0  13:00     12.19    0.15    0.29
15_RCP_EL0114        CONDUIT      3.98     0  13:00      8.41    0.15    0.41
S_LAKESHORE_WOODHAVEN_CHANNEL_3 CONDUIT     19.28     0  13:00      5.11    0.23    0.73
PROP_18_RCP_EL0590   CONDUIT     18.27     0  13:00     18.23    0.53    0.56
OVER_15_RCP_EL0590   CONDUIT      0.00     0  00:00      0.00    0.00    0.00
S_LAKESHORE_RIDGECREST_CHANNEL_1* CONDUIT     18.25     0  13:00      5.21    0.02    0.22
24_RCP_EL0125        CONDUIT     16.86     0  13:00     13.33    0.22    0.42
S_LAKESHORE_RIDGECREST_CHANNEL_2 CONDUIT     16.82     0  13:00      2.93    0.08    0.30
S_LAKESHORE_RIDGECREST_CHANNEL_3 CONDUIT     38.35     0  13:00      1.98    0.06    0.65
PROP_36_RCP_EL0086   CONDUIT     32.17     0  12:59     10.19    0.23    0.63
OVER_24_RCP_EL0086   CONDUIT      0.00     0  00:00      0.00    0.00    0.00
S_LAKESHORE_ROLLING_CHANNEL_1 CONDUIT     97.20     0  13:00      4.08    0.07    0.60
PROP_36_EL0089       CONDUIT     38.99     0  13:01      8.27    1.05    0.66
OVER_24_HDPVC_EL0089 CONDUIT      0.00     0  00:00      0.00    0.00    0.02
S_LAKESHORE_ROLLING_CHANNEL_2 CONDUIT     38.69     0  13:01      4.27    0.22    0.75
PROP_48_RCP_EL0092   CONDUIT     65.50     0  13:00     10.14    0.45    0.64
OVER_24_RCP_EL0092   CONDUIT      0.00     0  00:00      0.00    0.00    0.00
S_LAKESHORE_ROLLING_CHANNEL_3 CONDUIT     65.31     0  13:00      2.24    0.06    0.64
```

```
18_RCP_EL0081         CONDUIT       3.66     0  13:00      7.78    0.11    0.36
18_RCP_EL0082         CONDUIT       3.65     0  13:00      5.74    0.29    0.39
S_LAKESHORE_CHANNEL   CONDUIT      12.89     0  00:00      0.88    0.03    0.59
30_RCP_EL0043         CONDUIT      23.02     0  13:00      8.51    0.31    0.55
30_RCP_EL0044         CONDUIT      23.02     0  13:00      9.31    0.30    0.51
30_RCP_EL0045         CONDUIT      24.14     0  13:01     11.01    0.31    0.46
TWIN_18_RCP_EL0047    CONDUIT      24.15     0  13:01     11.95    0.38    0.56
30_RCP_EL0046         CONDUIT      24.14     0  13:01     15.40    0.26    0.36
S_LAKESHORE_ALLARD_CHANNEL CONDUIT     26.37     0  13:01      3.04    0.17    0.71
15_CLAY_EL0115        CONDUIT       0.44     0  12:59      3.36    0.02    0.17


**************************
Flow Classification Summary
**************************

-------------------------------------------------------------------------------------
                    Adjusted    --- Fraction of Time in Flow Class ----    Avg.     Avg.
                     /Actual         Up    Down  Sub   Sup   Up    Down   Froude   Flow
Conduit               Length    Dry  Dry   Dry   Crit  Crit  Crit  Crit   Number   Change
-------------------------------------------------------------------------------------
12_CLAY_EL0123          5.42   0.04  0.00  0.00  0.00  0.96  0.00  0.00     2.98   0.0002
OVER_12_CLAY_EL0123     9.02   0.97  0.00  0.00  0.00  0.00  0.00  0.03     0.05   0.0000
S_LAKESHORE_WOODHAVEN_CHANNEL_1   21.31   0.04  0.00  0.00  0.96  0.00  0.00  0.00     0.50   0.0000
15_RCP_EL0120           3.70   0.04  0.00  0.00  0.01  0.95  0.00  0.00     3.90   0.0001
S_LAKESHORE_WOODHAVEN_CHANNEL_2    1.36   0.04  0.00  0.00  0.20  0.76  0.00  0.00     1.08   0.0000
15_RCP_EL0112           6.32   0.04  0.00  0.00  0.00  0.00  0.00  0.96     3.09   0.0000
15_RCP_EL0113          12.83   0.04  0.00  0.00  0.00  0.00  0.00  0.96     3.85   0.0000
15_RCP_EL0114           3.04   0.04  0.00  0.00  0.00  0.95  0.00  0.00     3.00   0.0000
S_LAKESHORE_WOODHAVEN_CHANNEL_3    1.00   0.00  0.04  0.00  0.95  0.00  0.00  0.00     0.11   0.0001
PROP_18_RCP_EL0590      2.09   0.04  0.00  0.00  0.00  0.96  0.00  0.00     5.83   0.0001
OVER_15_RCP_EL0590      4.44   1.00  0.00  0.00  0.00  0.00  0.00  0.00     0.00   0.0000
S_LAKESHORE_RIDGECREST_CHANNEL_1*    2.66   0.04  0.00  0.00  0.30  0.66  0.00  0.00     1.08   0.0000
24_RCP_EL0125           4.07   0.04  0.00  0.00  0.00  0.96  0.00  0.00     3.13   0.0000
S_LAKESHORE_RIDGECREST_CHANNEL_2    2.12   0.04  0.00  0.00  0.96  0.00  0.00  0.00     0.45   0.0000
S_LAKESHORE_RIDGECREST_CHANNEL_3    1.00   0.00  0.04  0.00  0.96  0.00  0.00  0.00     0.03   0.0000
PROP_36_RCP_EL0086      6.67   0.04  0.00  0.00  0.00  0.95  0.00  0.00     2.93   0.0001
OVER_24_RCP_EL0086      9.44   1.00  0.00  0.00  0.00  0.00  0.00  0.00     0.00   0.0000
