Southland Drainage Study
Volume I of II

Drainage Basins Included in Study:
Rochester
Johnson Yards
Red Budd
Southland
Rosita

Prepared For:

City of Memphis
Division of Engineering

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Abbreviation:	**Meaning:**
(CIP)	Capital Improvement Project
(CMP)	Corrugated Metal Pipe
(FHWA)	Federal Highway Administration
(GIS)	Geographic Information System
(HERCP)	Horizontal Elliptical Reinforced Concrete Pipe
(H&H)	Hydrologic and Hydraulic
(NRCS)	National Resource Conservation Service
(RCAP)	Reinforced Concrete Arch Pipe
(RCP)	Reinforced Concrete Pipe
(ROW)	Right-of-Way
(SCS)	Soil Conservation Service
(SWM)	Storm Water Management
(TDOT)	Tennessee Department of Transportation
(UMRF)	University of Memphis Research Foundation
(US-EPA)	U.S. Environmental Protection Agency

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VOLUME I:

EXECUTIVE SUMMARY

Project Background and Purpose

Over the last 200 years the City of Memphis has grown in both size and population. This growth has resulted in an increased rate of development and a higher percentage of pavement and rooftop impervious area within the City. As the impervious area increases, so does the stormwater runoff during rainfall events. That said, much of the City stormwater infrastructure has not been improved to match the increased rate of stormwater runoff. As a result, numerous portions of the City stormwater infrastructure have inadequate conveyance capacity and repetitive flooding problems occur. This is particularly true for older areas of the City. These flooding concerns have been brought to the attention of the City of Memphis through flooding and drainage-related maintenance reports submitted by local residents.

In an effort to understand and correct these problems, the City of Memphis Division of Engineering began utilizing accumulated stormwater utility fees to fund a series of master plan drainage studies throughout 7 identified major drainage areas corresponding to City council districts. These 7 major drainage areas were subdivided into 37 minor drainage basins for analysis. The intent of the program was to study each basin in the City through a series of stormwater mapping, modeling, and analysis projects and determine cost effective solutions to the identified flooding problems. The City's storm drainage inventory within each basin was also updated during these projects through extensive field survey data collection efforts. The results of these studies help the City better understand the existing stormwater infrastructure and rainfall-runoff response of each unique drainage basin and to aid in the prioritization and implementation of corrective Capital Improvement Projects (CIPs).

Study Area Description and Existing Conditions Modeling Results

The study area discussed in Volumes I and II of this report is referred to as the Southland Drainage Study and is made up of five minor drainage basins. From west to east the basins included in the Southland Drainage Study are as follows: Rochester Basin, Johnson Yards Basin, Red Budd Basin, Southland Basin, and Rosita Basin. The Southland Drainage Study spans west to east from Riverport Harbor to the Dr. M.L.K. Jr. Expressway bridge and north to south from Nonconnah Creek to Ford Road Elementary School, Will Carruthers Softball Complex, and the Bluebird Estates. The total drainage area of the Southland Drainage Study is approximately 3,341 acres. During the data collection phase of the project the Johnson Yards Basin was removed from the study modeling efforts based on limited access and collection of stormwater infrastructure data within the private Illinois Central Gulf Railroad property. That said, the remaining 2,924 acres in the other four basins were included in the modeling efforts. The study area consists of a mixture residential, commercial, industrial, recreational, open natural, roadway, and water body land use classifications. The stormwater infrastructure components throughout the study area consist of underground pipe networks, culvert roadway crossings, open channel bridge crossings, man-made open channels, and natural open channels. Nonconnah Creek is the outfall of all of the tributaries in the study with the exception of the Rochester Basin tributary, which outfalls to Riverport Harbor.

The hydrologic and hydraulic (H&H) model developed during this study was created in the Innovyze modeling software package InfoSWMM Suite 15.0. A single existing conditions model was developed for the project that included the Rochester Basin, Red Budd Basin, Southland Basin, and Rosita Basin. Existing City stormwater infrastructure, topographic, and land use/ soil classification Geographic Information System (GIS) data were utilized in conjunction with survey data and measured rainfall/flow depth data gathered during the project to construct a representative stormwater model of the basins included in the study. The model was then calibrated to the measured rainfall and flow depth data collected during the survey phase of the project and various National Resource Conservation Service (NRCS) Type II 24-hour storm events were simulated in the model. The model flooding results were then mapped and compared to City flooding and drainage-related maintenance reports submitted by local residents and target areas were identified for infrastructure improvements.

Identified Problem Areas Summary

During the process of cross-referencing the known flooding reports and modeled inundation results the following eight areas were identified for proposed improvements:

- IA1: Improvement alternative one was located in the Rochester basin at and northwest of the intersection of West Peebles Road and Travis Road.

- IA2: Improvement alternative two was located in the Rochester basin and was split into two sub-areas, 2A and 2B. Improvement alternative 2A was located along an existing property easement spanning from Dixie Road to Flynn Road west of Alta Road. Improvement alternative 2B was located east of the intersection of West Peebles Road and Alta Road at a roadway sag on West Peebles Road.

- IA3: Improvement alternative three was located in the Rochester basin at the intersection of Jensen Road and Rochester Road.

- IA4: Improvement alternative four was located in the Red Budd basin at the intersection of West Brooks Road and New Horn Lake Road.

- IA5: Improvement alternative five was located in the Red Budd basin northwest of the East Peebles Road and Blues Highway (US-61) intersection.

- IA6: Improvement alternative six was located in the Southland basin east of the East Bell Haven Road and Blues Highway (US-61) intersection.

