APPENDIX B
DRAINAGE REPORT

CAS CONSULTING & SERVICES, INC.
Civil Engineering | Program Management | Construction Management

South Lamar Blvd. Transportation Corridor Study

Drainage Report

Prepared for:

City of Austin and HDR, Inc.

Prepared by:
CAS Consulting and Services, Inc.

Final — 07-09-2015
Michael C. Meriwether, P.E. #58563 — Date

Background

The South Lamar Transportation Corridor Study identifies short-, medium-, and long-term transportation projects to improve safety; increase vehicular, pedestrian and bicycle mobility and accessibility; and improve quality of life for the corridor. CAS Consulting and Services, Inc. (CAS), serving as a sub-consultant to HDR, Inc., was tasked with studying the existing drainage conditions and proposing solutions for areas that are out of compliance with the city requirements. These solutions coordinate with the overall South Lamar Blvd. improvements developed with the Transportation Corridor Study. The focus of the drainage study is along South Lamar Blvd. and its right of way, extending from Ben White Blvd (US 290) to Lady Bird Lake. CAS was also tasked with providing an order of magnitude opinion of probable construction cost for drainage related items.

Data Collection

Data collection included performing a site visit and obtaining GIS data, the hydraulic models accepted by the City of Austin (COA), and record drawings. A site visit was performed in February 2015 to identify the major drainage crossings, inlets, and flow patterns. COA GIS information was obtained from the City of Austin Development Web Map, including the storm drain, zoning, land use, and watershed boundaries.

Current hydraulic models (US Army Corp of Engineers HEC-RAS models), made available by the COA, were received for the West Bouldin Creek and Lady Bird Lake watersheds. The Lady Bird Lake model provided maximum water surface elevations for the 10-yr, 50-yr, 100-yr, and 500-yr storm frequency events.

Record drawings for projects along South Lamar Blvd. were obtained through the city. Several recent projects and site plans along the study corridor were identified for drainage information. Flow lines were estimated for old storm sewer lines with incomplete data. A list of record drawings that served as sources of data for this study is provided in Appendix A.

Evaluation Criteria

The COA Drainage Criteria Manual (DCM) provides guidance for current city requirements for drainage systems and structures. This study will determine whether the following criteria are met:

- COA DCM section 1.2.2.B states that street curbs, gutters, inlets and storm sewers shall be designed to intercept, contain, and transport all runoff from the 25-year frequency storm.
- COA DCM section 5.2.0 states that the 25-year hydraulic grade line (HGL) shall remain six inches below the theoretical gutter flow line of the storm drain inlets.
- COA DCM section 1.2.4 D states that for bridges and culverts in streets other than residential, runoff from the 100 year frequency storm shall not produce a headwater elevation at the roadway greater than six inches above the crown or six inches above any top of upstream curb elevation, whichever is lower.

Drainage System Identification

South Lamar Blvd. between US 290 and Lady Bird Lake is located within three watersheds with most of the study area within West Bouldin Creek watershed. The watersheds drain from south to north, discharging in Lady Bird Lake.

Fifteen drainage systems consisting of pipes and culverts were identified along South Lamar Blvd., based on data from a site visit, the COA storm drain GIS data and record drawings. A map of the location of the drainage systems and major existing drainage structures is provided in Appendix B.

Table 1 summarizes the locations of each system's major conveyance structure along South Lamar Blvd., its watershed, and the type of data source used to identify its level of service or used to model and analyze the system.

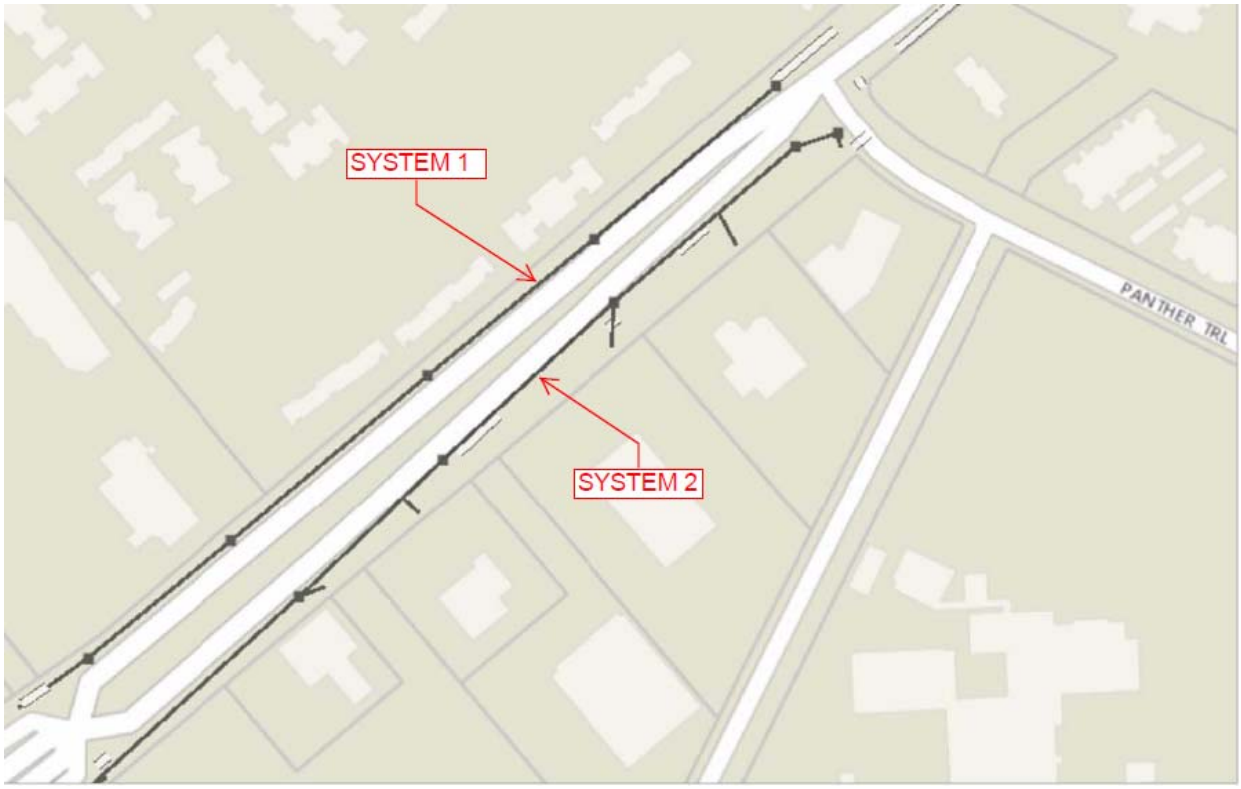
Table 1. Identified Drainage Systems along South Lamar Blvd.

Drainage System	Location Along S. Lamar Blvd.	Watershed	Data Source
1	US 290 to Panther Trail – West Side	Barton Creek	COA Development Web Map
2	US 290 to Panther Trail – East Side	Barton Creek	COA Development Web Map
3	Panther Trail to Westforest Drive	West Bouldin Creek	Record Drawings & COA Dev. Web Map
4	Westforest Drive to Barton Skyway	Barton Creek	Record Drawings & COA Dev. Web Map
5	Barton Skyway to Bluebonnet Drive	West Bouldin Creek	COA Development Web Map
6	Bluebonnet Drive to Kinney Road	West Bouldin Creek	Record Drawings & COA Dev. Web Map
7	Kinney Road to Oltorf Street	West Bouldin Creek	COA StormCAD
8	Oltorf Street to Hether Street	West Bouldin Creek	COA StormCAD
9	Collier Street Area	West Bouldin Creek	COA StormCAD
10	Lamar Square to Treadwell	West Bouldin Creek	COA StormCAD
11	Treadwell Street to Bluff Street	West Bouldin Creek	COA StormCAD
12	Bluff Street to Barton Springs Road	West Bouldin Creek	Record Drawings & COA StormCAD
13	Barton Springs Road	West Bouldin Creek	COA StormCAD
14	Barton Springs Road to Toomey Road	West Bouldin Creek	Record Drawings & COA StormCAD
15	Toomey Road to Riverside Drive	Lady Bird Lake	Record Drawings & COA Dev. Web Map

A description of each of the fifteen drainage systems follows. Land use for the study area is a mix of commercial, multi-family and single-family residences with commercial properties fronting Lamar and residential properties behind. Note that although South Lamar Blvd. is generally aligned from southwest to northeast, for the purposes of this narrative South Lamar Blvd was considered to run south to north with Barton Creek to the west and West Bouldin Creek to the east.

System 1

This network consists of 1980 feet of 18" RCP and five curb inlets along the west side of S. Lamar Blvd. beginning at Panther Trail and draining south towards Ben White Blvd. This feeds into additional larger pipes in TxDOT ROW that outfall into Barton Creek Watershed.



System 2

This network mirrors System 1 on the east side of S. Lamar Blvd and consists of 2021 feet of 24" to 48" RCP and five curb inlets with additional laterals feeding in from commercial developments to the east. This also feeds into additional larger pipes in TxDOT ROW that connect to the same outfall as System 1.

System 3

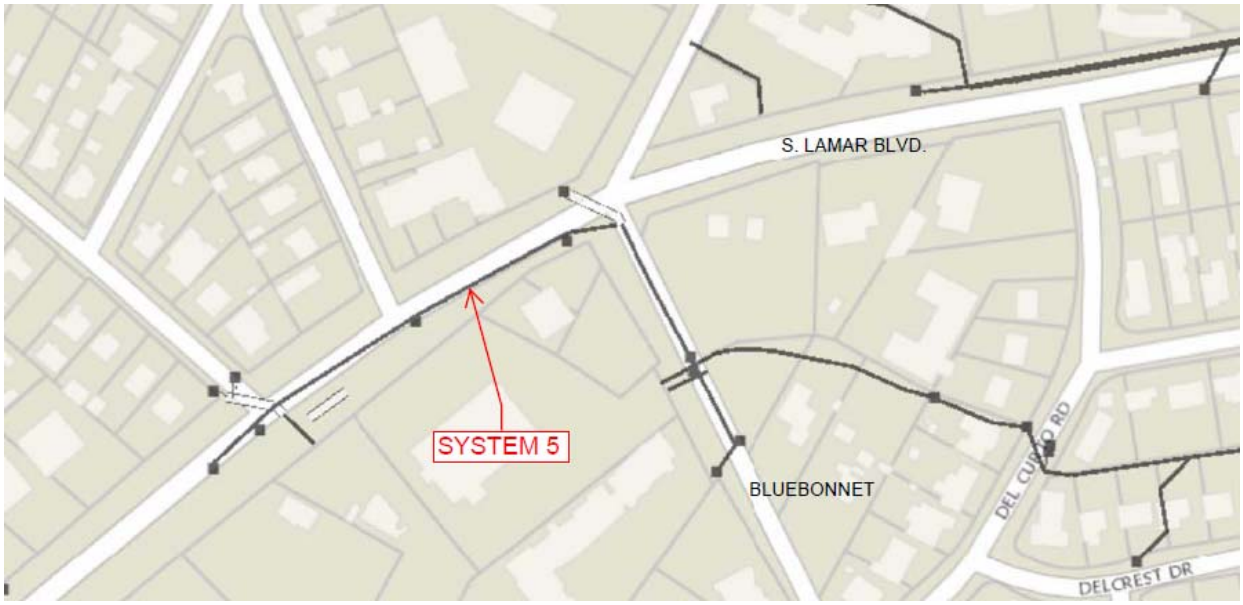
This system consists of a 4’x3’ box culvert crossing Lamar from west to east about 500’ south of Westrock. It drains 21 acres of land on the west side of Lamar, runs under a recently constructed apartment complex and outfalls into the West Bouldin Creek Watershed. Plans were found in DRG-5-A-540.

System 4

System 4 crosses South Lamar from east to west via a 2'x2' box culvert and then runs north along Lamar for 330 feet through a 30" RCP before turning west to outfall into Barton Creek Watershed. Partial plans were found in SSM-B-2-487.

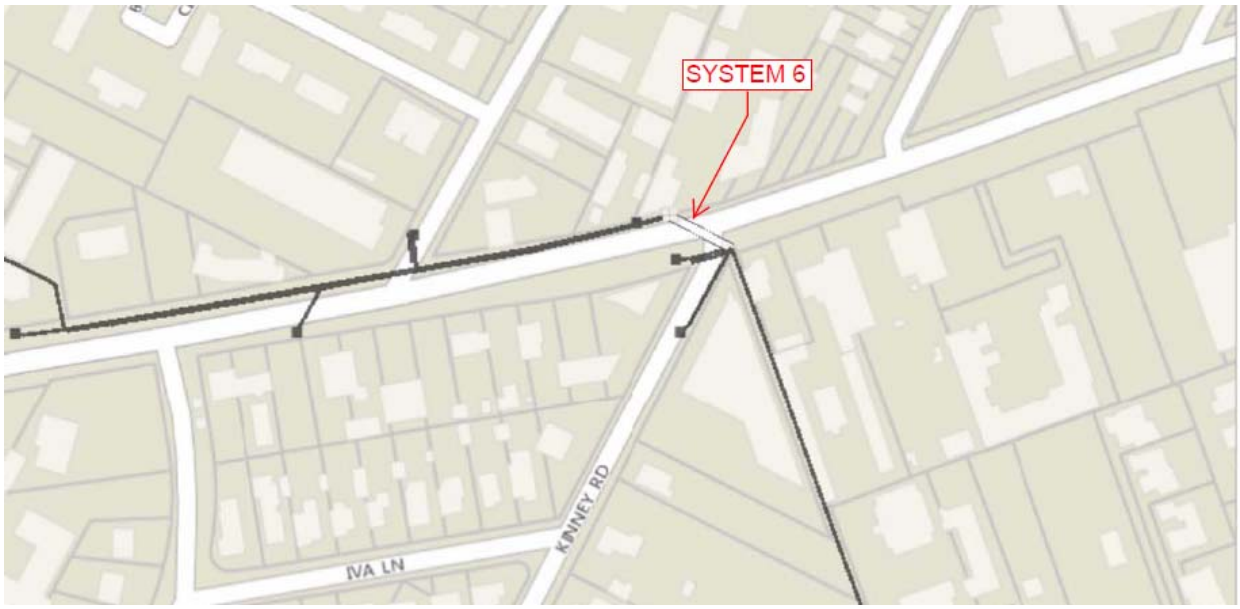
System 5

System 5 runs north along Lamar from Barton Skyway to Bluebonnet collecting flows from residential and commercial areas on both sides of Lamar. The main line consists of 574 feet of 18" to 24" RCP along the east side of Lamar. There are two laterals feeding the system from the west: a 4'x1.5' box culvert crossing Lamar at La Casa and another 4'x1.5' box culvert crossing Lamar at Bluebonnet. The system then turns east at Bluebonnet and outfalls into a tributary of West Bouldin Creek Watershed via a 30" RCP.