S_LAKESHORE_ROLLING_CHANNEL_1   36.14   0.04  0.00  0.00  0.95  0.01  0.00  0.00     0.43   0.0002
PROP_36_EL0089          5.20   0.04  0.00  0.00  0.02  0.94  0.00  0.00     1.24   0.0013
OVER_24_HDPVC_EL0089    4.33   1.00  0.00  0.00  0.00  0.00  0.00  0.00     0.00   0.0000
S_LAKESHORE_ROLLING_CHANNEL_2    1.00   0.04  0.01  0.00  0.95  0.00  0.00  0.00     0.39   0.0003
PROP_48_RCP_EL0092      5.25   0.04  0.00  0.00  0.00  0.96  0.00  0.00     2.16   0.0002
OVER_24_RCP_EL0092     12.50   1.00  0.00  0.00  0.00  0.00  0.00  0.00     0.00   0.0000
S_LAKESHORE_ROLLING_CHANNEL_3    1.15   0.00  0.05  0.00  0.95  0.00  0.00  0.00     0.03   0.0000
18_RCP_EL0081          23.21   0.04  0.00  0.00  0.00  0.03  0.00  0.93     3.14   0.0000
18_RCP_EL0082           4.46   0.00  0.00  0.00  0.93  0.07  0.00  0.00     0.36   0.0001
S_LAKESHORE_CHANNEL     1.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00     0.00   0.0001
30_RCP_EL0043          13.32   0.04  0.00  0.00  0.00  0.04  0.00  0.92     2.01   0.0001
30_RCP_EL0044           7.43   0.04  0.00  0.00  0.00  0.07  0.00  0.89     2.22   0.0001
30_RCP_EL0045           8.79   0.04  0.00  0.00  0.00  0.00  0.00  0.96     2.23   0.0001
TWIN_18_RCP_EL0047      5.00   0.04  0.00  0.00  0.00  0.96  0.00  0.00     3.36   0.0002
30_RCP_EL0046           1.05   0.04  0.00  0.00  0.00  0.00  0.00  0.96     2.87   0.0001
S_LAKESHORE_ALLARD_CHANNEL    1.00   0.00  0.04  0.00  0.96  0.00  0.00  0.00     0.06   0.0000
15_CLAY_EL0115          6.47   0.04  0.00  0.00  0.05  0.91  0.00  0.00     1.24   0.0000


*************************
Conduit Surcharge Summary
*************************

---------------------------------------------------------------------------
                                                    Hours        Hours
                        --------- Hours Full --------   Above Full   Capacity
Conduit                 Both Ends  Upstream  Dnstream   Normal Flow   Limited
---------------------------------------------------------------------------
PROP_36_EL0089              0.01      0.01      0.01      0.02         0.01


Analysis begun on:  Thu Oct 25 13:52:34 2018
Analysis ended on:  Thu Oct 25 13:52:35 2018
```

Alternative - South Lakeshore: Rolling & Ridgecrest (10-Year)

```
Total elapsed time: 00:00:01
```

Appendix I:

Condition Assessment Methodology

APPENDIX I
CONDITION ASSESSMENT METHODOLOGY

DATA COLLECTION AND ANALYSIS

Since running the prioritization tool is highly dependent upon existing infrastructure data, WK Dickson worked closely with the Town to compile as much available data regarding the stormwater infrastructure as possible. The data collection and analysis tasks included:

- Inventory and review of stormwater GIS database and attributes;
- Collection and review of relevant transportation and geographic data;
- Summary and analysis of data reviewed; and
- Confidence level and applicability to the prioritization tool.

As a result, the following information pertaining to the stormwater infrastructure was collected and analyzed for the prioritization tool:

- GIS data and attributes for stormwater systems
- GIS data for the following relevant layers:
    - Road centerlines;
    - Building footprints;
    - Soils;
    - Hydrography; and
    - Critical Facilities.

SUMMARY OF EXISTING FACILITIES

In order to clearly identify critical infrastructure for each utility, WK Dickson separated the stormwater infrastructure database into stormwater pipes and stormwater structures. The following discussion presents a summary of the stormwater system assets and relative attributes that were incorporated into the prioritization tool for the criticality assessment.

Stormwater System Assets

The Eastwood Lake stormwater system infrastructure data includes 889 assets. The only pipe end type that was included in the analysis was headwall, since stub and flared end section are part of the pipe itself. Attributes assigned to these assets and considered for the stormwater system included the following:

- Unique ID;
- Pipe diameter;
- Pipe material;
- Installation date;
- Pipe length;
- Pipe slope;
- Capacity for drainage impoundment;
- Soil data;

- Proximity to transportation facilities;
- Proximity to buildings; and
- Proximity to critical facility.

Table I-1 summarizes the stormwater system assets that were incorporated into the prioritization tool.