- IA7: Improvement alternative seven was located in the Rosita basin northeast of the East Brooks Road and McCorkle Road intersection.

- IA8: Improvement alternative eight was located in the Rosita basin and was split into three sub-areas, 8A, 8B, and 8C. Improvement alternative 8A was located through nine properties located along the western side Lakeview Road between Winchester Road and East Brooks Road. Improvement alternative 8B was located through thirteen properties spanning from the eastern side of Dogwood Lane to the eastern side of East Rosita Circle. Improvement alternative 8C was located at and northeast of the intersection of East Rosita Circle and West Rosita Circle.

These identified areas were presented to the City of Memphis on 06/17/2022 and the decision was made to move forward with modeling improvement alternatives in five of the eight identified areas. Accounting for the sub-areas individually, improvements were modeled for seven of the eleven proposed improvement alternatives. Improvements were not modeled for alternatives five, six, seven, and 8C.

Improvement Alternatives Summary

The proposed improvements presented below include a series of pipe network and channel improvements that increase the overall conveyance capacity of the network in addition to providing a minor increase in available surface and/or subsurface storage volume.

- IA1:
  Improvement alternative one was located in the Rochester basin at and northwest of the intersection of West Peebles Road and Travis Road. Based on the mapped inundation results for the 10-year storm simulation, the area experienced surface flooding throughout two private property parcels with a maximum individual parcel flooding area of 12%. The following parcels were impacted by the 10-year storm inundation: 075001 00065, 075001 00064. The existing system in the area consisted of one run of 24" reinforced concrete pipe (RCP) pipe, one run of 36" RCP pipe, one run of 48" RCP pipe, and a triangular grass-lined open channel downstream of the pipe network. The proposed improvements in the area included upsizing the system to one run of 36" RCP pipe, two runs of 48" RCP pipe, and regrading a new grass-lined trapezoidal channel downstream of the improved pipe network. The proposed improvements reduced the flooding to 6% or less of the parcel area in both parcels.

- IA2A:
  Improvement alternative 2A was located along an existing property easement spanning from Dixie Road to Flynn Road west of Alta Road. Based on the mapped inundation results for the 10-year storm simulation, the area experienced surface flooding along public right-of-way (ROW) and three private property parcels with a maximum individual parcel flooding area of 20%. The roadway impacted by the inundation was Dixie Road at the roadway sag between Alta Road and Ford Road. The following parcels were impacted by the inundation: 075016 00006, 075016 00007, and 075015 00013. The existing system in the area consisted of two runs of 24" RCP pipe, three runs of (42" RCP equivalent) 53" x 34" horizontal elliptical reinforced concrete pipe (HERCP), four runs of 48" RCP pipe, and one run of (60" RCP equivalent) 73" x 45" reinforced concrete arch pipe (RCAP). The proposed improvements in the area included upsizing the system to two runs of (36" RCP equivalent) 45" x 29" HERCP pipe, two runs of (48" RCP equivalent) 60" x 38" HERCP pipe, four runs of (54" RCP equivalent) 68" x 43" HERCP pipe, and two runs of (60" RCP equivalent) 73" x 45" RCAP pipe. The proposed improvements completely eliminated flooding in the ROW and all three parcels.

- IA2B:
  Improvement alternative 2B was located on West Peebles Road east of the intersection of West Peebles Road and Alta Road. Based on the mapped inundation results for the 10-year storm simulation the area didn't experience surface flooding, but it did experience surface flooding along public right-of-way (ROW) during the 100-year storm simulation. Therefore, we don't recommend this as a primary improvement, but we do recommend it as a secondary improvement. The roadway impacted by the 100-year storm inundation was West Peebles Road at the roadway sag between Alta Road and Rochester Road. The existing system in the area consisted of one run of 24" RCP pipe. The proposed improvements in the area included upsizing the system to one run of (36" RCP equivalent) 45" x 29" HERCP pipe. The proposed improvements completely eliminated flooding in the ROW during the 100-year storm simulation.

- IA3:
  Improvement alternative three was located in the Rochester basin at the intersection of Jensen Road and Rochester Road. Based on the mapped inundation results for the 10-year storm simulation, the area experienced surface flooding along public right-of-way (ROW) exclusively. The roadway impacted by the inundation was the intersection of Rochester Road and Jenson Road. The existing system in the area consisted of one run of 24" RCP pipe and one run of 30" RCP pipe. The proposed improvements in the area included upsizing the system to one run of 36" RCP pipe and one run of 42" RCP pipe. The proposed improvements completely eliminated flooding in the ROW.

- IA4:
  Improvement alternative four was located in the Red Budd basin at the intersection of West Brooks Road and New Horn Lake Road. Based on the mapped inundation results for the 10-year storm simulation, the area experienced surface flooding throughout two private property parcels with a maximum individual parcel flooding area of 24%. The following parcels were impacted by the inundation: 075007 00025C, and 075007 00049. The existing system in the area consisted of three runs of 24" RCP pipe. The proposed improvements in the area included upsizing the system to three runs of (36" RCP equivalent) 45" x 29" HERCP pipe. The proposed improvements completely eliminated flooding in both parcels.