System 6

System 6 collects flows from an area between Bluebonnet and Kinney. The main line consists of 850 feet of dual 24" RCP along the west side of Lamar. After crossing Lamar at Kinney, the 2-24" RCP feed into a 6'x1.5' box culvert that runs east into a tributary of West Bouldin Creek Watershed. Plans were found in SSM-B-2-549 and SSM-B-2-510.



System 7

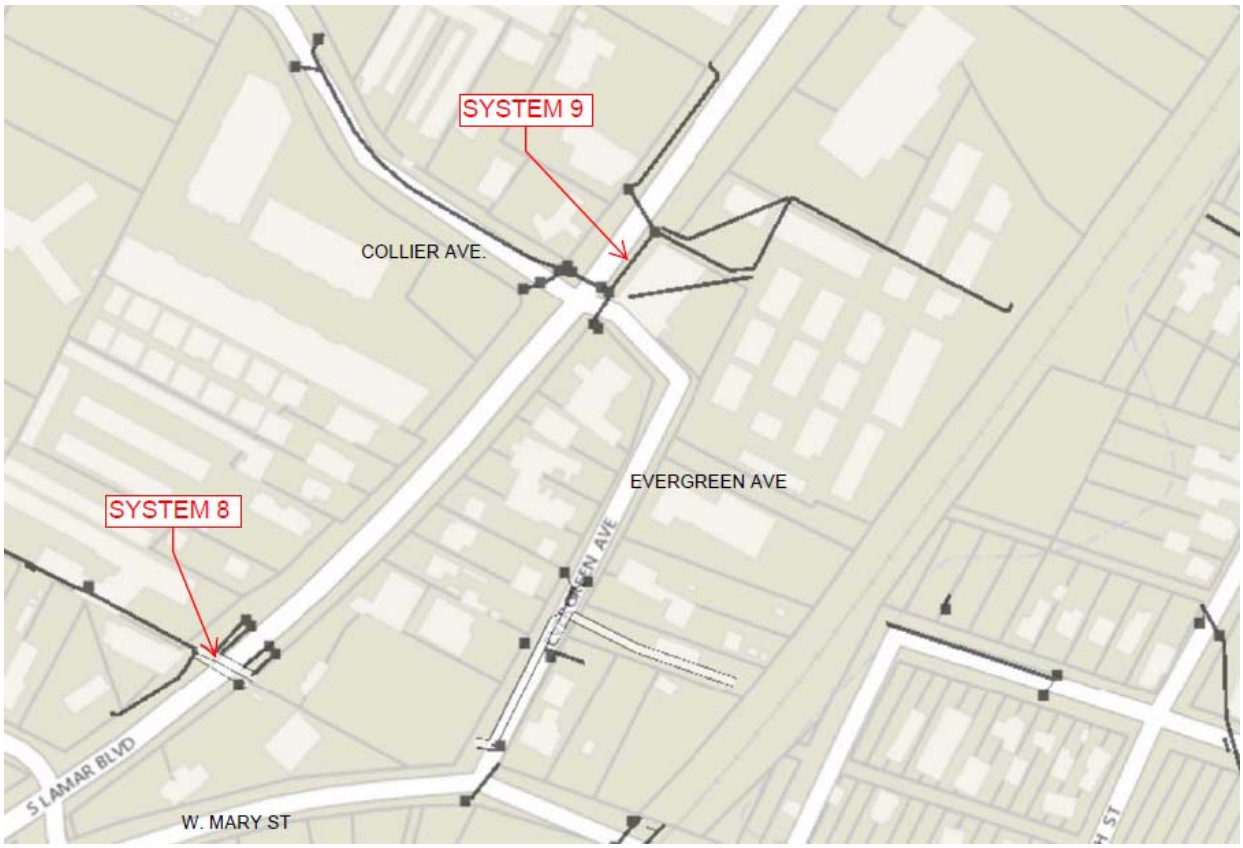
System 7 drains the Lamar ROW from Kinney to Oltorf via street surface flow until just south of Oltorf where inlets on both sides of the road capture the flow. The west side inlet feeds an 18" RCP that increases to a 4'x1.5' box culvert that crosses Lamar at Oltorf and transitions back to 18" RCP. The system than picks up the flow from an 18" RCP that drains the east side inlet and runs east via a 21" RCP in Oltorf St. The system outfalls into West Bouldin Creek at Oltorf St. Partial plans were found in PPC-1-A-5969.

System 8

System 8 drains the Hether St. area and consists of dual 4'x4' box culverts that cross Lamar from west to east about 250' north of Hether St. The culverts daylight at a vertical headwall at the east edge of Lamar ROW in the West Bouldin Creek Watershed. Plans were found in DRG-5-A-540.

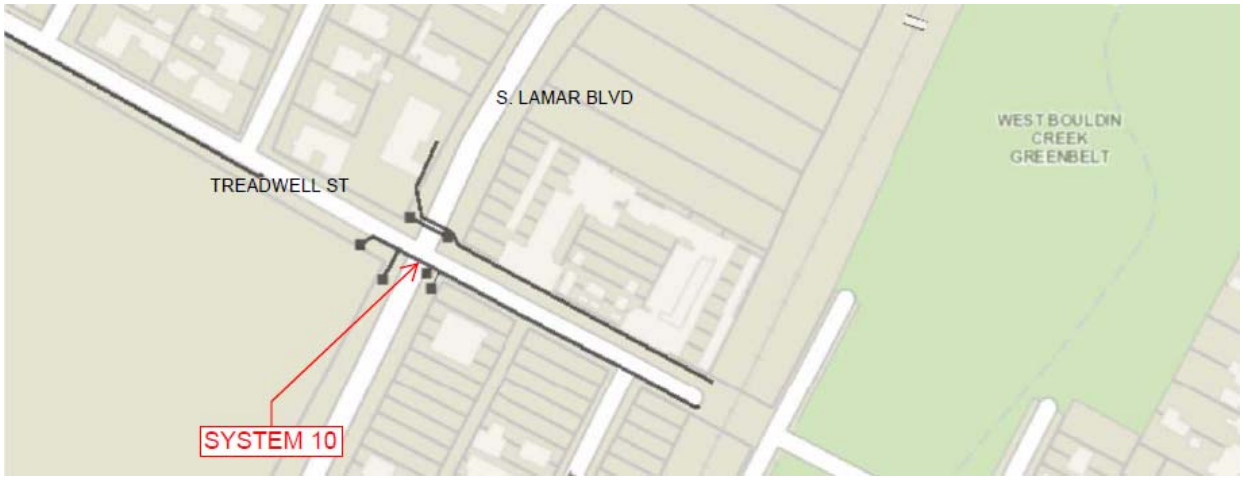
System 9

System 9 drains the Collier St. area and crosses Lamar via a 24" RCP at Collier St. The system also includes a curb inlet about 140 feet north of Collier St. that captures flow extending 1200 feet north on Lamar to Lamar Square. This inlet feeds an 18" RCP that crosses Lamar from west to east, joins with the main 24" RCP and transitions to a 36" RCP that outfalls in a drainage ditch parallel to the Union Pacific Railroad ROW. Plans were found in DRG-1-A-6833.



System 10

System 10 encompasses the area from Lamar Square to Treadwell and crosses Lamar at Treadwell via 24" RCP. The 24" RCP runs east along Treadwell and outfalls into the drainage ditch parallel to the Union Pacific Railroad ROW. Plans were found in SSM-B-2-524.

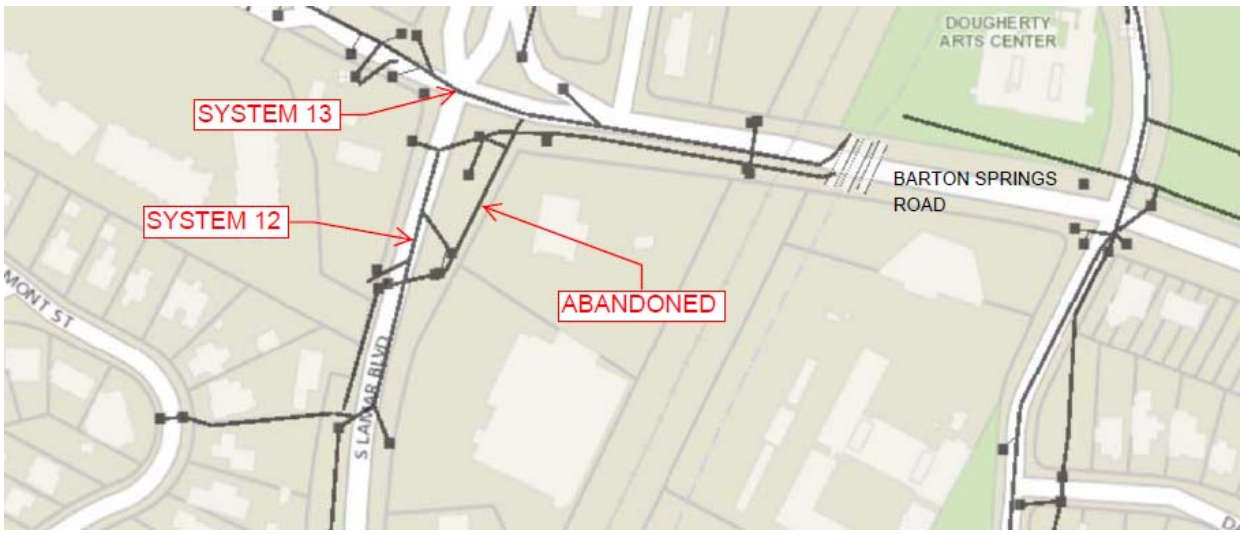


System 11

System 11 drains an area on the west side of Lamar bounded by Bluff St., Jessie St. and Treadwell St. The system crosses Lamar from west to east at Bluff St. via a 36" RCP that daylights into West Bouldin Creek.

System 12

System 12 drains both sides of Lamar from Bluff to Barton Springs Road and consists of 643 feet of 18" to 48" RCP. The main line runs down the center of Lamar and then turns east at Barton Springs Road where it transitions to a 54" RCP that outfalls into West Bouldin Creek at Barton Springs Road. Plans were found in PPC-1-A-7801.

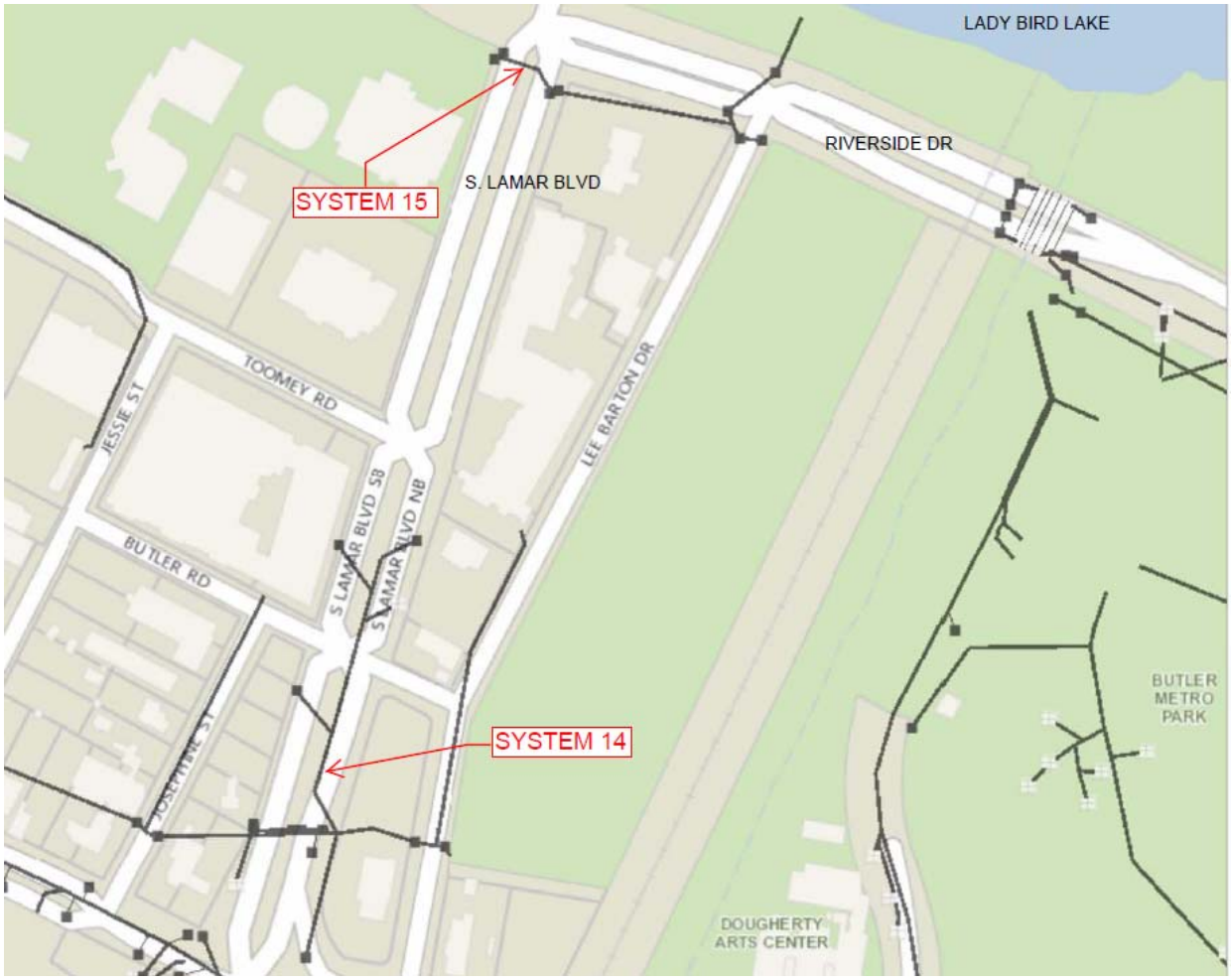


System 13

System 13 drains Barton Springs Road west of Lamar. It crosses Lamar via a 54" RCP that runs parallel to the System 12 main. It also outfalls into West Bouldin Creek at Barton Springs Road. Plans were found in PPC-1-A-7801.

System 14

System 14 drains both sides of Lamar from Barton Springs Road to Toomey and consists of about 940 feet of 18" to 36" RCP. The main line runs down the center of Lamar and then turns east about 100 feet north of Barton Springs Road where it transitions to a 42" RCP that crosses under Lee Barton Road and outfalls into a ditch leading to West Bouldin Creek. Plans were found in PPC-1-A-7801.



System 15

System 15 drains both sides of Lamar from Toomey to Riverside and includes about 100 feet of 18" RCP in the Lamar ROW. The main line starts at a curb inlet on the west side of Lamar, crosses Lamar, connects to another curb inlet and runs parallel to Riverside Drive and outfalls into Lady Bird Lake . Partial plans were found in PPC-1-A-7801.