Table I-1: Stormwater System Asset Summary

Asset Name	Number	Units
Unknown Storm Pipe	2,750	LF
8" Storm Pipe	30	LF
12" Storm Pipe	428	LF
15" Storm Pipe	12,295	LF
18" Storm Pipe	4,136	LF
24" Storm Pipe	4,127	LF
30" Storm Pipe	796	LF
36" Storm Pipe	1,291	LF
42" Storm Pipe	416	LF
48" Storm Pipe	207	LF
Catch Basin	213	EA
Drop Inlet	34	EA
Junction Box	32	EA
Pipe End	58	EA
Pond Structure	3	EA
Slab Top Inlet	15	EA
Difficult Access	24	EA
Underground Junction	3	EA

Critical Facilities

Critical facilities are those service locations within the system where failure of infrastructure would have an impact on a large concentration of customers or customers that provide critical operations. In the case of Chapel Hill, the critical facilities were determined to be a combination of schools, emergency response stations, as well as parks and select commercial facilities. The following critical facilities located in the Eastwood Lake subwatershed were identified:

- Guy B. Phillips Middle School; and
- Estes Hills Elementary School.

GIS DATA AUDIT

WK Dickson performed an audit of the Town's GIS data in order to establish a confidence level for utilizing the data in the creation of the criticality assessment tool. The audit consisted of the following tasks:

- Review of GIS layer data to determine ability to assess for the criticality analysis;
- Review of attribute fields utilized for the assessment tool;
- Analysis of attribute data for use in the assessment tool; and
- Review of weighted criticality scoring values to determine audit locations/databases.

The data collection and audit enabled the tool to be applied with a high level of confidence and reliability. Tables I-2 and I-3 summarize the reliability of the attribute data based on the percentage of data available for each attribute relative to the total number of assets. Reliability can be improved over time as more information is entered into and linked to the GIS database.

Table I-2: Stormwater Pipes Attribute Reliability

Stormwater Pipes – Likelihood		Stormwater Pipes – Consequence	
Field	**Data Set**	**Field**	**Data Set**
Installation Date	83.90%	Proximity to Impaired Streams	100.00%
Pipe Length	100.00%	Pipe Diameter	90.65%
Age	83.90%	Proximity to Critical Facilities	100.00%
Remaining Life	83.90%	Under Roadway	100.00%
Material Type	96.81%	Proximity to Buildings	100.00%
Under Roadway	100.00%	Potential for Water Impoundment	100.00%
Pipe Slope	78.18%	**Average**	**98.44%**
Corrosive Soils	100.00%		
Average	**90.84%**		

Table I-3: Stormwater Structure Attribute Reliability

Stormwater Pipes – Likelihood		Stormwater Pipes – Consequence	
Field	**Data Set**	**Field**	**Data Set**
Installation Date	90.08%	Potential for Water Impoundment	100.00%
Age	90.08%	Proximity to Streams	100.00%
Remaining Life	90.08%	Proximity to Impaired Streams	100.00%
Material Type	90.83%	Proximity to Buildings	100.00%
Corrosive Soils	100.00%	Proximity to Critical Facilities	100.00%
Average	**92.21%**	In Roadway	100.00%
		Average	**100.00%**

As shown in Tables I-2 and I-3, data reliability was sufficiently high to obtain a full measure of the criticality of each asset.

CRITICALLY SCORING AND METHODOLOGY

WK Dickson coordinated with the Town's staff to establish the criticality scoring criteria and assign weighted values for use in the prioritization tool. Attribute scoring categories provide a quantitative value for the likelihood and consequence of failure and associated criticality score summation. Tasks for the criticality scoring and methodology included:

- Establishment of scoring criteria and attribute factors;
- Prioritization of scoring criteria (weighted attribute scoring;)
- Establishment of final scoring system and documentation of methodology; and
- Application of scoring criteria to system assets to obtain ranking and thresholds.

System scoring was established based on each attribute having a total weighted score factor multiplied by an attribute weight factor. Each attribute was assigned between 2 to 6 factors with a scoring range between 0 and 10. The attribute factor was then multiplied by an attribute weighting score to develop a total attribute score. Scores were added together within the likelihood of failure category and the consequence of failure category.

Tables I-4 through I-7 summarize the final attributes, attribute factors, factor scoring, and weighted attribute scoring used in the prioritization tool for the criticality assessment.

Limitations of the scoring system included availability of data, accuracy of data, and associated reliability scoring as discussed in the GIS data audit section. Where limitations were identified, attribute weighting was adjusted to reflect lack of data. Therefore, the limitation would not skew the scoring as an extreme value, i.e. assuming zero for no data would indicate a recent install date.

APPENDIX I
CONDITION ASSESSMENT METHODOLOGY

Throughout the assessment data review and progress meetings, certain assumptions were made to provide higher data reliability and represent actual system conditions. Assumptions of attribute values were limited to only information the Town could verify with a high probability of accuracy. Where availability of data was limited, the weighting of that category was adjusted so that known system elements governed the criticality score. The following assumptions and efforts were made throughout the project to provide the most reliable asset scoring:

- Remaining Useful Life (RUL) – Remaining Useful Life considers the estimated life cycle of the asset based on material and calculates its remaining life based on the install date.

- Impoundment – Potential for water impoundment considers the following pipes and structures as higher criticality due to the potential for large quantities of stormwater to be detained and subsequently released if the given structure or pipe fails:
    - Pipes and structures that make up the outlets of stormwater detention facilities; and
    - Pipes and structures that make up road or railroad crossings.

- Information regarding corrosive soils was linked to GIS from County soil maps. Soil survey data rank metallic and cementitious pipe risk of corrosion as low, moderate or high based on soil drainage class, total acidity, electrical resistivity and conductivity.