- IA8A:
  Improvement alternative 8A was located through nine properties located along the western side Lakeview Road between Winchester Road and East Brooks Road. Based on the mapped inundation results for the 10-year storm simulation, the area experienced surface flooding throughout 11 private property parcels with a maximum individual parcel top water surface width of 32 feet. The following parcels were impacted by the inundation: 077005 00052, 077005 00022, 077005 00021, 077005 00020, 077005 00019, 077005 00018, 077005 00017, 077005 00016, 077005 00015, 077005 00014, 077005 00013. The existing system in the area consisted of one 36" corrugated metal pipe (CMP) culvert, one double barrel 42" RCP culvert, and one irregular-shaped grass-lined open channel connecting the two culverts.

  The proposed improvements in the area included upsizing the system to one (54" RCP equivalent) 68" x 43" HERCP culvert, one 60" RCP culvert, and regrading a new grass-lined trapezoidal channel between the two culverts. The proposed improvements reduced the amount of stormwater exceeding the top of bank of the channel. This was quantified by a comparing the pre- and post-improvement top water surface width along the channel. The proposed improvements reduced the top water surface width along the channel by a maximum of 19 feet and an average of 8 feet per parcel during the 10-year storm simulation.

- IA8B:
  Improvement alternative 8B was located through thirteen properties spanning from the eastern side of Dogwood Lane to the eastern side of East Rosita Circle. Based on the mapped inundation results for the 10-year storm simulation, the area experienced surface flooding throughout 4 private property parcels with a maximum individual parcel top water surface width of 55 feet. The following parcels were impacted by the inundation: 077009 00054, 077008 00003, 077008 00002, 077008 00001. The existing system in the area consisted of one run of 3.3' x 6.5' x 0.5' (total height x width x triangular bottom depth) concrete rectangular-triangular channel, one run of 4' x 7' x 0.5' concrete rectangular-triangular channel, one run of 4.3' x 6.5' x 0.5' concrete rectangular-triangular channel, one run of 4.5' x 7.25' x 0.5' concrete rectangular-triangular channel, one run of 5.33' x 7.5' x 0.5' concrete rectangular-triangular channel, two 24" RCP culverts, and a triangular grass-lined open channel between the two 24" RCP culverts.

The proposed improvements in the area included increasing the wall height of the 3.3' x 6.5' x 0.5' channel by approximately 0’ – 2.1’ across its length to elevation 236.5, increasing the wall height of the 4' x 7' x 0.5' channel by approximately 0’ – 1’ across its length to elevation 235, increasing the wall height of the 4.3' x 6.5' x 0.5' channel by approximately 0’ – 0.7’ across its length to elevation 235, increasing the wall height of the 4.5' x 7.25' x 0.5' channel by approximately 0.5’ – 0.7’ across its length to elevation 235, increasing the wall height of the 5.33' x 7.5' x 0.5' channel by approximately 0’ – 1.6’ across its length to elevation 235, replacing one of the 24” RCP culverts and the triangular grass-lined open channel with a 2.5’ – 4.1’ x 6.5’ (variable height x width) rectangular concrete channel with a top elevation of 236.5, upsizing one 24” RCP culvert with a (36” RCP equivalent) 44” x 27” RCAP pipe, and constructing a new 2.5’ x 4.5’ (height x width) rectangular concrete channel. The proposed improvements reduced the amount of stormwater exceeding the top of bank of the channel. This was quantified by a comparing the pre- and post-improvement top water surface width along the channels. The proposed improvements reduced the top water surface width along the channel by a maximum of 50 feet and an average of 31 feet per parcel during the 10-year storm simulation.

Preliminary Planning Costs Estimation Summary

Preliminary planning costs were prepared for the seven proposed improvement alternatives. These costs were based on planning-level design information and are not meant to be considered an Engineer’s Estimate of Probable Construction Costs. These estimates are purely a budget estimate for planning purposes. The costs were derived from Tennessee Department of Transportation (TDOT) bid tab unit costs. Table 1 shows a summary of the preliminary cost information for each improvement alternative.

Table 1: Preliminary Planning Cost Summary

Alternative	Preliminary Planning Cost
IA1	$ 492,038
IA2A	$ 881,175
IA2B	$ 175,560
IA3	$ 557,273
IA4	$ 594,488
IA8A	$ 555,150
IA8B	$ 855,038

Conclusions

The information collected during this stormwater mapping, modeling, and analysis project and the results of the study aid in the understanding of the reoccurring flooding concerns reported by local residents. The hydrologic and hydraulic model developed during this project provides a useful assessment of the performance of the stormwater infrastructure within the basins included in the study. It also serves as a valuable planning tool for the evaluation of possible cost-effective infrastructure improvements. The model is a dynamic tool that at any time can be updated to reflect new land development and infrastructure improvements and evaluate the effects of these changes on the entire drainage system in each basin.

Eleven areas experiencing flooding were identified during the study. Seven of the eleven areas were analyzed in extensive detail to assess the viability of infrastructure improvements. The alternatives selected are summarized in this report and additional details of each area, including the flooding and drainage-related maintenance reports submitted by local residents, are included in Volume II of this report. Based on the results of this study we recommend that the City of Memphis include the identified improvement alternatives in their plan for future Capital Improvement Projects.

1.0 PROJECT INTRODUCTION

1.1 Project Background and Purpose

Over the last 200 years the City of Memphis has grown in both size and population. This growth has resulted in an increased rate of development and a higher percentage of pavement and rooftop impervious area within the City. As the impervious area increases so does the stormwater runoff during rainfall events. That said, much of the City stormwater infrastructure has not been improved to match the increased rate of stormwater runoff. As a result, numerous portions of the City stormwater infrastructure have inadequate conveyance capacity and repetitive flooding problems occur. This is particularly true for older areas of the City.