Analysis Methodology

In order to determine whether the drainage systems are in compliance, the evaluation focused on:

- the capacity of major drainage structures to convey the 25-year storm event;
- the 25-year hydraulic grade line remaining six inches below the theoretical gutter flow line of the storm drain inlets;
- the water surface elevation at the bridge or culvert upstream face to be within the allowable 100-year event overtopping depth of six inches above the crown or any top of upstream curb elevation, whichever is lower.

Compliance with city code for the 15 systems was determined by either identifying the level of service in the City-provided StormCAD model, reviewing recent record drawings, or if recent documentation was not found, modeling the system with storm sewer analysis software.

The evaluation of Systems 8 through 14 is documented in the City-provided StormCAD model. Systems 1 through 7 were evaluated using Autodesk Storm and Sanitary Analysis 2015 software (Autodesk SSA). This analysis does not evaluate for the capacity of storm drain inlets and the resulting spread, nor the capacity and velocity within the lateral lines of the storm drain systems. Due to the small size of System 15, pipe capacity was evaluated using Manning's equation.

Model generation within Autodesk SSA requires determining the pipe invert elevations, pipe lengths, outfall information, and the network configuration. These parameters were based on record drawing information and reasonable assumptions based on ground elevations where no flowline information was available. Inlets were modeled as junctions to avoid identifying street and curb inlet details, which is beyond the scope of this study.

Discharges for the 25-year storm event were determined using the Rational Method. Calculation of discharge required several steps. Drainage areas for each system were delineated based on COA 2-ft contours. Time of concentration values were calculated using COA DCM guidelines for determination of sheet flow, shallow concentrated and channel flow. Manning's n values for sheet flow and overland flow calculations were determined using existing conditions zoning maps and the land use. Rational method runoff coefficient C values were based on the maximum allowable impervious cover percentages as listed in the COA's zoning ordinance and maps.

Calculations and data for the existing conditions analysis, including discharges, time of concentration calculations, and Rational Method parameters can be found in Appendix C.

Existing Conditions Analysis

This section summarizes the evaluation of existing drainage systems along South Lamar Blvd. A plan view schematic of the Autodesk SSA results is provided. The Autodesk SSA program identifies pipes that are surcharged or junctions with hydraulic grade lines that exceed the rim or ground elevation with the color red. The program considers pipes surcharged if the ratio of maximum flow depth to total depth exceeds one. Pipe capacity is exceeded if the ratio of maximum flow to design flow exceeds one. The existing drainage systems were modeled only within the South Lamar Transportation Corridor Study

area. Where systems extended well beyond the study area, the system was modeled to a point where down-gradient conditions no longer have an effect on the drainage systems in the study area.

System 1

Analysis with Autodesk SSA shows that this system does not meet criteria for a 25-yr level of service. As summarized in Table 1A, the modeled system is surcharged (pipes are running full) during the 25-yr storm event at the third pipe in the system. Pipes 3 thru 5 need to be upsized to 24" diameter.

Table 1A. System 1 Existing Conditions Results

Pipe	Pipe Shape	Pipe Dia. or Height (in)	Pipe Width (in)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Depth/ Total Depth Ratio	Reported Condition
Link-01	CIRCULAR	18	18	6.32	0.68	0.46	Calculated
Link-02	CIRCULAR	18	18	6.34	1.02	0.68	Calculated
Link-03	CIRCULAR	18	18	6.45	1.50	1.00	SURCHARGED
Link-04	CIRCULAR	18	18	6.79	1.40	0.93	> CAPACITY
Link-05	CIRCULAR	18	18	8.25	1.40	0.94	> CAPACITY

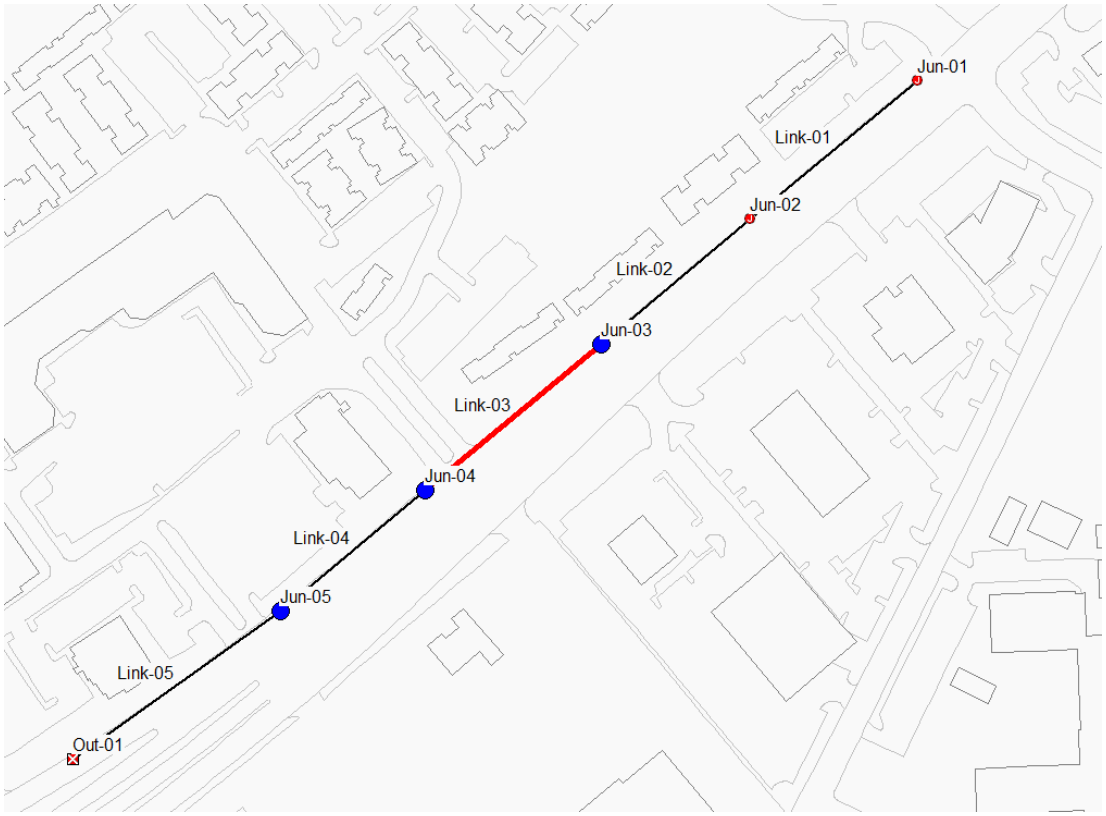


Figure 1. System 1 Existing Conditions Results Schematic

System 2

Analysis with Autodesk SSA shows that this system does not meet criteria for a 25-yr level of service. As summarized below in Figure 2 and Table 2, the modeled system is surcharged (pipes are running full) during the 25-yr storm event for Pipes 2 and 3 and Pipe 4 is over capacity. Pipes 2, 3 and 4 need to be upsized to 30", 36" and 42" diameter, respectively.

Table 2. System 2 Existing Conditions Results

Pipe	Pipe Shape	Pipe Dia. or Height (in)	Pipe Width (in)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Depth/ Total Depth Ratio	Reported Condition
Link-01	CIRCULAR	24	24	15.75	0.72	0.60	Calculated
Link-02	CIRCULAR	24	24	13.74	1.00	1.00	SURCHARGED
Link-03	CIRCULAR	30	30	25.64	1.01	1.00	SURCHARGED
Link-04	CIRCULAR	36	36	40.86	1.04	0.93	> CAPACITY
Link-05	CIRCULAR	42	42	60.66	1.00	0.82	Calculated
Link-06	CIRCULAR	48	48	113.21	0.72	0.63	Calculated
Link-07	CIRCULAR	48	48	112.64	0.90	0.74	Calculated

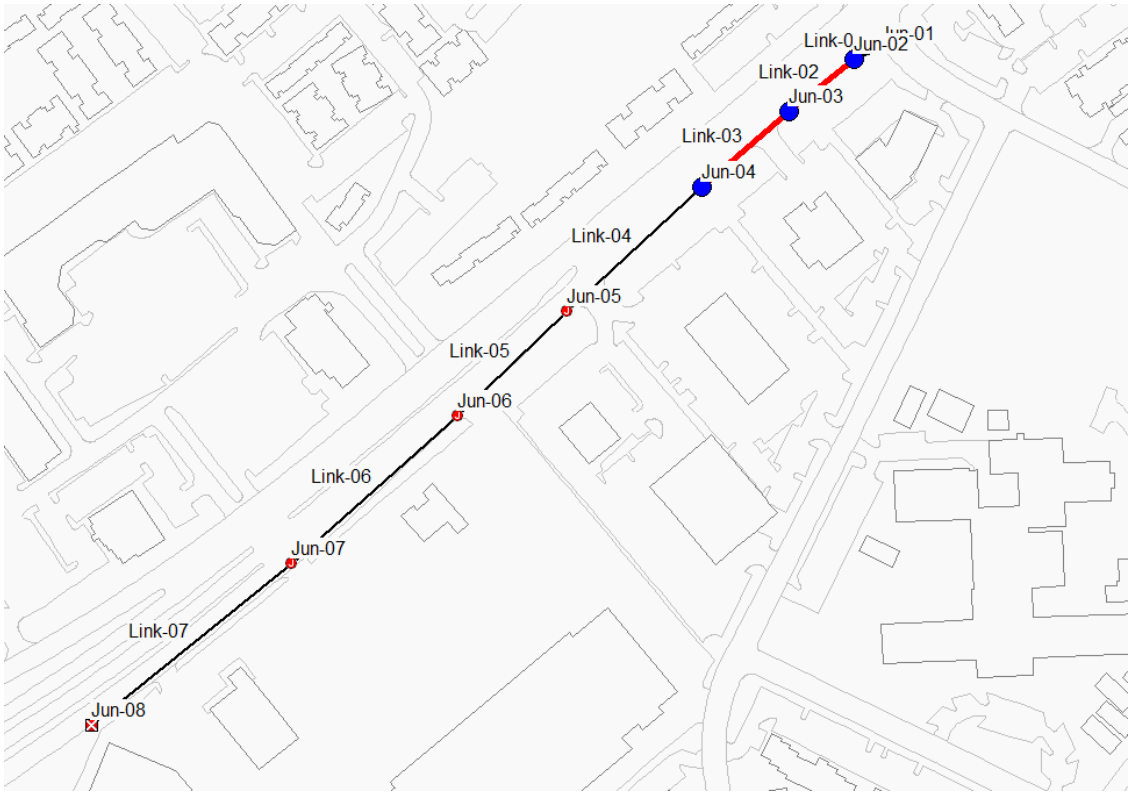


Figure 2. System 2 Existing Conditions Results Schematic

System 3

Analysis with Autodesk SSA shows that the entire system meets the criteria for a 25-yr level of service. Although the modeled 3'x4' box culvert is over capacity for the 25-year storm event as summarized below in Figure 3 and Table 3, the hydraulic grade line criteria is met for the entire system. The 100-year flow is 114.5 cfs and the box culvert needs to be upsized to 3'x6' to carry this flow.

Table 3. System 3 Existing Conditions Results

Pipe	Pipe Shape	Pipe Dia. or Height (in)	Pipe Width (in)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Depth/ Total Depth Ratio	Reported Condition
Link-01	Rectangular	36	48	83	1.02	0.90	> CAPACITY
Link-02	Rectangular	36	48	214	0.53	0.52	Calculated
Link-03	Rectangular	36	48	214	0.53	0.51	Calculated

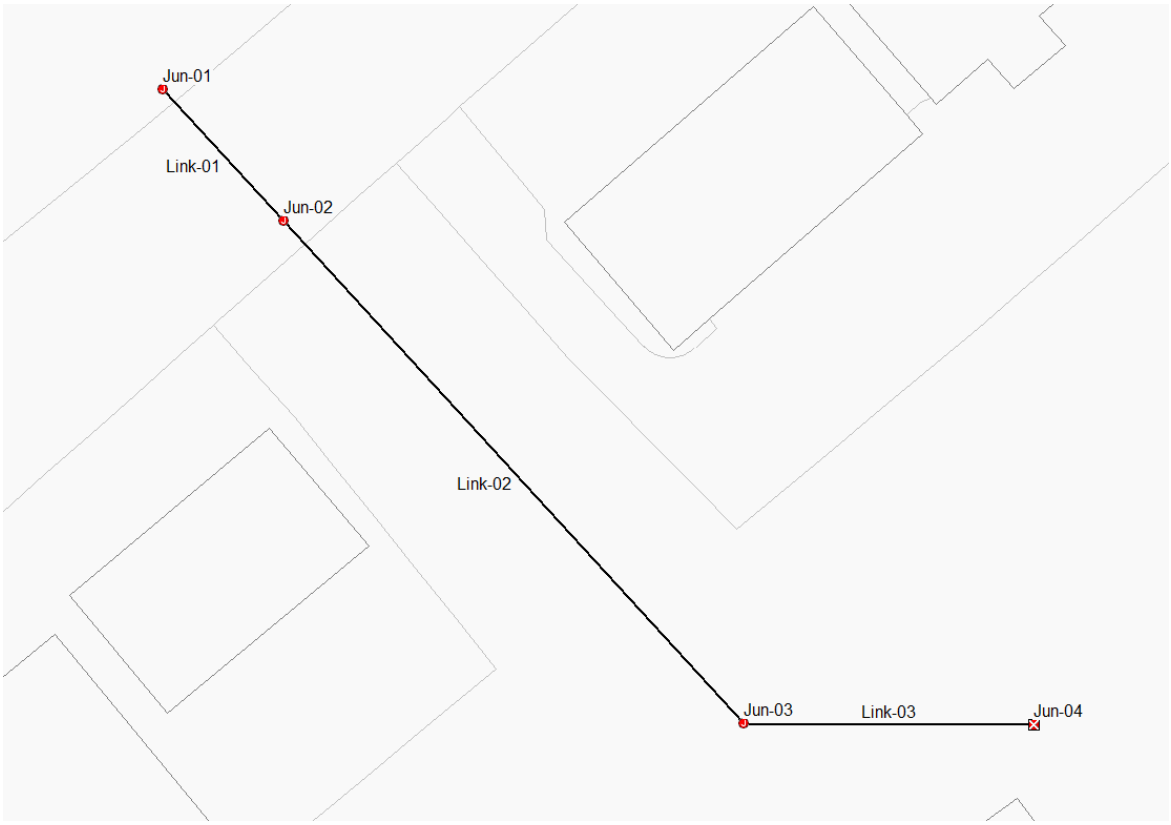


Figure 1. System 3 Existing Conditions Results Schematic

System 4

Analysis with Autodesk SSA shows that Pipes 2 and 3 do not meet criteria for a 25-yr level of service. As summarized below in Figure 4 and Table 4, pipes 2 and 3 are surcharged. In addition, the system has a 30 inch pipe flowing into a 27 inch pipe that in turn flows into a 24 inch pipe. This condition violates the DCM rule prohibiting larger diameter pipes flowing into smaller diameter pipes. Pipe 1 needs to be upsized from 15" to 18" diameter to meet the minimum pipe size requirement of the DCM.