Table I-4: Stormwater Pipes Scoring Matrix – Likelihood of Failure

Attribute	Attribute Weighted Scoring	Attribute Factor	Attribute Factor Weighting
Remaining Useful Life (RUL)*	16.00	Less than 10%	10
		Between 10 and 39%	8
		Between 40 and 49%	6
		Between 50 and 69%	4
		Between 70 and 89%	2
		Greater than 89%	0
Slope	20.00	Less than 0.2%	3
		Between 0.2% and 1%	1
		Between 1% and 2%	3
		Between 2% and 4%	3
		Greater than 4%	6
Corrosive Soils	4.00	Corrosive Soil/Metallic Pipe	10
		Non-Corrosive	0
Location under Transportation Facilities	20.00	Under Interstate/Highway	10
		Under Railroad	8
		Under Local Road	2

*Category considers pipe material in the analysis.

Table I-5: Stormwater Pipes Scoring Matrix – Consequence of Failure

Attribute	Attribute Weighted Scoring	Attribute Factor	Attribute Factor Weighting
Pipe Diameter	12.00	Greater than 42	10
		37 to 42	8
		25 to 36	6
		16 to 24	4
		8 to 15	2
		Less than 8	0
Proximity to Transportation Infrastructure	20.00	Under Interstate/Highway	10
		Under Railroad	8
		Under Local Road	2
Proximity to Building	16.00	Within Building Footprint	10
		Up to 20 feet from Building	5
		Greater than 20 feet	0
Potential for Water Impoundment	8.00	Potential Impoundment	10
		No Potential Impoundment	0
Proximity to Critical Facility	20.00	Up to 100 feet from Building	10
		Greater than 100 feet	0
Proximity to Impaired Streams	8.00	Up to 25 feet from stream	10
		26 to 50 feet from stream	5
		Greater than 50 feet	0
Proximity to Streams	8.00	Up to 25 feet from stream	10
		26 to 50 feet from stream	5
		Greater than 50 feet	0

Table I-6: Stormwater Structure Scoring Matrix – Likelihood of Failure

Attribute	Attribute Weighted Scoring	Attribute Factor	Attribute Factor Weighting
Remaining Useful Life (RUL)*	18.00	Less than 10%	10
		Between 10 and 39%	8
		Between 40 and 49%	6
		Between 50 and 69%	4
		Between 70 and 89%	2
		Greater than 89%	0
Corrosive Soils	8.0	Corrosive Soil	10
		Non-Corrosive	0

*Category considers manhole material in the analysis.

Table I-7: Stormwater Structure Scoring Matrix – Consequence of Failure

Attribute	Attribute Weighted Scoring	Attribute Factor	Attribute Factor Weighting
Proximity to Streams	14.00	Up to 100 feet	10
		101 feet to 500 feet	5
		Greater than 500 feet	0
Proximity to Impaired Streams	24.00	Up to 100 feet	10
		101 feet to 500 feet	5
		Greater than 500 feet	0
Proximity to Transportation Infrastructure	14.00	Under Interstate/Highway ROW	10
		Under Railroad ROW	8
		Under Local Road ROW	2
Proximity to Building	14.00	Within Building Footprint	10
		Up to 20 feet from Building	5
		Greater than 20 feet	0
Proximity to Critical Facility	18.00	Within Building Footprint	10
		Up to 25 feet from Building	5
		Greater than 25 feet	0
Potential for Water Impoundment	8.00	Potential Impoundment	10
		No Potential Impoundment	0

Eastwood Lake Subwatershed Study - System Prioritization

System ID	System Location	Maintained By	# of Pipes	# of Structures	Total Pipe Score	Total Structure Score	Average Pipe Score	Average Structure Score	Total Average Score	Highest Pipe Criticality	Highest Structure Criticality
1	Lakeshore Ln	ToCH	6	7	2124	1520	354	217	571	3	4
2	Red Bud Rd	ToCH	8	9	3580	2170	448	241	689	4	5
3	N Lakeshore Dr/Lakeshore Ct	ToCH	10	11	3816	2430	382	221	603	3	4
4	2113 N Lakeshore Dr	ToCH	1	2	504	420	504	210	714	4	3
5	2106 N Lakeshore Dr	ToCH	6	8	2612	2040	435	255	690	3	5
6	2009 S Lakeshore Dr	ToCH	2	3	848	660	424	220	644	3	4
7	Intersection of Ridgecrest Dr & S Lakeshore Dr	ToCH	1	2	504	420	504	210	714	4	3
8	1917 S Lakeshore Dr	ToCH	1	2	420	420	420	210	630	3	3
9	1901 S Lakeshore Dr	ToCH	3	5	1348	1070	449	214	663	4	4
10	1825 S Lakeshore Dr	ToCH	4	5	1956	1150	489	230	719	4	5
11	Intersection of Woodhaven Rd & Rolling Rd	ToCH	3	4	1276	660	425	165	590	4	4
12	Intersection of Knollwood Dr & Rolling Rd	ToCH	6	8	2792	1360	465	170	635	4	4
13	Michaux Rd between Allard Rd & Vernon Hills Ct	ToCH	9	10	3928	2080	436	208	644	4	4
14	East end of Allard Rd	ToCH	4	5	1888	1060	472	212	684	4	4
15	Intersection of Audubon Rd & Michaux Rd	ToCH	5	6	2344	1200	469	200	669	4	4
16	1816 S Lakeshore Dr	ToCH	2	4	768	840	384	210	594	3	3
17	1810 S Lakeshore Dr	ToCH	1	2	468	420	468	210	678	3	3
18	1808 S Lakeshore Dr	ToCH	2	3	716	610	358	203	561	2	4
19	1806 S Lakeshore Dr	ToCH	5	6	2476	1460	495	243	739	4	5
20	Intersection of Allard Rd & Lyons Rd	ToCH	2	3	620	450	310	150	460	2	3
21	414 Lyons Rd	ToCH	4	5	1908	1060	477	212	689	4	4