In fiscal year 2014, the Division of Engineering began utilizing accumulated stormwater utility fees to fund a series of master plan drainage studies throughout 7 identified major drainage areas corresponding to City council districts. These 7 major drainage areas have been subdivided into 37 smaller study areas. The original plan was to systematically analyze these 37 smaller study areas at a rate of one small study area per year in each of the 7 major drainage areas. The overall goal is to analyze each study area in the City based on priority and undertake specific projects to mitigate the impacts of future storm events on the public infrastructure and private property throughout the City.

The City of Memphis hired the SSR team to perform a drainage analysis on the study area by developing a hydrologic and hydraulic (H&H) model of the stormwater infrastructure throughout the drainage basins included in the Southland Drainage Study. The model was constructed based on the combination of Geographic Information System (GIS) data and field survey data and was utilized to identify areas with flooding problems and recommend infrastructure improvements that reduce or eliminate the amount of flooding in the selected improvement areas. The estimated cost of each improvement was also quantified along with the impacts of each improvement solution. This data will be utilized by the Division of Engineering to prioritize Capital Improvement Projects (CIPs) throughout the study area and throughout the City. The field surveyed stormwater infrastructure data collected throughout the duration of the study will also be utilized to update the City's stormwater asset inventory database.

1.2 Study Area Description

The Southland Drainage Study is located south of Downtown Memphis and consists of 5 adjacent drainage basins spanning west to east from Riverport Harbor to the Dr. M.L.K. Jr. Expressway bridge and north to south from Nonconnah Creek to Ford Road Elementary School, Will Carruthers Softball Complex, and the Bluebird Estates. All but one of the drainage basins has at least one outfall that discharges directly into Nonconnah Creek. The only exception is the westernmost drainage basin, which has a single outfall that discharges directly into Riverport Harbor. From west to east the basins included in the Southland Drainage Study are as follows: Rochester Basin, Johnson Yards Basin, Red Budd Basin, Southland Basin, and Rosita Basin. The total drainage area of the Southland Drainage Study is approximately 3,341 acres and the individual basin areas are as follows: Rochester Basin (538 acres), Johnson Yards Basin (417 acres), Red Budd Basin (503 acres), Southland Basin (1,222 acres), and Rosita Basin (661 acres). Exhibit 1 in Appendix A shows the location of the five drainage basins included in the study.

The Johnson Yards Basin was removed from the study based on limited access and collection of stormwater infrastructure data within the private Illinois Central Gulf Railroad property (Parcel ID: 075001 00087). That said, the remaining 2,924 acres in the other four basins were included in the study. The study area consists of a mixture of land use classifications including but not limited to the following: single unit and multi-family residential, low and high intensity commercial, parks and recreational facilities, open natural areas, industrial/industrial flex, roadways, and water bodies. The stormwater infrastructure throughout the basins consists of pipe networks of a variety of shapes and sizes, pipe and box culvert roadway crossings, concrete line channels, and natural channels. Nonconnah Creek is the outfall of all of the tributaries in the study with the exception of the Rochester Basin tributary, which outfalls to Riverport Harbor.

1.3 Public Involvement

The project included a public outreach component that focused on informing the public of the impending drainage project, providing a platform for citizens to inform the City of existing drainage-related issues, and aggregation of such data for use in modeling and planning purposes. Flyers were made and posted to advertise the public meeting and inform the public of the drainage study. A public meeting took place on April 28, 2016, at the Riverside M. B. Church located at 3560 S. Third Street. During the meeting details of the study were presented to local residents who attended the meeting. Those who attended were asked to provide their name and email address, complete a questionnaire, and note problem areas on map stations placed around the meeting room. Six individuals attended the meeting and provided the information requested above. The flyer, questionnaire, map, and presentation documents utilized during the public outreach component of this project are located in Appendix B.

The City of Memphis Public Works Drain Maintenance Department also collected flooding and drainage-related maintenance reports and compiled a running list of the reports in the form a GIS point file. The collected reports within the Southland study area were utilized to check the model flooding results and aid in the identification of areas with repetitive flooding problems for proposed infrastructure improvements.

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2.0 HYDROLOGIC AND HYDRAULIC MODELING

The Southland Drainage Study hydrologic and hydraulic model is a tool that simulates rainfall events and the conveyance of the runoff resulting from those storm events through the stormwater infrastructure throughout each of the four basins included in the model. The model calculates the volume, flow rate, and water surface elevation of the runoff throughout the entire drainage network simultaneously. These simulated rainfall-runoff measurements aid in the analysis of each basin's conveyance infrastructure. The model is a dynamic tool that at any time can be updated to reflect new land development and infrastructure improvements and evaluate the effects of these changes on the entire drainage system in each basin.

2.1 Methodology Overview

The hydrologic and hydraulic model developed during this study was created in the Innovyze modeling software package InfoSWMM Suite 15.0. InfoSWMM utilizes an enhanced version of the US-EPA Storm Water Management Model (SWMM) analysis engine as developed and distributed by the Water Supply and Water Resources Division of the U.S. Environmental Protection Agency's National Risk Management Research Laboratory (SWMM Version EPA SWMM 5.1.015). The hydrologic and hydraulic parameters input into the model are consistent with Volume 2 of the City of Memphis/ Shelby County Stormwater Management Manual in addition to the guidance outlined in the InfoSWMM and EPA SWMM software user manuals.