Table 2. System 4 Existing Conditions Results

Pipe	Pipe Shape	Pipe Dia. or Height (in)	Pipe Width (in)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Depth/ Total Depth Ratio	Reported Condition
Link-01	CIRCULAR	15	15	7.71	0.42	0.45	Calculated
Link-02	CIRCULAR	30	30	33.71	1.00	1.00	SURCHARGED
Link-03	CIRCULAR	27	27	26.34	1.00	1.00	SURCHARGED
Link-04	CIRCULAR	24	24	37.26	0.72	0.62	Calculated
Link-05	Rectangular	24	24	20.41	0.80	0.68	Calculated

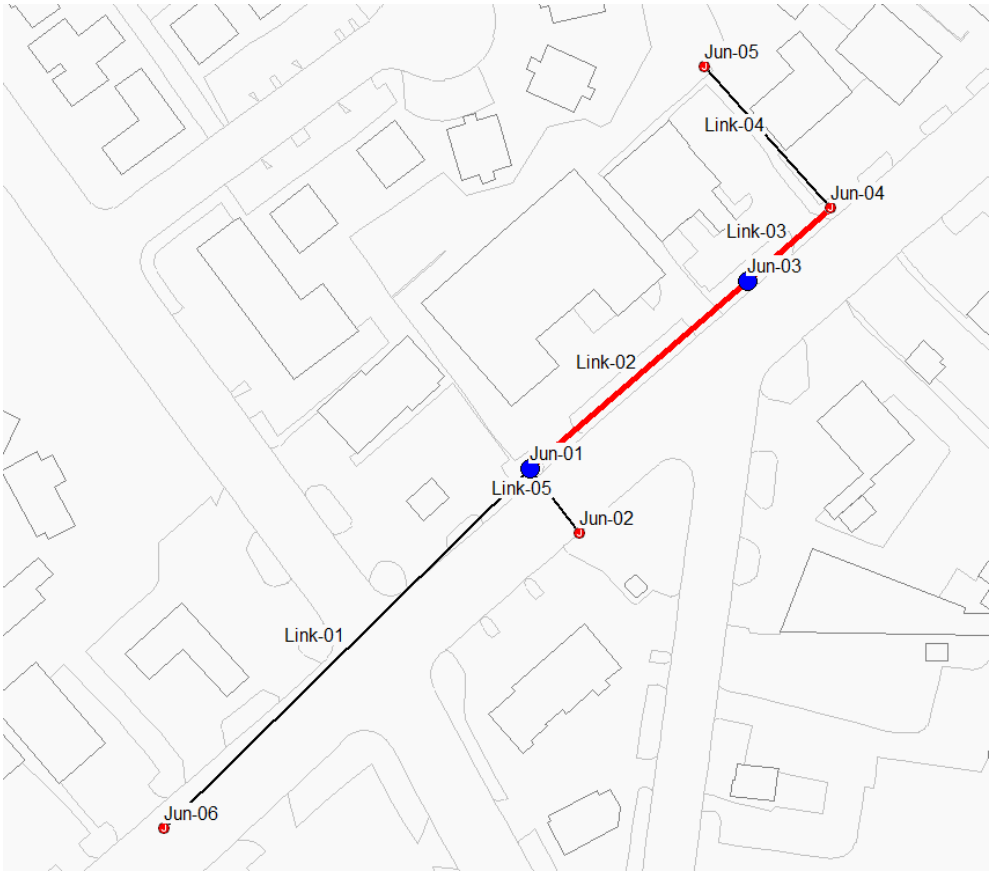


Figure 2. System 4 Existing Conditions Results Schematic

System 5

Analysis with Autodesk SSA shows that the majority of the system meets criteria for a 25-yr level of service. Results, as summarized below in Figure 5 and Table 5, show that 25-yr storm event peak flows do not exceed pipe design flow capacity for the system, except at Pipes 1 and 2. These two pipes need to be upsized to 24" diameter. Pipes 7 and 8 cross Lamar Blvd.

Table 3. System 5 Existing Conditions Results

Pipe	Pipe Shape	Pipe Dia. or Height (in)	Pipe Width (in)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Depth/ Total Depth Ratio	Reported Condition
Link-01	CIRCULAR	18	18	23.09	1.00	1.00	SURCHARGED
Link-02	CIRCULAR	18	18	23.05	1.00	1.00	SURCHARGED
Link-03	CIRCULAR	24	24	49.71	0.62	0.56	Calculated
Link-04	CIRCULAR	24	24	49.66	0.70	0.60	Calculated
Link-05	CIRCULAR	30	30	101.39	0.38	0.43	Calculated
Link-06	CIRCULAR	30	30	93.22	0.61	0.56	Calculated
Link-07	Rectangular	18	48	102.45	0.21	0.27	Calculated
Link-08	Rectangular	18	48	80.47	0.08	0.15	Calculated

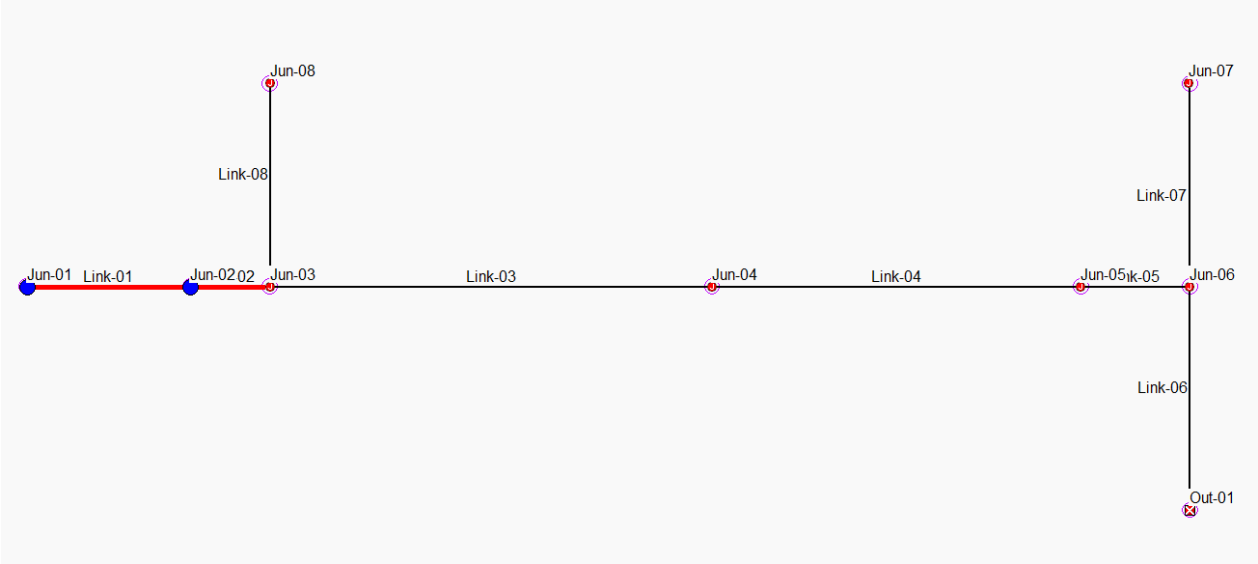


Figure 3. System 5 Existing Conditions Results Schematic

System 6

Analysis with Autodesk SSA shows that this system does not meet criteria for a 25-yr level of service. As summarized below in Figure 2 and Table 3, the modeled system is surcharged (pipes are running full) during the 25-yr storm event for Pipes 1 and 2. The links shown as red lines in Figure 6 indicate that Pipes 3 through 7 need to be upsized as well. New sizes are: Pipe 1 – 30”; Pipe 2 – 30”; Pipe 3 – 30”; Pipe 4 – 36”; Pipe 5 – 42”; Pipe 6 – 42”; and Pipe 7 – 30”x72”. Existing and proposed Pipes 1 through 6 are dual barrels.

Table 6. System 6 Existing Conditions Results

Pipe	Pipe Shape	Pipe Dia. or Height (in)	Pipe Width (in)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Depth/ Total Depth Ratio	Reported Condition
Link-01	CIRCULAR	24	24	23.09	1.00	1.00	SURCHARGED
Link-02	CIRCULAR	24	24	23.05	1.00	1.00	SURCHARGED
Link-03	CIRCULAR	24	24	49.71	0.62	0.56	Calculated
Link-04	CIRCULAR	24	24	49.66	0.70	0.60	Calculated
Link-05	CIRCULAR	24	24	101.39	0.38	0.43	Calculated
Link-06	CIRCULAR	24	24	93.22	0.61	0.56	Calculated
Link-07	Rectangular	18	72	102.45	0.21	0.27	Calculated
Link-08	CIRCULAR	42	42	80.47	0.08	0.15	Calculated

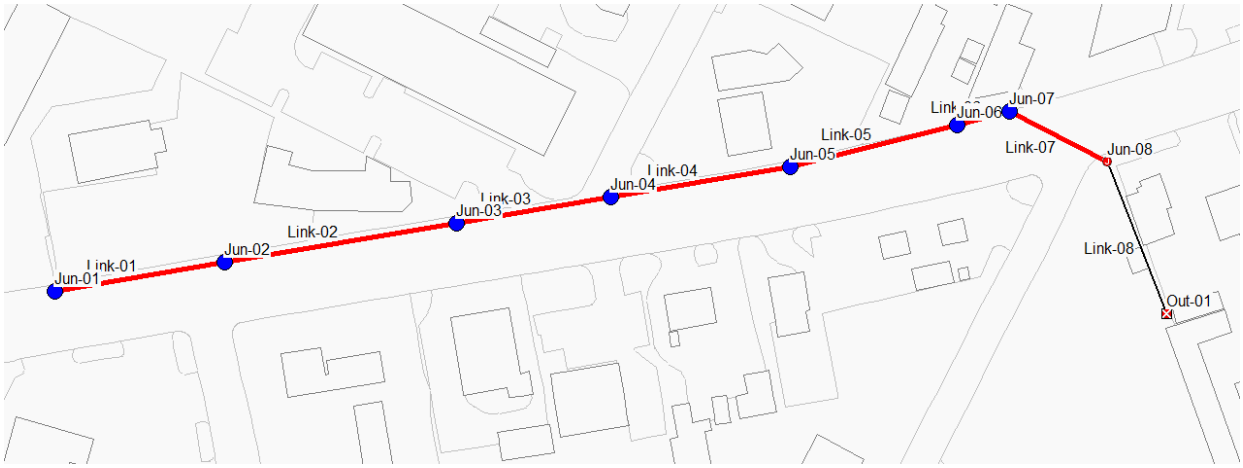


Figure 6. System 6 Existing Conditions Results Schematic

System 7

Analysis with Autodesk SSA shows that the entire system meets the criteria for a 25-yr level of service. Although Pipe 4 is over capacity for the 25-year storm event as summarized below in Figure 7 and Table 7, the hydraulic grade line criteria is met for the entire system.

Table 7. System 7 Existing Conditions Results

Pipe	Pipe Shape	Pipe Dia. or Height (in)	Pipe Width (in)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Depth/ Total Depth Ratio	Reported Condition
Link-01	CIRCULAR	18	18	15.46	0.96	0.75	Calculated
Link-02	Rectangular	18	48	74.11	0.20	0.27	Calculated
Link-03	CIRCULAR	18	18	16.96	0.85	0.69	Calculated
Link-04	CIRCULAR	21	21	23.27	1.01	0.89	> CAPACITY

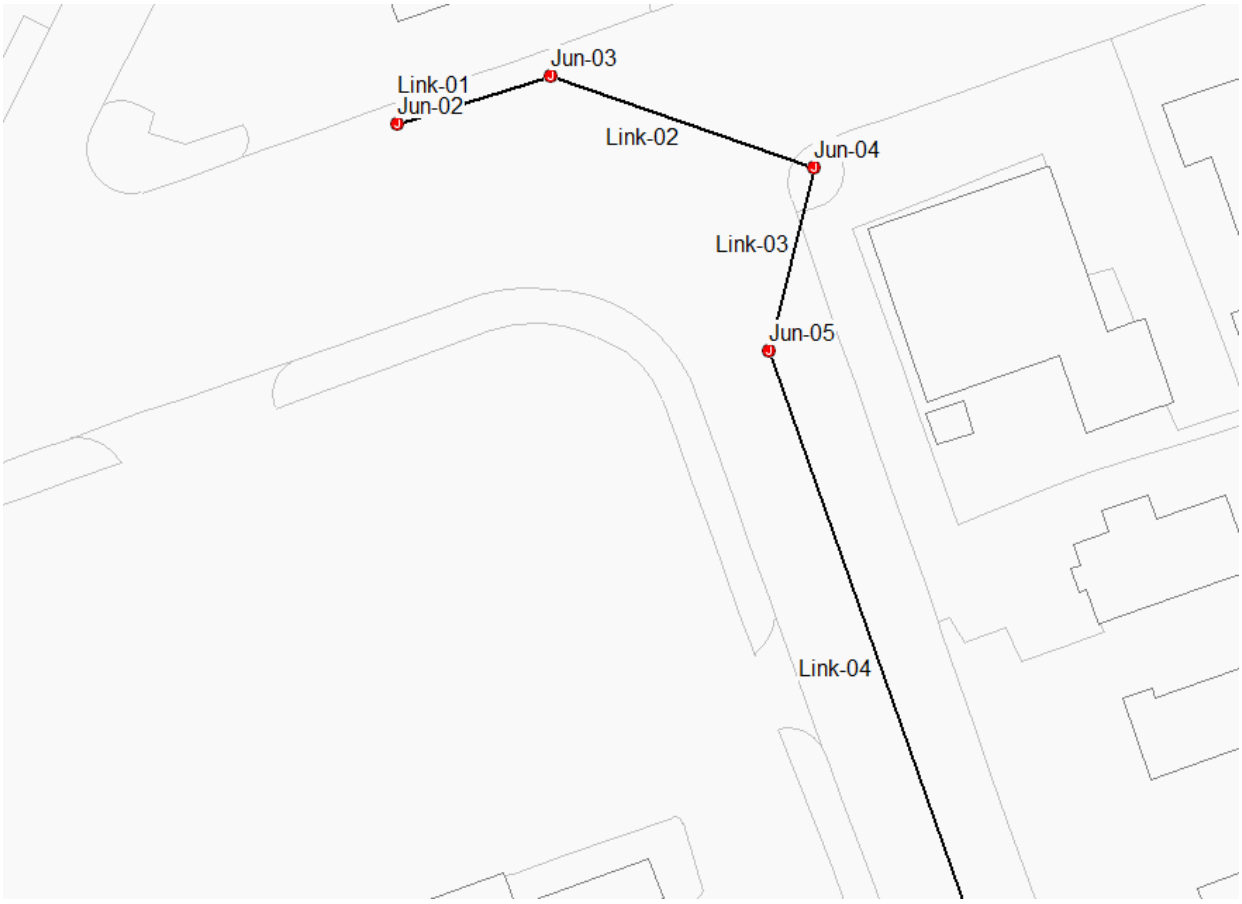


Figure 7. System 7 Existing Conditions Results Schematic

System 8

System 8 was analyzed by the City using StormCAD. Line 14167.1 (dual 4'x4' box culvert) is undersized for the 25-year event. This line crosses Lamar and daylights at a headwall on the east ROW of Lamar. In order to accommodate the increased width of the proposed ideal roadway section, the headwall would need to be moved back 10 feet to the east and the box culverts extended to match. In addition, two 4'x4' box culverts would need to be added to satisfy the capacity requirements. Lateral line 14170 (18" RCP) is also undersized per the analysis and would need to be upsized to 30" diameter.