22	405 N Elliott Rd	ToCH	2	3	764	450	382	150	532	3	3
23	N Lakeshore Dr/Kenmore Rd	ToCH	9	10	3964	2210	440	221	661	4	5
24	Kenmore Rd between N Lakeshore Dr & Shadylawn Rd	ToCH	4	5	1576	590	394	118	512	3	3
25	Intersection of Kenmore Rd & Shadylawn Rd	ToCH	3	4	1020	280	340	70	410	2	1
26	624 Shadylawn Rd	ToCH	1	2	552	280	552	140	692	4	2
27	Summit Rd/Shadylawn Rd	ToCH	3	4	1152	520	384	130	514	3	3
28	Shadylawn Rd between Summit Rd & N Lakeshore Dr	ToCH	2	3	752	420	376	140	516	2	3
29	2004 N Lakeshore Dr	ToCH	3	4	1092	800	364	200	564	2	4
30	2000 N Lakeshore Dr	ToCH	3	4	1172	750	391	188	578	3	4
31	1831 N Lakeshore Dr	ToCH	6	7	2728	2070	455	296	750	3	5
32	1833 N Lakeshore Dr	ToCH	3	4	1184	1080	395	270	665	3	5
33	1818 N Lakeshore Dr	ToCH	2	3	840	630	420	210	630	3	3
34	Intersection of N Lakeshore Dr & Rock Creek Rd	ToCH	1	2	364	400	364	200	564	2	4
35	601 Rock Creek Rd	ToCH	5	6	1876	1660	375	277	652	3	5
36	Intersection of N Lakeshore Dr & Kensington Dr	ToCH	3	4	1684	1340	561	335	896	5	5
37	Intersection of N Lakeshore Dr & S Lakeshore Dr	ToCH	3	4	1228	1080	409	270	679	3	5
38	2122 Meares Rd	Private	1	2	340	280	340	140	480	2	2
39	604 Arlington St	ToCH	2	3	728	540	364	180	544	2	4
40	620 Arlington St	ToCH	3	4	1632	950	544	238	782	5	4
41	622 Arlington St	ToCH	2	3	1148	640	574	213	787	5	4
42	624 Arlington St	ToCH	2	3	928	520	464	173	637	4	3
43	Rock Creek Rd/Croom Ct/Wells Ct	ToCH	13	14	6852	3770	527	269	796	4	5
44	600 Kensington Dr	ToCH	1	2	420	560	420	280	700	3	4
45	Intersection of Kensington Dr & Concordia Ct	ToCH	7	8	3480	2160	497	270	767	4	5
46	611 Kensington Dr	ToCH	1	2	496	420	496	210	706	4	3
47	Intersection of Kensington Dr & Beech Tree Ct	ToCH	7	9	2880	2420	411	269	680	4	5
48	Curtis Rd between N Elliott Rd & Allard Rd	ToCH	13	14	5920	2910	455	208	663	4	5
49	919 Shadylawn Rd	Private	1	2	364	140	364	70	434	2	1
50	645 Rock Creek Rd	ToCH	3	4	1332	1200	444	300	744	4	5
51	Totten Pl	ToCH	3	4	1132	990	377	248	625	3	4
52	625 Kensington Dr	ToCH	3	5	1588	1290	529	258	787	4	5
53	627 Kensington Dr	ToCH	1	2	492	420	492	210	702	4	3
54	629 Kensington Dr	ToCH	1	2	552	280	552	140	692	4	2
55	500 N Estes Dr	ToCH	1	2	400	400	400	200	600	2	4
56	500 N Estes Dr	ToCH	2	3	752	710	376	237	613	3	4
57	500 N Estes Dr	ToCH	5	6	1404	1020	281	170	451	2	3

Eastwood Lake Subwatershed Study - System Prioritization

System ID	System Location	Maintained By	# of Pipes	# of Structures	Total Pipe Score	Total Structure Score	Average Pipe Score	Average Structure Score	Total Average Score	Highest Pipe Criticality	Highest Structure Criticality
58	500 N Estes Dr	ToCH	3	4	984	500	328	125	453	2	3
59	500 N Estes Dr	ToCH	1	2	340	70	340	35	375	2	1
60	500 N Estes Dr	ToCH	4	6	1300	1120	325	187	512	2	4
61	635 Kensington Dr	ToCH	1	2	472	420	472	210	682	3	3
62	Intersection of Kensington Dr & Wellington Dr	ToCH	6	7	2840	1370	473	196	669	4	4
63	706 Wellington Dr	ToCH	4	5	2292	1410	573	282	855	5	5
64	Porter Pl	ToCH	2	3	916	660	458	220	678	3	4
65	235 Huntington Dr	ToCH	1	2	424	400	424	200	624	3	4
66	104 Nuttal Pl	Private	2	3	728	730	364	243	607	3	4
67	Intersection of Nuttal Pl & Collinson Dr	Private	10	11	4104	2410	410	219	629	4	4
68	100 Nuttal Pl	Private	1	2	528	280	528	140	668	4	2
69	105 Catesby Ln	ToCH	2	3	704	540	352	180	532	2	4
70	Intersection of Eastwood Rd & Piney Mountain Rd	ToCH	4	5	1352	780	338	156	494	2	4
71	Billie Holiday Ct	Private	4	6	1536	1200	384	200	584	3	5
72	Intersection of Louis Armstrong Ct & Piney Mountain Rd	ToCH	3	4	1312	920	437	230	667	4	4
73	Intersection of Forest Hill Rd & Seminole Dr	ToCH	1	2	408	140	408	70	478	3	1
74	247 Seminole Dr	ToCH	1	2	388	210	388	105	493	2	2
75	242 Indian Trail Dr	ToCH	1	2	488	420	488	210	698	4	3
76	Intersection of Forest Hill Rd & Indian Trail Dr	ToCH	1	2	608	280	608	140	748	5	2
77	235 Forest Hill Rd	ToCH	1	2	548	280	548	140	688	4	2
78	162 Lake Ellen Dr	ToCH	1	2	548	280	548	140	688	4	2
79	147 Lake Ellen Dr	ToCH	1	2	468	280	468	140	608	3	2
80	Intersection of Priestly Creek Dr & Oosting Dr	ToCH	6	7	2956	1930	493	276	768	5	5
81	101 Oosting Dr	ToCH	1	2	284	260	284	130	414	1	3
82	100 Collinson Dr	Private	1	2	420	420	420	210	630	3	3
83	100 Priestly Creek Dr	ToCH	1	2	380	350	380	175	555	2	3
84	Intersection of Piney Mountain Rd & Priestly Creek Dr	ToCH	1	2	388	350	388	175	563	2	3
85	105 Priestly Creek Dr	ToCH	2	3	888	800	444	267	711	4	4
86	Old Forest Creek Dr/Darlin Cir	ToCH	6	7	2448	1700	408	243	651	4	4
87	137 Old Forest Creek Dr	ToCH	6	7	2812	2000	469	286	754	4	5