Existing City stormwater infrastructure, topographic, and land use/ soil classification GIS data were utilized in conjunction with survey data and measured rainfall/flow depth data gathered during the data collection phase of the project to construct a representative stormwater model of the basins included in the study. The field survey effort took place in 2016 and included collection of the geospatial location and vertical elevation of the stormwater infrastructure in the study area along with georeferenced photos of the surveyed stormwater infrastructure. The following stormwater elements were included in the survey data collection efforts: open drainage channels, roadway culvert crossings, bridge crossings, storm sewer pipe networks, and catch basin/ manhole/ headwall structures. Section 2 of the Volume II report contains additional details regarding the data collection efforts included in this study.

An existing conditions model was constructed from the provided GIS data and collected survey data. The model was then calibrated to the measured rainfall and flow depth data gathered during the survey phase of the project and the rainfall for various NRCS Type II 24-hour storm events were simulated in the model. The model flooding results were then mapped and compared to City flooding complaints and target areas were identified for infrastructure improvements. Improvement alternatives were modeled in these identified areas to analyze the flood reduction impacts of each solution along with its estimated construction cost.

2.2 Existing Conditions Model

A single existing conditions H&H model was developed for the project that included the Rochester Basin, Red Budd Basin, Southland Basin, and Rosita Basin. The existing conditions model relies on a variety of hydrologic and hydraulic parameters to perform the rainfall-runoff simulations. These parameters were input into the appropriate model elements and are based on engineering judgement, EPA SWMM and InfoSWMM software user manual guidance, and Volume 2 of the City of Memphis/ Shelby County Stormwater Management Manual. The hydrologic parameters accounted for in the model include but are not limited to the following: sub-basin area, width, impervious area, slope, pervious and impervious overland flow Manning's n value, pervious and impervious depression storage, and soil infiltration. These parameters are utilized within soil, rain gage, and subcatchment model elements to calculate the amount of soil infiltration, surface storage, and surface runoff resulting from a single or series of rainfall events.

The hydraulic parameters accounted for in the model include but are not limited to the following: conveyance geometry, pipe/channel/overbank Manning's n value, length, slope, entry/exit losses, open/closed flow type, available surface ponding area, detention pond storage and outlet structures, and Federal Highway Administration (FHWA) inlet/outlet control culvert codes and roadway overflow weir coefficients. These parameters are utilized in the flow routing portion of the simulation as the calculated surface runoff travels through the conveyance infrastructure. The surveyed stormwater infrastructure data was converted to a GIS format and merged with the appropriate hydraulic parameters to create conveyance elements in the model. These model conveyance elements consist of junctions, conduits, storage ponds, weirs, orifices, and outfalls that mimic real world stormwater infrastructure such as pipe networks, pipe or box culvert crossing, roadway overflow weirs, man-made ditches and armored channels, natural creeks and streams, and detention ponds. Exhibit 2 through Exhibit 5 in Appendix A display the hydrologic and hydraulic model elements within each of the four modeled drainage basins. The individual basins are

presented west to east in the following order: Rochester Basin (Exhibit 2), Red Budd Basin (Exhibit 3), Southland Basin (Exhibit 4), and Rosita Basin (Exhibit 5). Section 3 of the Volume II report contains a more thorough explanation of the model development process and H&H modeling methodology utilized during the study.

2.3 Existing Model Calibration and Verification

Model calibration consists of fine tuning the model until it simulates field conditions to an established degree of accuracy. Fine-tuning of the model entails making adjustments to the model parameters to obtain the desired output data. The degree of accuracy refers to the difference between simulated and actual values and is used to establish a level of confidence in the model. Calibration is important to establish model credibility, increase knowledge and understanding of the system and its operations, and make it representative of the actual rainfall-runoff response of the watershed being studied.

In an effort to make the model representative of the unique rainfall-runoff response of each drainage basin in the study the initial parameters input into the model had to be altered through a series of calibration iterations. These calibration iterations utilized the field measured rainfall and conduit flow depth data obtained during the data collection phase of the project. The University of Memphis Research Foundation (UMRF) was contracted by the City of Memphis to install and collect data from three rain gages and two stage gages (pressure transducers) placed throughout the basins in study area. These gages were monitored for a time span of approximately six and a half months and the data was furnished in two-week intervals. The data for all gages were taken in 5-minute intervals and all anomalies were purged prior to use in the calibration efforts.

The following five storm events were selected for the model calibration and verification efforts:

- May 24 - 25, 2015 (Verification)
- July 3 - 4, 2015 (Verification)
- August 5 - 6, 2015 (Verification)
- September 2 - 3, 2015 (Verification)
- November 17 - 18, 2015 (Calibration)

The field measured rainfall for these storm events were used as the simulation input data for the calibration efforts and the field measured conduit flow depth data was used as the target output data. The calibration iterations were performed within the model itself utilizing a calibration tool that adjusts the specified parameters within a provided minimum and maximum range. Three soil infiltration parameters and five subcatchment parameters were selected for modification during calibration. Table 2 summarizes the selected model parameters that were modified during the calibration process.

Table 2: Calibrated Model Parameters

Green-Ampt Soil Infiltration Parameters	Suction Head (in)
	Hydraulic Conductivity (in/hr)
	Initial Moisture Deficit
Subcatchment Parameters	Imperviousness (%)
	Width (ft)
	Slope (%)
	Depression Storage for Impervious Portion (in)
	Depression Storage for Pervious Portion (in)

Initially, over 30 calibration iterations were performed utilizing the calibration tool. After the initial calibration efforts were completed, specific parameters were selected and fine-tuned via manual adjustment to finalize the model calibration process. The final simulated conduit flow depth curve for the November 17 - 18, 2015 storm event closely matched the relative shape, peak timing, peak quantity, and fluctuations of the field measured flow depth curve for both sets of stage gage data. The simulated results for the remaining four verification storm events matched the relative shape of the measured flow depth data for each storm event, but they did not align as closely with the measured peak values as the November calibration storm event. Section 4 of the Volume II report contains a more thorough explanation of the model calibration and verification process utilized during the study. Additionally, comparison graphs of the calibration and verification data are located in Appendix C of the Volume II report.