Table 8. System 8 Existing Conditions Results

Label	Element	Flow (cfs)	Message	Source
14167.1	Conduit	451.63	Conduit discharge is above design discharge.	Hydraulics Validation
14170	Conduit	38.95	Conduit discharge is above design discharge.	Hydraulics Validation

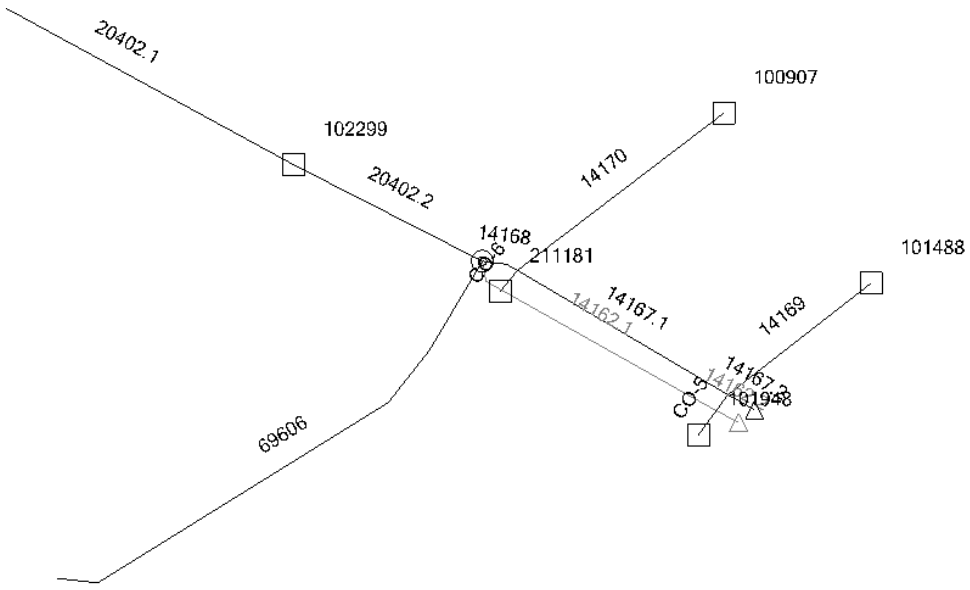


Figure 8. System 8 Existing Conditions Schematic

System 9

System 9 was analyzed by the City using StormCAD. Lines 13834 (24" RCP), 13841 (36" RCP) and 13840 (18" RCP) are undersized for the 25-year event. Using Manning's equation, the proposed lines crossing Lamar (Conduit 13834 and 13840) need to be 30" and 36" diameter and Line 13841 running parallel to Lamar needs to be upsized to 42" diameter.

Table 9. System 9 Existing Conditions Results

Label	Element	Flow (cfs)	Message	Source
13834	Conduit	61.38	Conduit discharge is above design discharge.	Hydraulics Validation
13840	Conduit	85.05	Conduit discharge is above design discharge.	Hydraulics Validation
13841	Conduit	105.05	Conduit discharge is above design discharge.	Hydraulics Validation

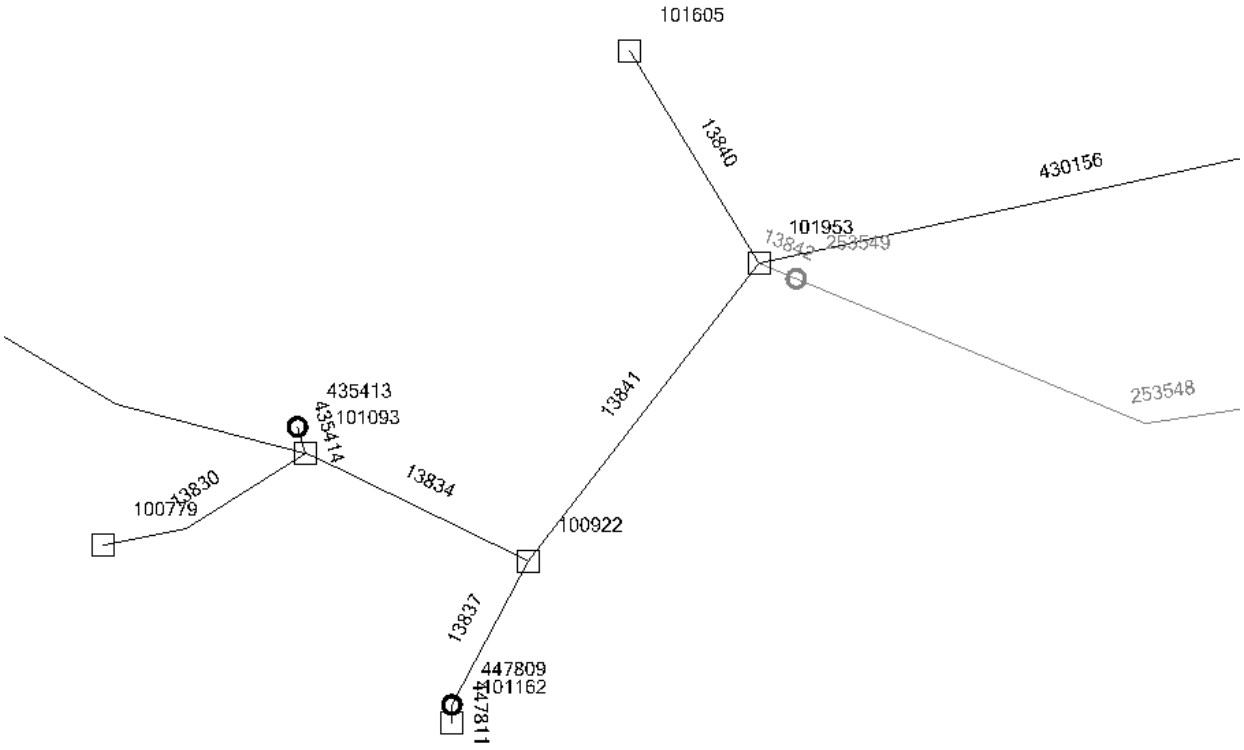


Figure 9. System 9 Existing Conditions Schematic

System 10

System 10 was analyzed by the City using StormCAD. Lines 12930 (18" RCP) and 94388 (24" RCP) are undersized for the 25-year event. To meet capacity requirements, the lines need to be upsized to 24" and 30" respectively. Conduit 12933 crosses Lamar Blvd.

Table 10. System 10 Existing Conditions Results

Label	Element	Flow (cfs)	Message	Source
12930	Conduit	43.99	Conduit discharge is above design discharge.	Hydraulics Validation
12933	Conduit	46.96	None	---
94388	Conduit	46.91	Conduit discharge is above design discharge.	Hydraulics Validation

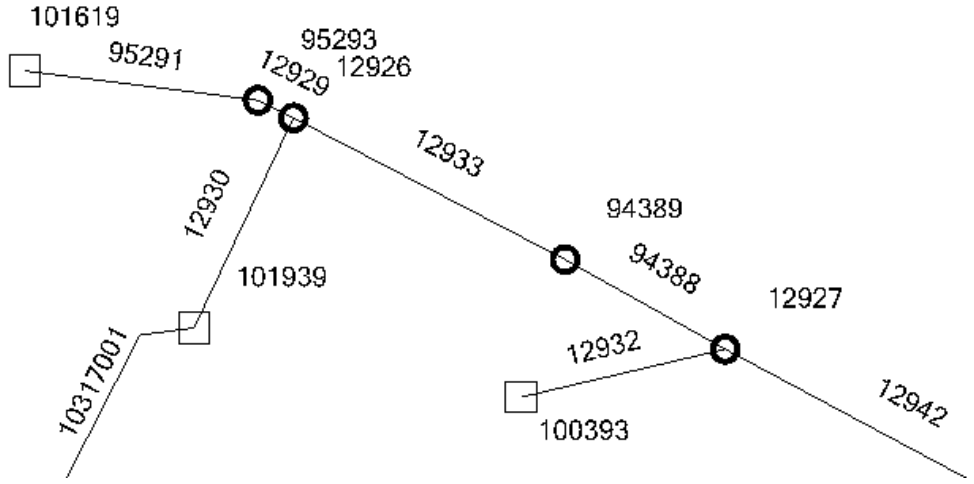


Figure 10. System 10 Existing Conditions Schematic

System 11

System 11 was analyzed by the City using StormCAD. The results show that existing pipes 23216 and 23244 (both 36" RCP) have adequate capacity for the 25-year storm. Pipe 23216 needs to be upsized to 42" diameter to carry the 100-year flows (Q100=135.78 cfs). Conduit 23216 crosses Lamar Blvd.

Table 11. System 11 Existing Conditions Results

Label	Element	Flow (cfs)	Message	Source
23244	Conduit	82.11	None	Hydraulics Validation
23216	Conduit	98.66	None	Hydraulics Validation

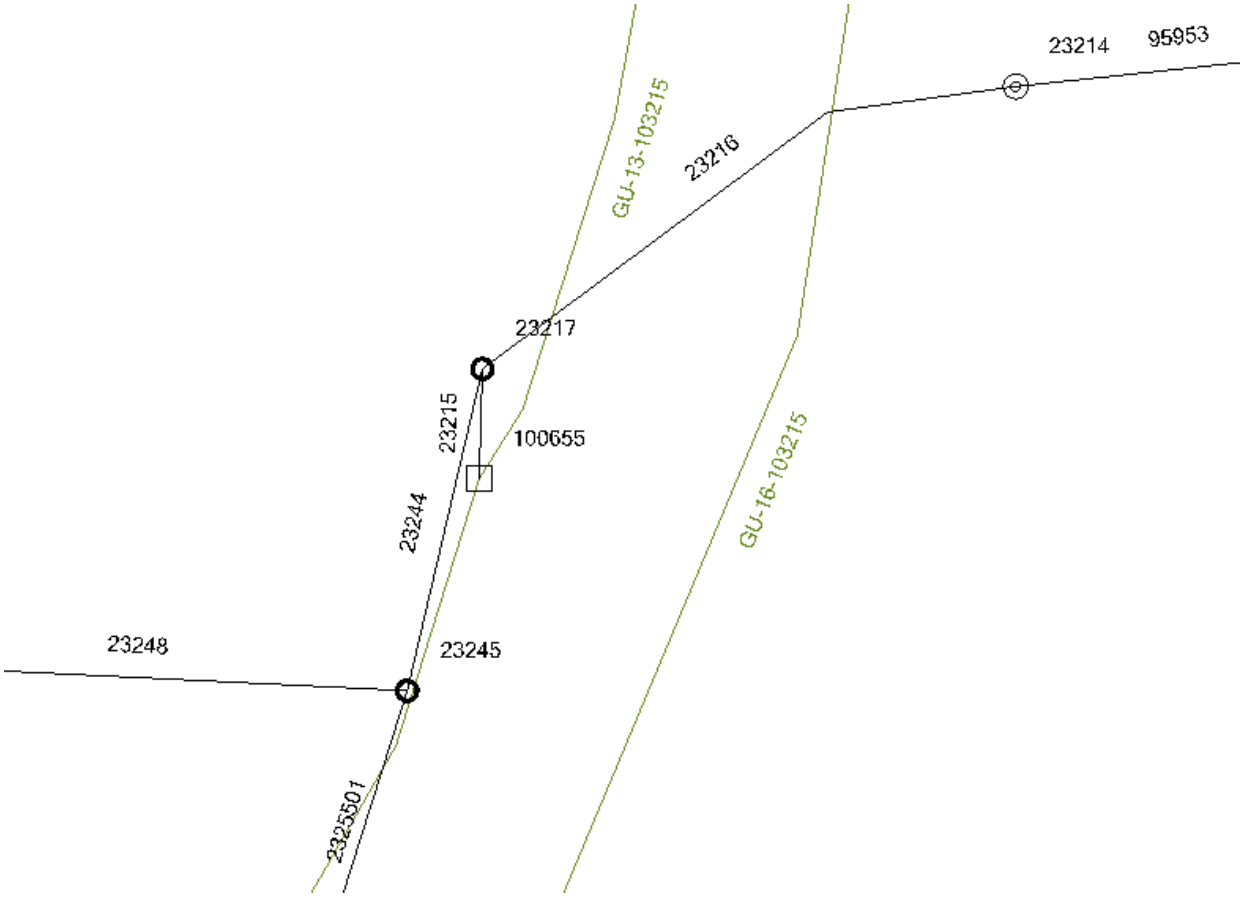


Figure 11. System 11 Existing Conditions Schematic

System 12

System 12 was analyzed by the City using StormCAD. The results show that existing pipe 260391 (30" RCP) is undersized for the 25-year storm and pipe 260399 (42" RCP) is oversized for minimum velocity. A review of the approved plans (PPC-1-A-7801) shows that pipes 260391 and 260399 meet the criteria of the DCM. The system experiences pressure flow in some cases, but the HGL is below pavement. No changes to this system are needed. Conduit 260401 crosses Lamar Blvd.