88	112 Mendel Dr	ToCH	2	3	768	560	384	187	571	2	4
89	231 Huntington Dr	ToCH	1	2	548	420	548	210	758	4	3
90	Pinchot Ln	ToCH	1	2	528	470	528	235	763	4	4
91	Old Forest Creek Dr/Piney Mountain Rd	ToCH	9	10	4048	1770	450	177	627	4	4
92	223 Huntington Dr	ToCH	3	4	1800	800	600	200	800	5	4
93	Somerset Dr/Huntington Dr	ToCH	7	8	2248	1210	321	151	472	2	3
94	221 Huntington Dr	ToCH	1	2	504	310	504	155	659	4	3
95	216 Huntington Dr	ToCH	2	3	828	520	414	173	587	3	3
96	217 Huntington Dr	ToCH	2	4	680	560	340	140	480	2	2
97	Linnaeus Pl	ToCH	5	6	2204	1300	441	217	657	4	4
98	110 Linnaeus Pl	ToCH	1	2	340	280	340	140	480	2	2
99	108 Linnaeus Pl	ToCH	1	2	340	280	340	140	480	2	2
100	Timber Hollow Ct	ToCH	1	2	340	280	340	140	480	2	2
101	Behind 105 Woodshire Ln	ToCH	1	2	480	280	480	140	620	3	2
102	Woodshire Ln	ToCH	8	9	4044	1960	506	218	723	4	4
103	Timber Hollow Ct/Mendal Dr	ToCH	10	11	3628	2180	363	198	561	4	4
104	Piney Mountain Rd/Timber Hollow Ct	ToCH	8	9	2840	1590	355	177	532	3	3
105	Behind 110 Woodshire Ln	ToCH	1	2	360	290	360	145	505	2	2
106	Shadowood Apartments	Private/NCDOT/ToCH	31	33	14920	7750	481	235	716	5	5
107	Intersection of N Estes Dr & MLK Jr Blvd	NCDOT	1	2	708	400	708	200	908	5	4

Appendix J:

Digital Copy of Hydrologic and Hydraulic Models

DIGITAL COPY OF HYDROLOGIC AND HYDRAULIC MODELS TO BE INCLUDED WITH SEALED REPORT

Appendix K:

Stream Assessment Data

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

STREAM NAME	LOCATION	
STATION #_____ RIVERMILE_____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE _____ TIME _____ AM PM	REASON FOR SURVEY

Parameters to be evaluated in sampling reach	Habitat Parameter	Condition Category			
		Optimal	Suboptimal	Marginal	Poor
	1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score _____

OVERALL STREAM CONDITION				
	Optimal	**Suboptimal**	**Marginal**	**Poor**
IN-STREAM HABITAT *(May modify criteria based on appropriate habitat regime)*	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
VEGETATIVE PROTECTION *(score each bank, determine sides by facing downstream)*	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0
BANK EROSION (facing downstream)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.	Past downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0
FLOODPLAIN CONNECTION	High flows (greater than bankfull) able to enter floodplain. Stream not deeply entrenched.	High flows (greater than bankfull) able to enter floodplain. Stream not deeply entrenched.	High flows (greater than bankfull) not able to enter floodplain. Stream deeply entrenched.	High flows (greater than bankfull) not able to enter floodplain. Stream deeply entrenched.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
OVERALL BUFFER AND FLOODPLAIN CONDITION				
	Optimal	**Suboptimal**	**Marginal**	**Poor**
VEGETATED BUFFER WIDTH	Width of buffer zone >50 feet; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, crops) have not impacted zone.	Width of buffer zone 25-50 feet; human activities have impacted zone only minimally.	Width of buffer zone 10-25 feet; human activities have impacted zone a great deal.	Width of buffer zone <10 feet: little or no riparian vegetation due to human activities.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0
FLOODPLAIN VEGETATION	Predominant floodplain vegetation type is mature forest	Predominant floodplain vegetation type is young forest	Predominant floodplain vegetation type is shrub or old field	Predominant floodplain vegetation type is turf or crop land
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
FLOODPLAIN HABITAT	Even mix of wetland and non-wetland habitats, evidence of standing/ponded water	Even mix of wetland and non-wetland habitats, no evidence of standing/ponded water	Either all wetland or all non-wetland habitat, evidence of standing/ponded water	Either all wetland or all non-wetland habitat, no evidence of standing/ponded water
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
FLOODPLAIN ENCROACH-MENT	No evidence of floodplain encroachment in the form of fill material, land development, or manmade structures	Minor floodplain encroachment in the form of fill material, land development, or manmade structures, but not effecting floodplain function	Moderate floodplain encroachment in the form of filling, land development, or manmade structures, some effect on floodplain function	Significant floodplain encroachment (i.e. fill material, land development, or man-made structures). Significant effect on floodplain function