2.4 Identification of Problem Areas

Once the model parameters were calibrated so that the model simulation results fit the shape, timing, and peak of the observed data to the maximum extent practicable, frequency rainfall data was entered into the model. The NRCS (SCS) Type II 24-hour storm precipitation distribution was utilized to develop frequency rainfall data for use in the InfoSWMM model. The rainfall depths used in the model for the 2-year through 100-year return period storm events were taken directly from Table 2-2 of Volume 2 of the City of Memphis/ Shelby County Stormwater Management Manual (SWMM).

Even though the 2-year through 100-year return period storm events were simulated in the calibrated model, the analysis of the existing conditions model focused primarily on the 10-year return period storm event and secondarily on the 100-year return period storm event. The simulated model results for these storm events were used to identify and verify locations experiencing repetitive flooding problems. This process included mapping the model inundation results across the topographic elevation data for various storm events and analyzing the quantity and severity of

the mapped flooding throughout the basins in the study area. The mapped inundation was compared to any reports of known flooding collected during the public meeting in addition to flooding reports provided by the City of Memphis. The City of Memphis Public Works Drain Maintenance Department aided our efforts by collecting flooding and drainage-related maintenance reports and compiling a running list of the reports in the form of a GIS point file. Areas where observed flooding reports and modeled inundation overlapped were identified for further evaluation and possible infrastructure improvements. Section 5 of the Volume II report contains a more thorough explanation of the existing conditions model and how the results of the model were utilized to identify problem areas for potential improvements.

During the process of cross-referencing the known flooding reports and modeled inundation results the following eight areas were identified for proposed improvements:

- IA1: Improvement alternative one was located in the Rochester basin at and northwest of the intersection of West Peebles Road and Travis Road.

- IA2: Improvement alternative two was located in the Rochester basin and was split into two sub-areas, 2A and 2B. Improvement alternative 2A was located along an existing property easement spanning from Dixie Road to Flynn Road west of Alta Road. Improvement alternative 2B was located east of the intersection of West Peebles Road and Alta Road at a roadway sag on West Peebles Road.

- IA3: Improvement alternative three was located in the Rochester basin at the intersection of Jensen Road and Rochester Road.

- IA4: Improvement alternative four was located in the Red Budd basin at the intersection of West Brooks Road and New Horn Lake Road.

- IA5: Improvement alternative five was located in the Red Budd basin northwest of the East Peebles Road and Blues Highway (US-61) intersection.

- IA6: Improvement alternative six was located in the Southland basin east of the East Bell Haven Road and Blues Highway (US-61) intersection.

- IA7: Improvement alternative seven was located in the Rosita basin northeast of the East Brooks Road and McCorkle Road intersection.

- IA8: Improvement alternative eight was located in the Rosita basin and was split into three sub-areas, 8A, 8B, and 8C. Improvement alternative 8A was located through nine properties located along the western side Lakeview Road between Winchester Road and East Brooks Road. Improvement alternative 8B was located through thirteen properties spanning from the eastern side of Dogwood Lane to the eastern side of East Rosita Circle. Improvement alternative 8C was located at and northeast of the intersection of East Rosita Circle and West Rosita Circle.

These identified areas were presented to the City of Memphis on 06/17/2022 and the decision was made to move forward with modeling improvement alternatives in five of the eight identified areas. Accounting for the sub-areas individually, improvements were modeled for seven of the eleven proposed improvement alternatives. Improvements were not modeled for alternatives five, six, seven, and 8C. Exhibit 6 in Appendix A displays the locations of the identified improvement alternative areas and the City of Memphis flooding and drainage-related maintenance reports throughout the four modeled drainage basins.

3.0 IMPROVEMENT ALTERNATIVES SUMMARY

3.1 Modeled Improvement Alternatives

The proposed improvements presented below include a series of pipe network and channel improvements that increase the overall conveyance capacity of the networks in addition to providing a minor increase in available surface and/or subsurface storage volume within each of the identified improvement areas. Section 6 of the Volume II report contains more detail regarding the existing conditions and post-improvement flooding inundation, extent of the proposed improvements, and surrounding flooding and drainage-related maintenance reports.

- IA1:
  Improvement alternative one was located in the Rochester basin at and northwest of the intersection of West Peebles Road and Travis Road. Based on the mapped inundation results for the 10-year storm simulation, the area experienced surface flooding throughout two private property parcels with a maximum individual parcel flooding area of 12%. The following parcels were impacted by the 10-year storm inundation: 075001 00065, 075001 00064. The existing system in the area consisted of one run of 24" RCP pipe, one run of 36" RCP pipe, one run of 48" RCP pipe, and a triangular grass-lined open channel downstream of the pipe network. The proposed improvements in the area included upsizing the system to one run of 36" RCP pipe, two runs of 48" RCP pipe, and regrading a new grass-lined trapezoidal channel downstream of the improved pipe network. The proposed improvements reduced the flooding to 6% or less of the parcel area in both parcels.

  Additional improvements outside of the project modeling scope were recommended for this area. These additional improvements include the following: replacing an adjacent existing 15" RCP pipe run with a run of 24" RCP pipe.