Table 12. System 12 Existing Conditions Results

Label	Element	Flow (cfs)	Message	Source
260391	Conduit	56.12	Conduit discharge is above design discharge.	Hydraulics Validation
260393	Conduit	82.29	None	Hydraulics Validation
260396	Conduit	94.65	None	Hydraulics Validation
260399	Conduit	14.13	Conduit does not meet min. velocity constraint.	Hydraulics Validation
260401	Conduit	104.52	None	Hydraulics Validation

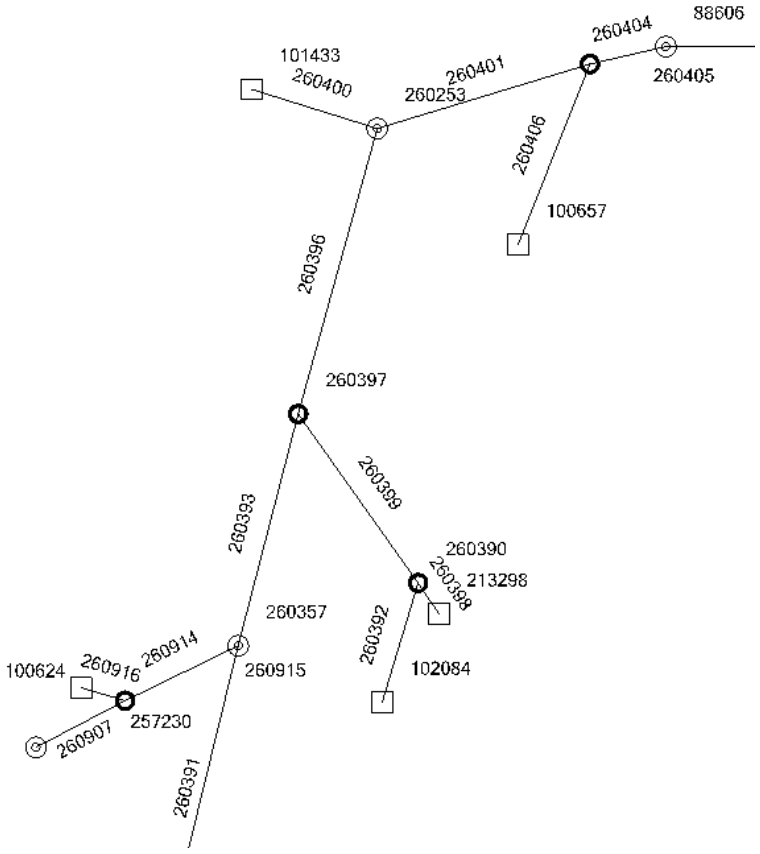


Figure 12. System 12 Existing Conditions Schematic

System 13

System 13 was analyzed by the City using StormCAD. This system was designed in 1992 to carry 135 cfs at the Lamar crossing. In 2000, the City constructed a bypass to the west that reduced the flow to 28 cfs. As a result, the pipes (54" RCP) are oversized and the velocity is below 2.5 fps. No changes to this system are needed. Conduit 381908 and 381909 cross Lamar Blvd.

Table 13. System 13 Existing Conditions Results

Label	Element	Flow (cfs)	Message	Source
381908	Conduit	28.40	Conduit does not meet min. velocity constraint.	Hydraulics Validation
381909	Conduit	28.09	Conduit does not meet min. velocity constraint.	Hydraulics Validation

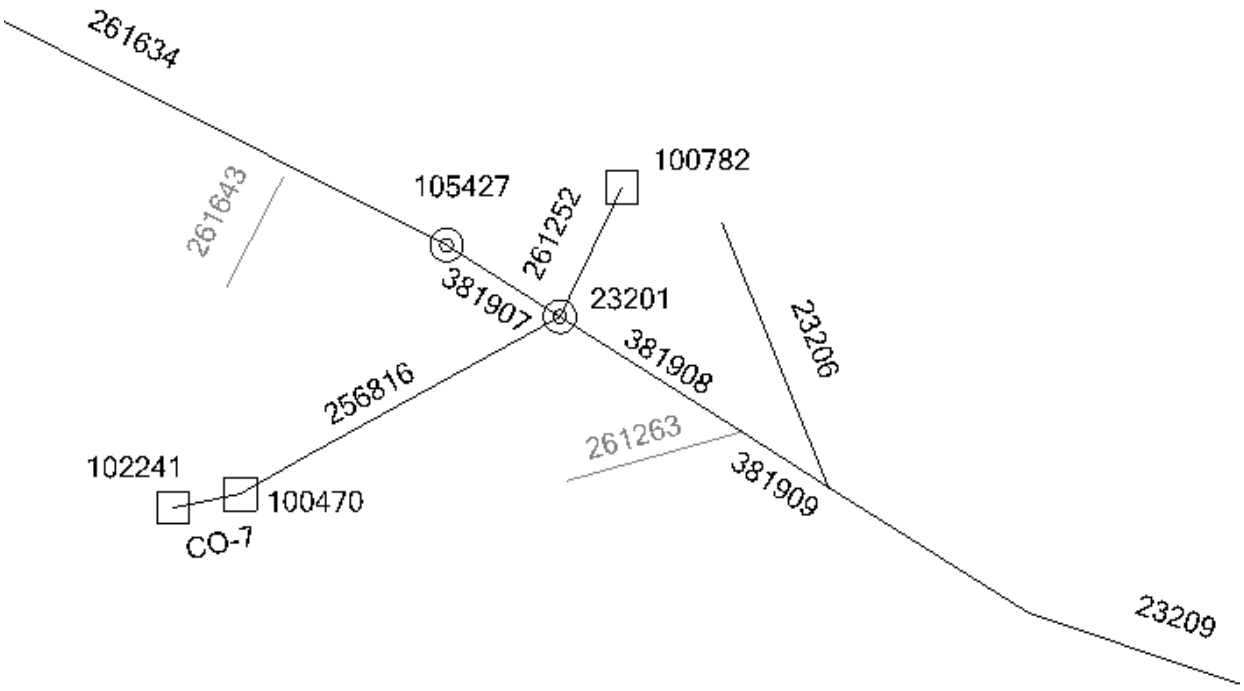


Figure 13. System 13 Existing Conditions Schematic

System 14

System 14 was analyzed by the City using StormCAD. This system design was approved by the City in 1992 despite having pressure flow in the trunk line. The HGL is above pavement level but this can be attributed in part to backwater effects from West Bouldin Creek. Upsizing the pipes in this system will have minimal effect and are not recommended. A solution that merits further study is diverting the flows from the west into System 13. Conduit 260435 crosses Lamar Blvd.

Table 14. System 14 Existing Conditions Results

Label	Element	Flow (cfs)	Message	Source
260421	Conduit	46.97	Conduit discharge is above design discharge.	Hydraulics Validation
260435	Conduit	45.74	Conduit discharge is above design discharge.	Hydraulics Validation
261599	Conduit	23.90	Conduit discharge is above design discharge.	Hydraulics Validation
261600	Conduit	26.20	Conduit discharge is above design discharge.	Hydraulics Validation

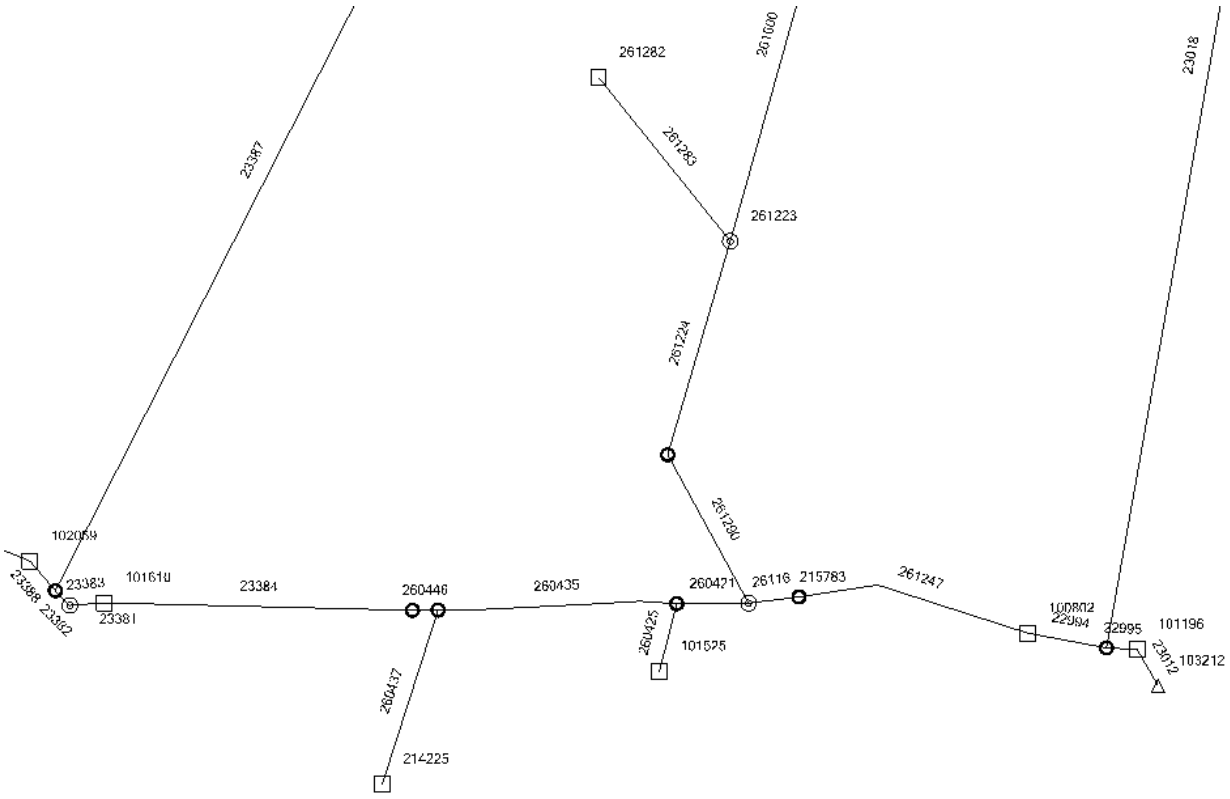


Figure 14. System 14 Existing Conditions Schematic

System 15

Analysis with Autodesk SSA shows that the entire system meets the criteria for a 25-yr level of service. Although Pipe 4 is over capacity for the 25-year storm event as summarized below in Figure 15 and Table 15, the hydraulic grade line criteria is met for the entire system. Flow line elevations were assumed for System 15 as the record drawings did not have this information. Link 06 and 07 cross Lamar Blvd.

Table 15. System 15 Existing Conditions Results

Pipe	Pipe Shape	Pipe Dia. or Height (in)	Pipe Width (in)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Depth/ Total Depth Ratio	Reported Condition
Link-06	CIRCULAR	18	18	11.37	0.80	0.65	Calculated
Link-07	CIRCULAR	18	18	11.32	0.79	0.68	Calculated
Link-08	CIRCULAR	18	18	10.99	0.80	0.68	Calculated
Link-09	CIRCULAR	18	18	18.04	1.04	0.84	> CAPACITY

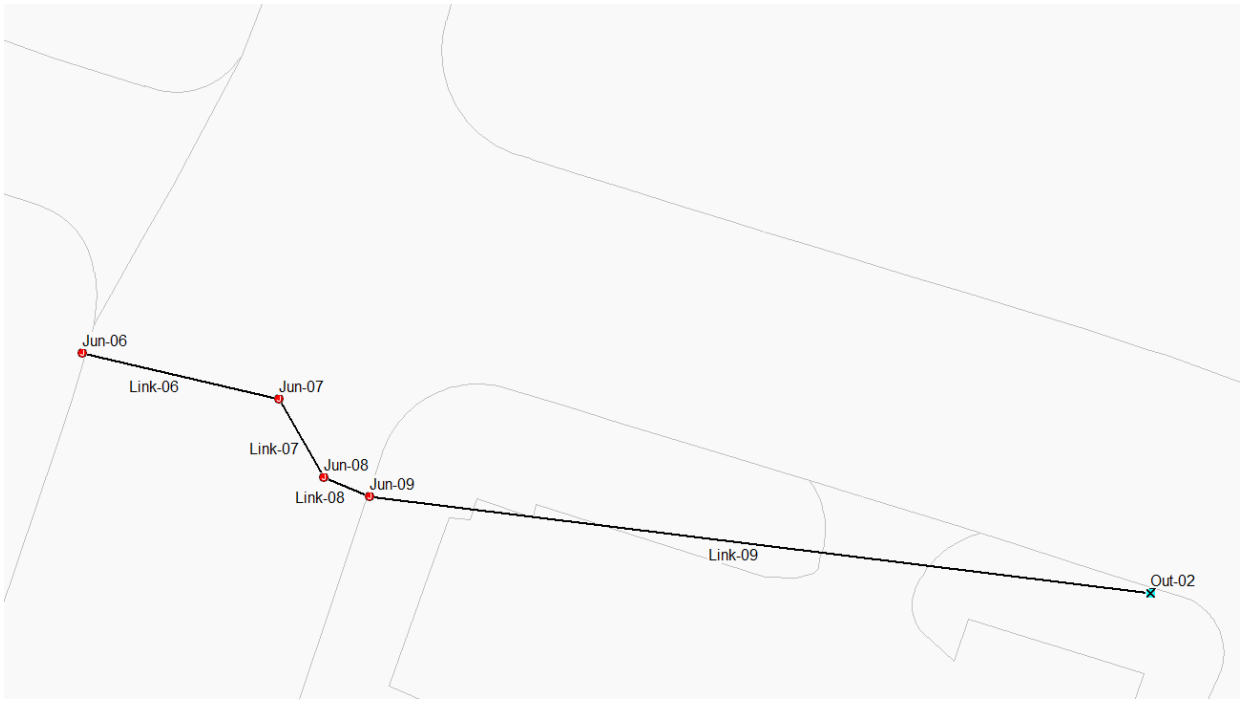


Figure 4. System 15 Existing Conditions Results Schematic

Table 16. Summary of Existing Systems

Drainage System	Do the major drainage structure(s) have capacity to convey the 25-yr event?	Is the 25-year hydraulic grade line six inches or less below the theoretical gutter flow line of the storm drain inlets?	Is the water surface elevation at the bridge or culvert upstream face within the allowable 100-year event overtopping depth of six inches above the crown or any top of upstream curb elevation, whichever is lower?	Is the COA criteria met?
1	no	no	----	no
2	no	no	----	no
3	yes	yes	no	no
4	no	no	----	no
5	no	no	----	no
6	no	no	----	no
7	yes	yes	----	yes
8	no	no	no	no
9	no	no	----	no
10	no	no	----	no
11	no	no	----	no
12	no	no	----	no
13	yes	no	----	no
14	no	no	----	no
15	yes	yes	----	yes

A summary of the hydrology calculations is found in Appendix C. A copy of the existing conditions Autodesk SSA analysis output is found in Appendix D.

Proposed Improvements

The transportation configuration proposed for South Lamar Blvd. will require modification of existing major storm drain systems due to reconfiguring the roadway. Most existing inlets and lateral lines will need to be replaced. Assuming the proposed roadway drains outward toward the right of way lines, the storm drain design includes the upsizing the existing lines as needed and adding trunk lines and laterals to connect to proposed curb inlets.