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Sub Total In-stream: _____ **/80** + Buffer/Floodplain: _____ **/80** = **Total** Survey Reach _____ **/160**

You created this PDF from an application that is not licensed to print to novaPDF printer (http://www.novapdf.com)

Riparian Buffer Enhancement

Before

After

Streambank Stabilization

Head-cut Stabilization and Stream Channel Grade Control

Perched Culvert Rectification

Stream Channel Restoration/Relocation

Regenerative Stormwater Conveyances (RSC)

Appendix L:

Prioritization Matrix

List of Contents:

1. Eastwood Lake Project Prioritization Matrix

2. Category Summary for Prioritization Matrix

Project Prioritization Matrix

CATEGORY	Public Health and Safety		Severity of Street Flooding (Public ROW)		Cost Effectiveness		Effect of Improvements		Water Quality - BMP		Water Quality - Erosion Control		Implementation Constraints		Constructibility		TOTAL WEIGHTED SCORE
Primary System Projects																	
Piney Mountain Road - Culvert	3	30	3	30	3	30	3	18	0	0	0	0	3	9	1	3	**120**
Secondary System Projects																	
Woodshire Lane/Huntington Road	1	10	1	10	3	30	3	18	0	0	3	18	3	9	3	9	**104**
Shady Lawn Road System	1	10	1	10	3	30	1	6	0	0	1	6	5	15	5	15	**92**
Arlington Street #1 System	3	30	1	10	5	50	1	6	0	0	0	0	5	15	3	9	**120**
Arlington Street #2 System	1	10	1	10	3	30	1	6	0	0	0	0	5	15	3	9	**80**
South Lakeshore Drive/Ridgecrest Drive System	3	30	1	10	5	50	1	6	0	0	1	6	5	15	3	9	**126**
South Lakeshore Drive/Rolling Road System	1	10	3	30	3	30	3	18	0	0	3	18	3	9	3	9	**124**

Category	General Description	Score	Evaluation Criteria
Public Health and Safety	Evaluates potential impact of flooding on public health and safety. Generally, refers to flooding in and around habitable structures.	5	Flood water depth and/or velocity completely surrounds and threatens the structural integrity of habitable structures or vehicles.
			Finished Floor Flooding Occurs during the design storm.
		3	Flood water surrounds structure but does not cause imminent danger.
			Crawl space and HVAC units are flooded.
		1	Yard flooding occurs and flood waters are near HVAC, crawl spaces or foundations.
		0	Minor yard flooding may occur but habitable structure is not directly affected.
Severity of Street Flooding (Town Owned)	Evaluates impact of flood depths to or through an area	5	Street spread requirements are not met and are so severe that the street becomes impassable during the design storm or street flooding has spread into private property.
			Flooding is noted on NCDOT roads as a result spread issues on adjacent town owned street.
		4	
		3	Street spread requirements are not met and the streets are passable only through the center of the street.
			Flooding noted on collector and local streets.
		2	
		1	Spread requirements exceeded but street flooding is considered minor nuisance for traffic.
		0	Spread requirements are met.
Cost Effectiveness	Evaluates the benefit/cost of the proposed improvements	5	Project benefit ratio is greater than 1.5
		3	Project benefit ratio is between 0.5 and 1.5
		1	Project benefit ratio is between 0.075 and 0.5
		0	Project ratio is less than 0.075
Effect of Improvements	Evaluates the number of drainage issues resolved and the number of citizens positively affected	5	Multiple major drainage issues are being resolved through the proposed improvements such as street spread and increased drainage capacity.
			Proposed improvements would resolve major drainage issues for more than 5 properties.
		4	
		3	Single drainage issue is being resolved and it is considered major.
			Proposed improvements would resolve drainage issues for 3-5 properties.
		2	
		1	Single drainage issue is being resolved and it is considered major.
			Proposed improvements would resolve drainage issues for 2-3 properties.
		0	Single drainage issue is being resolved and it is considered minor.
			Proposed improvements would resolve drainage issue(s) for a single property at most.
Water Quality/Quantity	Evaluates the impact a BMP would have on water quality, water quantity and NPDES Phase II Compliance	5	Provides both water quantity and water quality benefits.
			Does not use manufactured or proprietary BMP technology.
			Incorporates some form of green solution such as infiltration, LID, sustainability etc.
			Is considered a BMP retrofit.