  Exhibit 7 in Appendix A outlines the proposed improvements within area IA1. Exhibit 8 in Appendix A compares the extent of the existing vs. post-improvement inundation results for the 10-year recurrence interval storm event.

- IA2A:
  Improvement alternative 2A was located along an existing property easement spanning from Dixie Road to Flynn Road west of Alta Road. Based on the mapped inundation results for the 10-year storm simulation, the area experienced surface flooding along public right-of-way (ROW) and three private property parcels with a maximum individual parcel flooding area of 20%. The roadway impacted by the inundation was Dixie Road at the roadway sag between Alta Road and Ford Road. The following parcels were impacted by the inundation: 075016 00006, 075016 00007, and 075015 00013. The existing system in the area consisted of two runs of 24" RCP pipe, three runs of (42" RCP equivalent) 53" x 34" HERCP pipe, four runs of 48" RCP pipe, and one run of (60" RCP equivalent) 73" x 45" RCAP pipe. The proposed improvements in the area included upsizing the system to two runs of (36" RCP equivalent) 45" x 29" HERCP pipe, two runs of (48" RCP equivalent) 60" x 38" HERCP pipe, four runs of (54" RCP equivalent) 68" x 43" HERCP pipe, and two runs of (60" RCP equivalent) 73" x 45" RCAP pipe. The proposed improvements completely eliminated flooding in the ROW and all three parcels.

  Exhibit 9 in Appendix A outlines the proposed improvements within area IA2A. Exhibit 10 in Appendix A compares the extent of the existing vs. post-improvement inundation results for the 10-year recurrence interval storm event.

- IA2B:
  Improvement alternative 2B was located on West Peebles Road east of the intersection of West Peebles Road and Alta Road. Based on the mapped inundation results for the 10-year storm simulation the area didn't experience surface flooding, but it did experience surface flooding along public right-of-way (ROW) during the 100-year storm simulation. Therefore, we don't recommend this as a primary improvement, but we do recommend it as a secondary improvement. The roadway impacted by the 100-year storm inundation was West Peebles Road at the roadway sag between Alta Road and Rochester Road. The existing system in the area consisted of one run of 24" RCP pipe. The proposed improvements in the area included upsizing the system to one run of (36" RCP equivalent) 45" x 29" HERCP pipe. The proposed improvements completely eliminated flooding in the ROW during the 100-year storm simulation.

  Additional improvements outside of the project modeling scope were recommended for this area. These additional improvements include the following: replacing two adjacent existing 15" RCP pipe runs with two runs of (24" RCP Eq.) 30" x 19" HERCP pipe.

  Exhibit 11 in Appendix A outlines the proposed improvements within area IA2B. Exhibit 12 in Appendix A compares the extent of the existing vs. post-improvement inundation results for the 10-year recurrence interval storm event. The extent of the existing vs. post-improvement inundation results for the 100-year recurrence interval storm event are shown in Volume II of this report.

- IA3:
  Improvement alternative three was located in the Rochester basin at the intersection of Jensen Road and Rochester Road. Based on the mapped inundation results for the 10-year storm simulation, the area experienced surface flooding along public right-of-way (ROW) exclusively. The roadway impacted by the inundation was the intersection of Rochester Road and Jenson Road. The existing system in the area consisted of one run of 24" RCP pipe and one run of 30" RCP pipe. The proposed improvements in the area included upsizing the system to one run of 36" RCP pipe and one run of 42" RCP pipe. The proposed improvements completely eliminated flooding in the ROW.

  Additional improvements outside of the project modeling scope were recommended for area IA3. These additional improvements include the following: replacing one adjacent existing 15" RCP pipe run with a run of 24" RCP pipe, and one adjacent existing 24" RCP pipe run with a run of 36" RCP pipe.

  Exhibit 13 in Appendix A outlines the proposed improvements within area IA3. Exhibit 14 in Appendix A compares the extent of the existing vs. post-improvement inundation results for the 10-year recurrence interval storm event.

- IA4:
  Improvement alternative four was located in the Red Budd basin at the intersection of West Brooks Road and New Horn Lake Road. Based on the mapped inundation results for the 10-year storm simulation, the area experienced surface flooding throughout two private property parcels with a maximum individual parcel flooding area of 24%. The following parcels were impacted by the inundation: 075007 00025C, and 075007 00049. The existing system in the area consisted of three runs of 24" RCP pipe. The proposed improvements in the area included upsizing the system to three runs of (36" RCP equivalent) 45" x 29" HERCP pipe. The proposed improvements completely eliminated flooding in both parcels.

  Additional improvements outside of the project modeling scope were recommended for this area. These additional improvements include the following: replacing three adjacent existing 18" RCP pipe runs with three runs of (24" RCP Eq.) 30" x 19" HERCP pipe.

  Exhibit 15 in Appendix A outlines the proposed improvements within area IA4. Exhibit 16 in Appendix A compares the extent of the existing vs. post-improvement inundation results for the 10-year recurrence interval storm event.

- IA8A:
  Improvement alternative 8A was located through nine properties located along the western side Lakeview Road between Winchester Road and East Brooks Road. Based on the mapped inundation results for the 10-year storm simulation, the area experienced surface flooding throughout 11 private property parcels with a maximum individual parcel top water surface width of 32 feet. The following parcels were impacted by the inundation: 077005 00052, 077005 00022, 077005 00021, 077005 00020, 077005 00019, 077005 00018, 077005 00017, 077005 00016, 077005 00015, 077005 00014, 077005 00013. The existing system in the area consisted of one 36" CMP culvert, one double barrel 42" RCP culvert, and one irregular-shaped grass-lined open channel connecting the two culverts.