Table 4. Summary of Existing Major Drainage Structures and Proposed Improvements

Drainage System	Existing Conditions		Proposed Conditions
	Existing Structures	Evaluation Summary	Proposed Improvement
1	18" RCP	Design capacity<peak flow	Replace with 1004 LF of 24" RCP
2	24" RCP, 30" RCP, 36" RCP, 42" RCP	Design capacity<peak flow	Replace with 909 LF of 30" to 48" RCP
3	3'X4' Box Culvert	Design capacity<peak flow	Replace with 55 LF of 3'x6' Box Culvert
4	15" RCP, 24" RCP, 27" RCP, 30" RCP, 2'x2' Box Culvert	Design capacity<peak flow, larger diameter pipe drains to smaller diameter pipe	Replace with 255 LF of 30" RCP
5	18" RCP, 24" RCP, 30" RCP	Design capacity<peak flow	Replace with 909 LF of 24" to 36" RCP
6	2-24" RCP, 1.5'X4' Box Culvert	Design capacity<peak flow	Replace with 943 LF of 30" to 42" RCP & 2.5'x6' Box Culvert
7	18" RCP, 21" RCP, 1.5'X4' Box Culvert	Meets code	---
8	2-4'X4' Box Culverts	Design capacity<peak flow	Add two 4'X4' Box Culverts - 78 LF
9	18" RCP, 24" RCP, 36” RCP	Design capacity<peak flow	Replace with 238 LF of 30” TO 42” RCP
10	15" RCP, 18" RCP, 24" RCP	Design capacity<peak flow	Replace with 217 LF of 18" to 30" RCP
11	36" RCP	Design capacity<peak flow	Replace with 152 LF of 42" RCP
12	18" TO 54" RCP	Design capacity>peak flow but street is inundated by West Bouldin Creek (inside 25- & 100-year flood plain)	Need to reduce West Bouldin Creek flooding - out of project scope
13	54" RCP	Same as 12	See comment for System 12
14	18" TO 36" RCP	Same as 12	See comment for System 12
15	18" RCP	Meets code	---

Discharge calculations for proposed analysis can be found in Appendix E. A map of the location of the storm sewer systems is found in Appendix B, Exhibits 1 & 2.

Detention and Water Quality Treatment Requirements

The COA DCM states that peak flow rates under proposed development must be returned to existing peak flow rates as considered from a point of discharge. Controlling the peak flow rates can be done by either storage on-site or off-site (detention pond) or by participation in an approved Regional Stormwater Management Program (RSMP). To participate in the RSMP a fee is required based on the impervious acres and includes a cost for construction and land. Currently, West Bouldin Creek is not included in the list of watersheds eligible for participation in the RSMP per DCM 8.2.2. If storm water runoff peak flow rates increase within the right of way due to the increase in impervious cover, then detention will be

required. Since raised, landscaped medians will be added where currently pavement exists it is not anticipated that detention will be required for this project.

Water quality treatment is required if the proposed project increases the impervious cover amount. Sidewalks are excluded from impervious cover calculations for the purposes of water quality requirements. It is not anticipated that water quality treatment will be required for this project.

Cost Estimate

Drainage-related items included in the cost estimate are box culverts, pipes, inlets, headwalls, and manholes. The cost of pavement trench repair and non-drainage items such as traffic control and sedimentation/erosion control were assumed to be covered under the roadway cost estimate. Sources of cost were City of Austin bid tabs, and TxDOT bid information.

Several design assumptions were made to determine the cost estimate for the drainage systems. The lateral lines draining from the inlet to the trunk line are assumed as 18" RCP. Lateral pipe sizes for the trunk will increase towards the system's major structure, starting at no more than 300 feet from the system's drainage divide. Inlets were assumed to be spaced 300 feet apart along the trunk line. Lateral pipe lengths were determined based on the location of the inlet with respect to the proposed typical section. The drainage system's trunk line segments were sized based on the number of inlets feeding into each segment. Headwalls were required if replacement or extension of the major structure was required. Storm sewer manholes were added to account for the DCM manhole spacing requirements.

The order of magnitude opinion of probable construction cost is $3.13 million. A breakdown of costs are provided in Table 18.

Table 5. Cost Estimate for Drainage-Related Items

Item	Units	Quantity	Unit Cost	Cost
18" RCP	LF	4260	$75	$319,475
24" RCP	LF	5402	$90	$486,140
30" RCP	LF	4345	$105	$456,187
36" RCP	LF	2772	$120	$332,668
42" RCP	LF	568	$135	$76,645
48" RCP	LF	258	$195	$50,370
2 - 30" RCP	LF	847	$180	$152,383
30"x72" box culvert	LF	96	$300	$28,836
36"x72" box culvert	LF	55	$450	$24,557
48"x48" box culvert	LF	196	$250	$49,000
Headwalls	EA	1	$10,000	$10,000
Inlets	EA	90	$5,300	$477,000
Manholes	EA	10	$4,000	$40,000
			Subtotal	$2,503,260
			25% Contingency	$625,815
			Total Cost	**$3,12,9075**

APPENDIX A

Data Sources

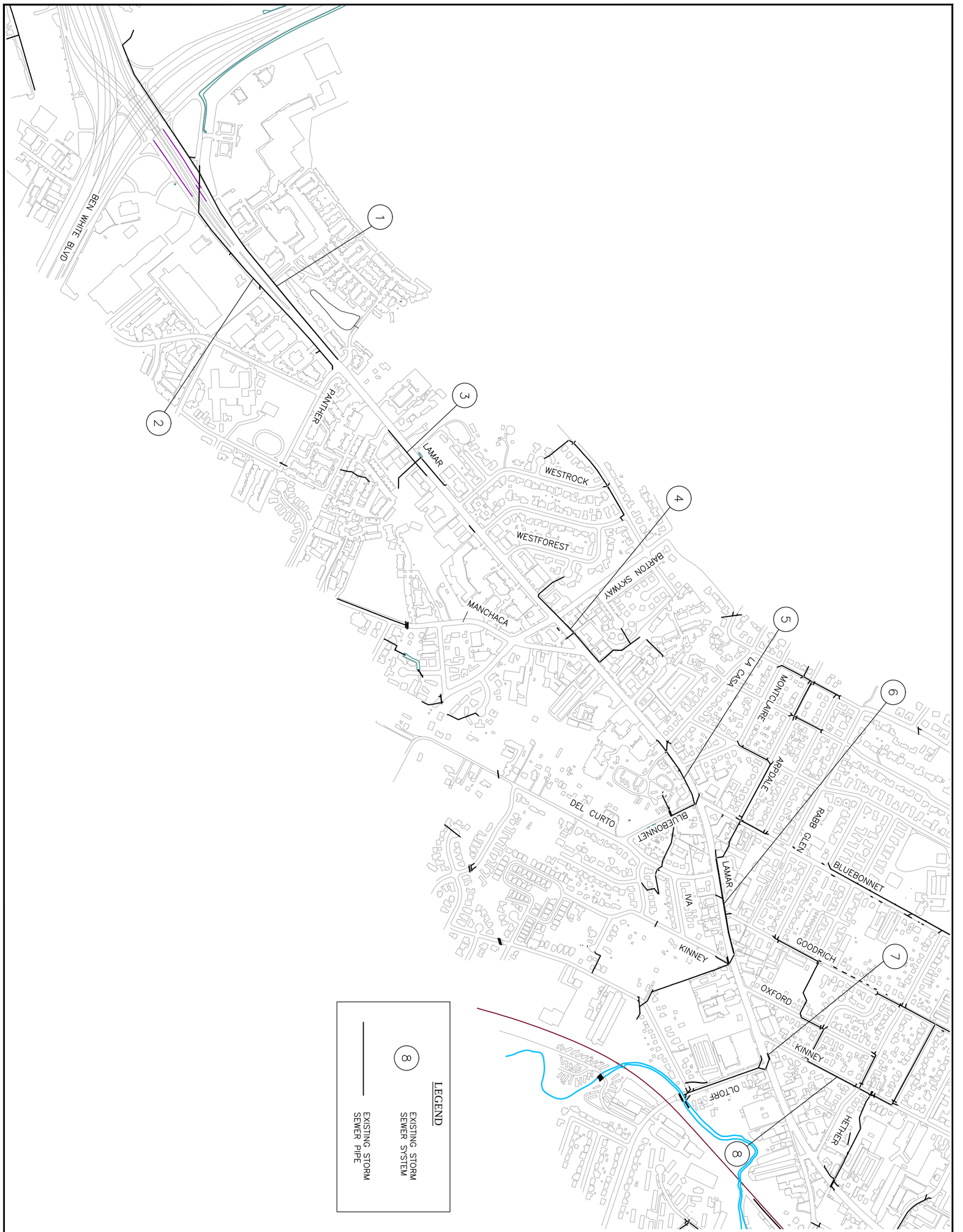
Record Drawings

- SSM-B-2-510 Storm Sewer on South Lamar Blvd. from Kinney Road to Bluebonnet Lane, 1958
- SSM-B-2-549 Storm Sewer on Kinney Road Easement from South Lamar Blvd. to south of Thornton Road, 1959
- SSM-B-2-524 Storm Sewer on Treadwell Street from South Lamar Blvd. east 467 feet, 1959
- SSM-B-2-487 Storm Sewer on South Lamar Blvd. from Barton Skyway 160’ north to 240’ south, 1957
- DRG-5-A-540 Miscellaneous Storm Sewers on Hether Street, Kinney Ave., Bauerle Ave., and Goodrich Ave., 1960
- DRG-5-A-1019 Plan & Profile of 4’x3’ Box Culvert for Jay Johnson Enterprises, prepared by Bury & Pittman, Inc., 1986
- PPC-1-A-5952 Storm Sewer on Collier Street at South Lamar Blvd., 1969
- PPC-1-A-5962 Storm Sewer on South Lamar Blvd. at Westrock Drive, 1969
- PPC-1-A-5969 Storm Sewer on West Oltorf Street at South Lamar Blvd.
- DRG-1-A-6833 Shepherd Tract Drainage and Fill Plans, prepared by O.W. Holmes, 1980
- PPC-1-A-7801 South Lamar Blvd./Barton Springs Road Intersection Improvements, prepared by HDR Engineering, Inc., 1992
- PPC-1-A-7934 TSM Improvements, South Lamar at Oltorf Street, prepared by COA PW, 1990
- SPL-SP-86-009 State Farm Insurance Service Center, prepared by Clayton Rutter Engineers, Inc., 1986
- SPL-SP-2010-0264C Wells Fargo Bank, 3931 S. Lamar, prepared by Prossner and Associates, Inc., 2011

APPENDIX B

Exhibit 1 – Existing Storm Sewer Systems (1 of 2)

Exhibit 2 - Existing Storm Sewer Systems (2 of 2)



CITY OF AUSTIN

THIS EXHIBIT IS RELEASED FOR THE PURPOSES OF INTERIM REVIEW UNDER THE AUTHORITY OF MICHAEL C. MERIWETHER P.E. NO. 58563 April 16, 2015 THIS DOCUMENT IS NOT INTENDED FOR BIDDING, PERMITTING AND/OR CONSTRUCTION PURPOSES

SOUTH LAMAR TRANSPORTATION CORRIDOR STUDY

CAS CONSULTING & SERVICES INC
7908 CAMERON RD
AUSTIN, TEXAS 78754
REG. No. F-003572

EXHIBIT 1
EXISTING STORM SEWER SYSTEMS

SHEET 1 OF 2

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EXHIBIT 2
EXISTING STORM SEWER SYSTEMS

SHEET 2 OF 2

APPENDIX C

Summary of Hydrology Calculations

Table 19. Calculated 25-Year Peak Flow Rates for Sub-basins for Storm Drain Analysis

Drainage System	Basins	Area (ac)	Time of Concentration, tc (min)	25-Year Storm Event			Q/Acre
				Intensity, I (in/hr)	Runoff Coefficient, C	Ultimate Conditions Discharge, Q=CIA (cfs)	
1	1-A	0.80	5.0	10.1	0.86	7.0	8.7
	1-B	1.16	7.8	8.9	0.86	8.9	7.7
2	2-A	6.42	8.7	8.6	0.85	47.0	7.3
	2-B	13.89	10.9	7.9	0.84	92.1	6.6
3	3-A	2.32	5.0	10.1	0.81	19.1	8.2
	3-B	21.07	32.1	4.7	0.78	77.7	3.7
	3-C	1.10	5.0	10.1	0.86	9.6	8.7
4	4-A	0.52	5.0	10.1	0.60	3.2	6.1
	4-B	6.73	17.8	6.4	0.72	31.1	4.6
	4-C	2.15	9.7	8.3	0.81	14.5	6.7
5	5-A	7.73	22.4	5.7	0.81	36.0	4.7
	5-B	6.80	10.2	8.1	0.81	45.0	6.6
	5-C	1.38	14.7	7.0	0.60	5.8	4.2
	5-D	0.83	5.0	10.1	0.81	6.8	8.2
	5-E	3.44	12.5	7.5	0.71	18.3	5.3
6	6-A	1.22	5.0	10.1	0.86	10.6	8.7
	6-B	19.07	16.4	6.7	0.64	81.3	4.3
	6-C	2.34	5.0	10.1	0.86	20.3	8.7
	6-D	5.51	14.5	7.1	0.71	27.4	5.0
	6-E	0.88	5.0	10.1	0.86	7.7	8.7
	6-F	1.54	5.0	10.1	0.84	13.0	8.5
7	7-A	1.56	5.0	10.1	0.85	13.3	8.6
	7-B	1.05	5.0	10.1	0.84	8.9	8.5
15	15-A	0.97	5.0	10.1	0.81	8.0	8.2
	15-B	1.15	5.0	10.1	0.84	9.7	8.5

Table 20. Calculated 100-Year Peak Flow Rates for Sub-basins for Storm Drain Analysis

Drainage System	Basins	Area (ac)	Time of Concentration, tc (min)	100-Year Storm Event			Q/Acre
				Intensity, I (in/hr)	Runoff Coefficient, C	Ultimate Conditions Discharge, Q=CIA (cfs)	
1	1-A	0.80	5.0	12.5	0.95	9.5	11.9
	1-B	1.16	7.8	11.2	0.95	12.4	10.7
2	2-A	6.42	8.7	10.9	0.94	65.6	10.2
	2-B	13.89	10.9	10.1	0.93	129.7	9.3
3	3-A	2.32	5.0	12.5	0.90	26.2	11.3
	3-B	21.07	32.1	6.2	0.88	114.5	5.4
	3-C	1.10	5.0	12.5	0.95	13.1	11.9
4	4-A	0.52	5.0	12.5	0.68	4.4	8.5
	4-B	6.73	17.8	8.3	0.82	45.9	6.8
	4-C	2.15	9.7	10.5	0.90	20.3	9.4
5	5-A	7.73	22.4	7.5	0.90	51.9	6.7
	5-B	6.80	10.2	10.3	0.90	63.3	9.3
	5-C	1.38	14.7	9.0	0.68	8.5	6.1
	5-D	0.83	5.0	12.5	0.90	9.4	11.3
	5-E	3.44	12.5	9.6	0.81	26.7	7.8
6	6-A	1.22	5.0	12.5	0.95	14.5	11.9
	6-B	19.07	16.4	8.6	0.73	119.9	6.3
	6-C	2.34	5.0	12.5	0.95	27.9	11.9
	6-D	5.51	14.5	9.1	0.81	40.2	7.3
	6-E	0.88	5.0	12.5	0.95	10.5	11.9
	6-F	1.54	5.0	12.5	0.93	17.9	11.6
7	7-A	1.56	5.0	12.5	0.94	18.3	11.7
	7-B	1.05	5.0	12.5	0.93	12.3	11.7