		3	Provides water quality benefits but does not provide water quantity benefit.
			Is considered a BMP retrofit
		1	Improvements will have minimal impacts on water quality and would primarily serve as a demonstration project.
			Is considered a BMP retrofit.
		0	Improvements will have no measurable impact on water quality and would serve only as a demonstration project.
Open Channel - Erosion Control	Evaluates the severity of erosion control issues and impact on water quality	5	Severe erosion problems are evident and are contributing significantly to water quality issues.
		3	Moderate erosion problems are evident and are contributing to water quality issues.
		1	Minor erosion control issues are evident and are contributing to water quality issues.
		0	Minor erosion control issues are evident and are not contributing to water quality issues in a significant way.

Implementation Constraints	Considers potential constraints that may either delay or make the project too difficult to construct. Some examples would include significant permitting issues, high mitigation costs, numerous easement needs, required partnering with other communities, the NCDOT, or railroads.	5	Only minor local or state permits required. Does not involve ACOE, DWQ or FEMA.
			Proposed improvements can be completed without permanent or temporary easements.
			Project can proceed independent of other stormwater improvements identified in the master plan.
		3	Requires State and Federal permits that are typically easy to obtain such as Nationwide permits, FEMA No Rise etc.
			Primarily requires temporary easements with only a few permanent easements needed to build the project.
			Improvements may have limited coordination with other projects such as DOT widening, GUC utility improvements or down stream drainage improvements. Significant delays in the schedule due to this coordination is not anticipated.
			Project can proceed independent of other stormwater improvements identified in the master plan.
			Project is self mitigating or requires very minor mitigation.
		1	Numerous permits required including federal, state and local agencies. Examples would include an individual permit or FEMA CLOMR/LOMR.
			Extensive permanent and temporary easements are required.
			Project can not proceed independent of other stormwater improvements identified in the master plan.
Constructability	Evaluates relative constructability of the project including site constraints, traffic and neighborhood impacts, and impacts on adjacent property owners.	5	Limited to no site constraints.
			Limited to no utility conflicts.
			Limited to no impacts on adjacent property owners.
			Limited to no impacts on traffic or surround neighborhoods.
		3	Some site constraints exist but are considered fairly minor.
			Some utility conflicts exist but are routine and do not require major utility relocation.
			Some traffic and neighborhood impacts occur but are fairly minor. Examples include temporary lane closures, occasional hauling or traffic detours though adjacent neighborhoods.
		1	Site constraints exist and are fairly major.
			Utility conflicts exist and require rerouting or relocation of existing utilities.
			Traffic and neighborhood impacts occur and are fairly major. Examples included extended road closures or hauling operations.

Weight Factor	Criteria
10	Public Health and Safety
	Severity of Street Flooding (Town Owned)
	Cost Effectiveness
6	Effect of Improvements
	Water Quality - Quantity
	Open Channel - Erosion Control
	Implementation Constraints
	Grant Funding
3	Construction Impacts
	Constructability

The above table presents the weighting factors that will be applied to the prioritization criteria, with the reason being that some criteria are viewed as more important (i.e. deserve a higher weighting) than others. So each score of each prioritization criteria will be multiplied by the assigned weight factor for that prioritization criteria category as shown in the Priority Matrix.

MERGED LISTS OF PRIORITY PROJECTS - LOWER BOOKER CREEK AND EASTWOOD LAKE

PRIORITIZATION	CATEGORY	IDENTIFIED IN SUBWATERSHED STUDY	COST*
Primary System Projects			
COMPLETED	Elliott Storage (Booker Creek Park)	Lower Booker Creek	$2,900,000
1	Red Bud Storage	Lower Booker Creek	$1,058,000
2	Lake Ellen	Lower Booker Creek	$1,160,000
3	Piney Mtn Road Storage	Lower Booker Creek	$2,206,000
4	Booker Creek Road U/S	Lower Booker Creek	$1,488,000
5	Honeysuckle Road	Lower Booker Creek	$408,000
6	Dobbins	Lower Booker Creek	$232,000
7	Piney Mountain Road - Culvert	Eastwood	$529,000
8	Willow	Lower Booker Creek	$4,642,000
9	New Parkside Drive	Lower Booker Creek	$3,225,000
10	Daley Storage	Lower Booker Creek	$3,635,000
11	Martin Luther King Jr. Boulevard	Lower Booker Creek	$4,386,000
12	Foxcroft Drive	Lower Booker Creek	$764,000
			$23,733,000 **
Secondary System Projects			
1	Old Oxford Road/Booker Creek Road System	Lower Booker Creek	$718,000
2	Markham Drive/Old Oxford Road Closed System	Lower Booker Creek	$522,000
3	South Lakeshore Drive/Ridgecrest Drive System	Eastwood	$145,000
4	South Lakeshore Drive/Rolling Road System	Eastwood	$251,000
5	Chesley Lane Closed System	Lower Booker Creek	$169,000
6	Booker Creek Road/Lakeshore Lane System	Lower Booker Creek	$214,000
7	Arlington Street #1 System	Eastwood	$121,000
8	Old Oxford Road	Lower Booker Creek	$341,000
9	Wood Circle/Velma Road System	Lower Booker Creek	$197,000
10	Woodshire Lane/Huntington Road	Eastwood	$431,000
11	Ephesus Church Road	Lower Booker Creek	$1,210,000
12	Shady Lawn Road System	Eastwood	$177,000
13	Summerfield Crossing System	Lower Booker Creek	$95,000
14	Arlington Street #2 System	Eastwood	$154,000

* 2021 Dollars

** Total does not include the Elliott Rd Flood Storage Project cost