  The proposed improvements in the area included upsizing the system to one (54" RCP equivalent) 68" x 43" HERCP culvert, one 60" RCP culvert, and regrading a new grass-lined trapezoidal channel between the two culverts. The proposed improvements reduced the amount of stormwater exceeding the top of bank of the channel. This was quantified by a comparing the pre- and post-improvement top water surface width along the channel. The proposed improvements reduced the top water surface width along the channel by a maximum of 19 feet and an average of 8 feet per parcel during the 10-year storm simulation.

  Exhibit 17 in Appendix A outlines the proposed improvements within area IA8A. Exhibit 18 in Appendix A compares the extent of the existing vs. post-improvement inundation results for the 10-year recurrence interval storm event.

- IA8B:
  Improvement alternative 8B was located through thirteen properties spanning from the eastern side of Dogwood Lane to the eastern side of East Rosita Circle. Based on the mapped inundation results for the 10-year storm simulation, the area experienced surface flooding throughout 4 private property parcels with a maximum individual parcel top water surface width of 55 feet. The following parcels were impacted by the inundation: 077009 00054, 077008 00003, 077008 00002, 077008 00001. The existing system in the area consisted of one run of 3.3' x 6.5' x 0.5' (total height x width x triangular bottom depth) concrete rectangular-triangular channel, one run of 4' x 7' x 0.5' concrete rectangular-triangular channel, one run of 4.3' x 6.5' x 0.5' concrete rectangular-triangular channel, one run of 4.5' x 7.25' x 0.5' concrete rectangular-triangular channel, one run of 5.33' x 7.5' x 0.5' concrete rectangular-triangular channel, two 24" RCP culverts, and a triangular grass-lined open channel between the two 24" RCP culverts.

The proposed improvements in the area included increasing the wall height of the 3.3' x 6.5' x 0.5' channel by approximately 0' – 2.1' across its length to elevation 236.5, increasing the wall height of the 4' x 7' x 0.5' channel by approximately 0' – 1' across its length to elevation 235, increasing the wall height of the 4.3' x 6.5' x 0.5' channel by approximately 0' – 0.7' across its length to elevation 235, increasing the wall height of the 4.5' x 7.25' x 0.5' channel by approximately 0.5' – 0.7' across its length to elevation 235, increasing the wall height of the 5.33' x 7.5' x 0.5' channel by approximately 0' – 1.6' across its length to elevation 235, replacing one of the 24" RCP culverts and the triangular grass-lined open channel with a 2.5' – 4.1' x 6.5' (variable height x width) rectangular concrete channel with a top elevation of 236.5, upsizing one 24" RCP culvert with a (36" RCP equivalent) 44" x 27" RCAP pipe, and constructing a new 2.5' x 4.5' (height x width) rectangular concrete channel. The proposed improvements reduced the amount of stormwater exceeding the top of bank of the channel. This was quantified by a comparing the pre- and post-improvement top water surface width along the channels. The proposed improvements reduced the top water surface width along the channel by a maximum of 50 feet and an average of 31 feet per parcel during the 10-year storm simulation.

Exhibit 19 in Appendix A outlines the proposed improvements within area IA8B. Exhibit 20 in Appendix A compares the extent of the existing vs. post-improvement inundation results for the 10-year recurrence interval storm event.

3.2 Preliminary Planning Cost Estimate

Preliminary planning costs were prepared for the seven proposed improvement alternatives. These costs were based on planning-level design information and are not meant to be considered an Engineer's Estimate of Probable Construction Costs. These estimates are purely a budget estimate for planning purposes. The costs were derived from Tennessee Department of Transportation (TDOT) bid tab unit costs. Table 3 shows a summary of the preliminary cost information for each improvement alternative.

Table 3: Preliminary Planning Cost Summary

Alternative	Preliminary Planning Cost
IA1	$ 492,038
IA2A	$ 881,175
IA2B	$ 175,560
IA3	$ 557,273
IA4	$ 594,488
IA8A	$ 555,150
IA8B	$ 855,038

Figure 1 through Figure 7 in Appendix C summarize, in table format, an itemized planning level cost estimate for each recommended improvement alternative. The cost estimates are presented in the following order: IA1 (Figure 1), IA2A (Figure 2), IA2B (Figure 3), IA3 (Figure 4), IA4 (Figure 5), IA8A (Figure 6), and IA8B (Figure 7).

4.0 CONCLUSIONS

The information collected during this stormwater mapping, modeling, and analysis project and the results of the study aid in the understanding of the reoccurring flooding concerns reported by local residents. The hydrologic and hydraulic model developed during this project provides a useful assessment of the performance of the stormwater infrastructure within the basins included in the study. It also serves as a valuable planning tool for the evaluation of possible cost-effective infrastructure improvements. The model is a dynamic tool that at any time can be updated to reflect new land development and infrastructure improvements and evaluate the effects of these changes on the entire drainage system in each basin

Eleven areas experiencing flooding were identified during the study for potential improvement modeling. Improvements in seven of the eleven areas were modeled to assess the viability of infrastructure improvements. The alternatives selected are summarized in this report and additional details of each area, including the flooding and drainage-related maintenance reports submitted by local residents, are included in Volume II of this report. Based on the results of this study we recommend that the City of Memphis include the identified improvement alternatives in their plan for future Capital Improvement Projects.