Table 21. Time of Concentration

Time of Concentration		1-A	1-B	2-A	2-B	3-A	3-B	3-C
Sheet Flow								
Manning's Roughness	n	0.02	0.02	0.02	0.02	0.02	0.3	0.02
Sheet Flow Distance (ft)	L	56	40	100	100	0	100	36
Land Slope (ft/ft)	S	0.007	0.010	0.008	0.005	0.008	0.007	0.007
Travel Time (min)	T	1.80	1.20	2.72	3.28	0.00	25.04	1.27
Shallow Concentrated Flow								
Length (ft)	L	0	309	391	547	0	94	0
Slope	S	0.007	0.013	0.012	0.012	0.010	0.010	0.010
n-r factor	n	20.33	20.33	20.33	20.33	20.33	20.33	20.33
Time (min)	T	0.0	2.2	2.9	4.1	0.0	0.8	0.0
Channel Flow								
Length (ft)	L	533	1059	730	851	800	1498	761
Velocity (fps)	V	4	4	4	4	4	4	4
Time (min)	T	2.2	4.4	3.0	3.5	3.3	6.2	3.2
Total Travel Time (min)	Tc	5.0	7.8	8.7	10.9	5.0	32.1	5.0

Time of Concentration		4-A	4-B	4-C	5-A	5-B	5-C	5-D	5-E
Sheet Flow									
Manning's Roughness	n	0.02	0.3	0.3	0.3	0.3	0.3	0.02	0.3
Sheet Flow Distance (ft)	L	0	100	62	100	34	93	56	100
Land Slope (ft/ft)	S	1.000	0.030	0.048	0.020	0.040	0.032	0.048	0.060
Travel Time (min)	T	0.00	13.99	7.91	16.45	5.26	12.86	0.84	10.60
Shallow Concentrated Flow									
Length (ft)	L	100	240	242	52		100		190
Slope	S	0.020	0.038	0.025	0.040	0.010	0.060	0.010	0.050
n-r factor	n	20.33	20.33	20.33	20.33	20.33	20.33	20.33	20.33
Time (min)	T	0.6	1.0	1.3	0.2	0.0	0.3	0.0	0.7
Channel Flow									
Length (ft)	L	0	665	138	1388	1185	361	390	422
Velocity (fps)	V	4	4	4	4	4	4	4	6
Time (min)	T	0.0	2.8	0.6	5.8	4.9	1.5	1.6	1.2
Total Travel Time (min)	Tc	5.0	17.8	9.7	22.4	10.2	14.7	5.0	12.5

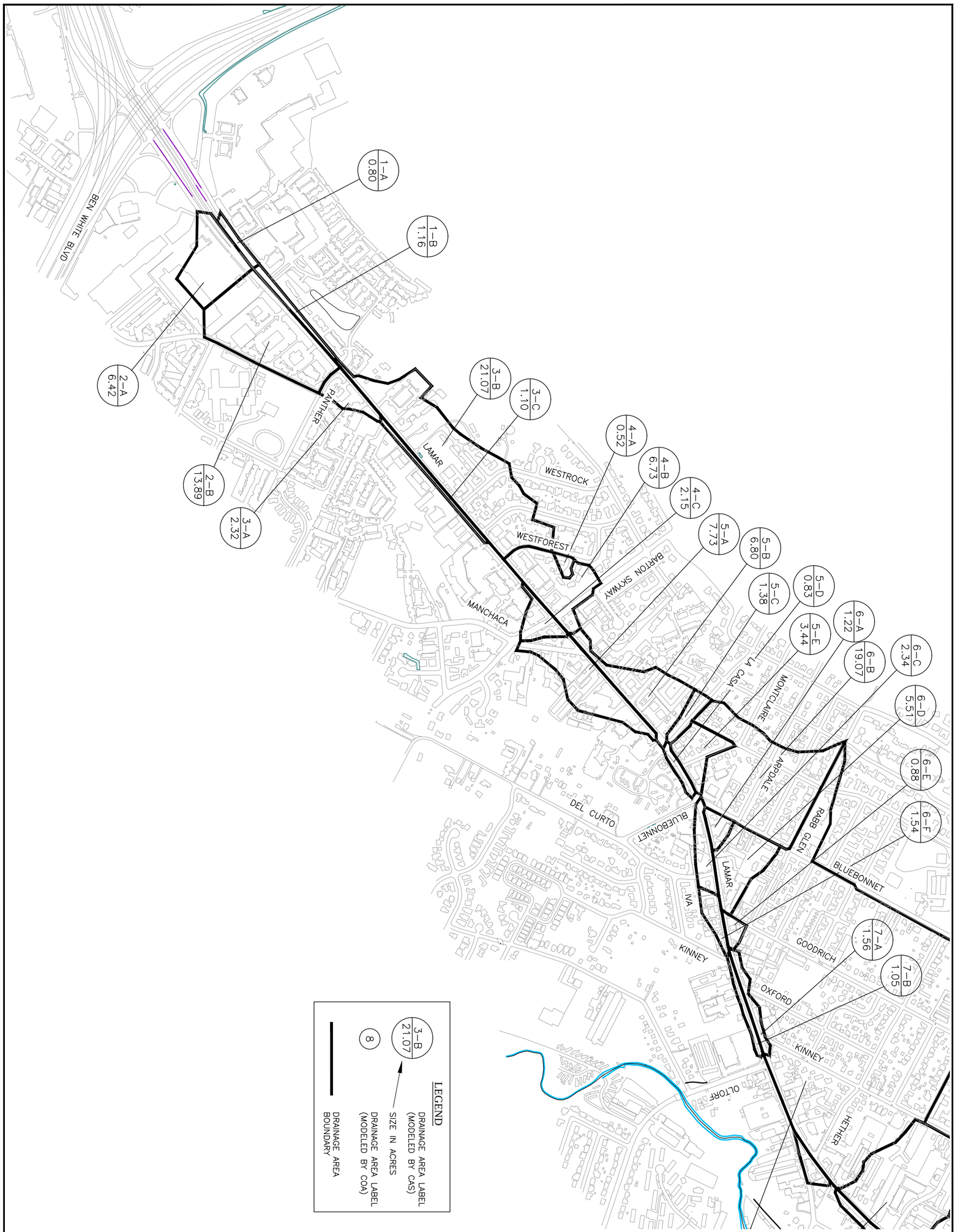
Time of Concentration		6-A	6-B	6-C	6-D	6-E	6-F	7-A	7-B	15-A	15-B
Sheet Flow											
Manning's Roughness	n	0.3	0.3	0.3	0.3	0.3	0.3	0.02	0.02	0.02	0.02
Sheet Flow Distance (ft)	L	0	100	0	100	10	10	50	50	50	50
Land Slope (ft/ft)	S	0.050	0.050	0.050	0.050	0.050	0.050	0.048	0.048	0.048	0.048
Travel Time (min)	T	0.00	11.40	0.00	11.40	1.81	1.81	0.76	0.76	0.76	0.76
Shallow Concentrated Flow											
Length (ft)	L	0	68	0	323						
Slope	S	0.059	0.059	0.059	0.056	0.010	0.010	0.010	0.010	0.010	0.010
n-r factor	n	16.13	16.13	16.13	16.13	20.33	20.33	20.33	20.33	20.33	20.33
Time (min)	T	0.0	0.3	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0
Channel Flow											
Length (ft)	L	0	1688	0	399	935	925	100	100	100	100
Velocity (fps)	V	6	6	6	4	6	6	4	4	4	4
Time (min)	T	0.0	4.7	0.0	1.7	2.6	2.6	0.4	0.4	0.4	0.4
Total Travel Time (min)	Tc	5.0	16.4	5.0	14.5	5.0	5.0	5.0	5.0	5.0	5.0

APPENDIX D

Exhibit 3 –Drainage Area Map (1 of 2)

Exhibit 4 –Drainage Area Map (2 of 2)

Existing Conditions Autodesk Storm and Sewer Analysis Output



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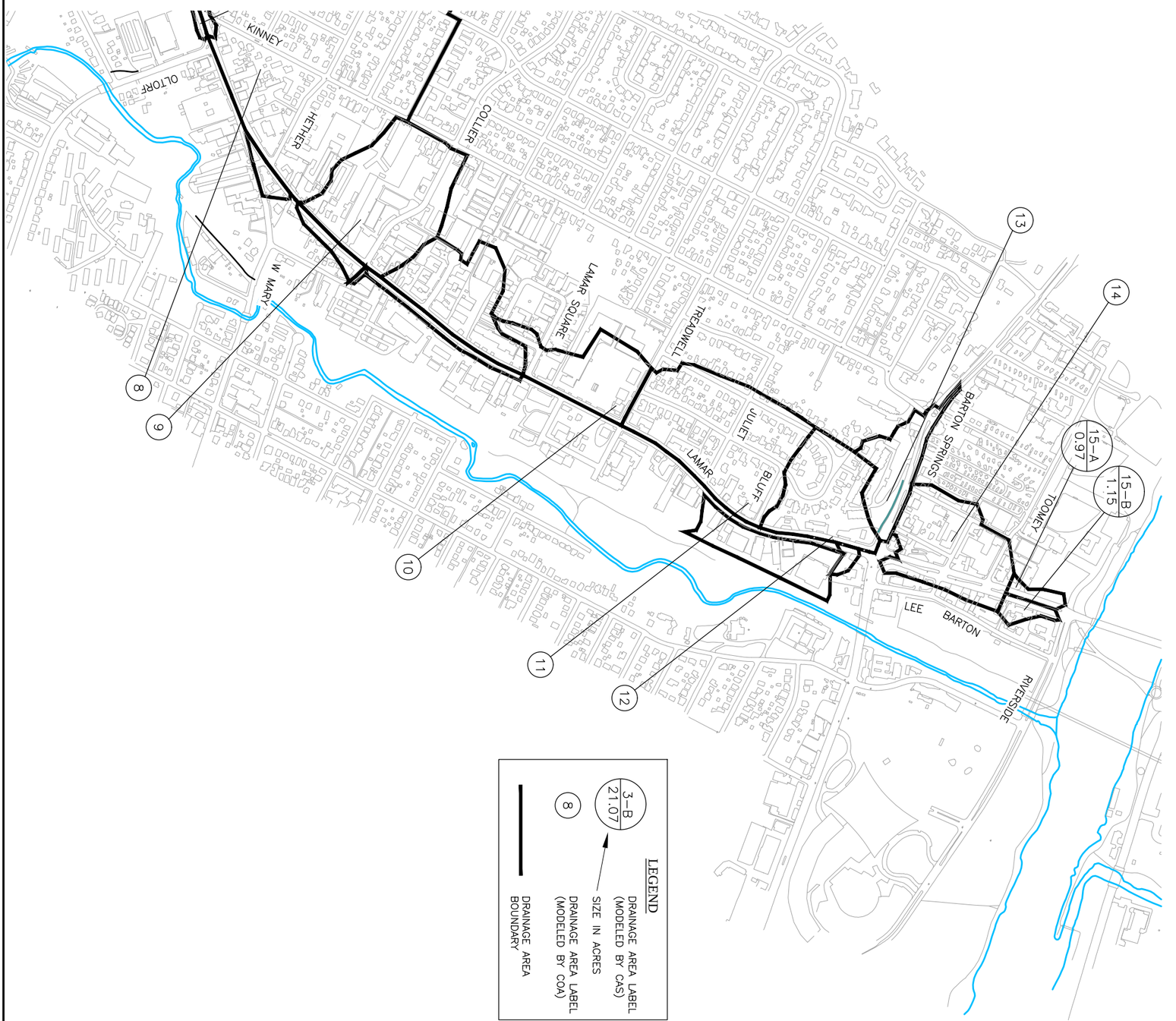
SOUTH LAMAR TRANSPORTATION CORRIDOR STUDY

CAS CONSULTING & SERVICES INC
7908 CAMERON RD
AUSTIN, TEXAS 78754
REG. No. F-003572

EXHIBIT 3
DRAINAGE AREA MAP

SHEET 1 OF 2



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AUSTIN, TEXAS 78754
REG. No. F-003572

EXHIBIT 4
DRAINAGE AREA MAP

SHEET 2 OF 2

Project Description

File Name ..... System 1.SPF
Description .....
S. Lamar Corridor System 1

Lamar from Panther to US 290 - west side

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Jun-01	Junction	694.00	697.00	0.00	0.00	0.00	2.69	694.68	0.00	2.32	0 00:00	0.00	0.00
2	Jun-02	Junction	693.00	701.00	0.00	0.00	0.00	5.13	694.02	0.00	6.98	0 00:00	0.00	0.00
3	Jun-03	Junction	692.10	702.50	0.00	0.00	0.00	8.02	702.50	0.00	0.00	0 00:28	37.30	1439.00
4	Jun-04	Junction	691.00	702.10	0.00	0.00	0.00	7.81	702.10	0.00	0.00	0 00:04	12.73	1438.00
5	Jun-05	Junction	690.00	702.40	0.00	0.00	0.00	8.92	702.40	0.00	0.00	0 00:35	15.90	1437.00
6	Out-01	Outfall	688.00					13.85	689.31					

Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)	Minimum Pipe Cover (in)
1	Jun-01	694.00	697.00	3.00	0.00	-694.00	0.00	-697.00	0.00	0.00
2	Jun-02	693.00	701.00	8.00	0.00	-693.00	0.00	-701.00	0.00	0.00
3	Jun-03	692.10	702.50	10.40	0.00	-692.10	0.00	-702.50	0.00	0.00
4	Jun-04	691.00	702.10	11.10	0.00	-691.00	0.00	-702.10	0.00	0.00
5	Jun-05	690.00	702.40	12.40	0.00	-690.00	0.00	-702.40	0.00	0.00

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Jun-01	2.69	2.69	694.68	0.68	0.00	2.32	694.68	0.68	0 00:00	0 00:00	0.00	0.00
2	Jun-02	5.13	2.44	694.02	1.02	0.00	6.98	694.02	1.02	0 00:26	0 00:00	0.00	0.00
3	Jun-03	8.02	2.89	702.50	10.40	0.00	0.00	702.49	10.39	0 00:02	0 00:28	37.30	1439.00
4	Jun-04	7.81	0.88	702.10	11.10	0.00	0.00	702.08	11.08	0 00:03	0 00:04	12.73	1438.00
5	Jun-05	8.92	1.80	702.40	12.40	0.00	0.00	702.37	12.37	0 00:04	0 00:35	15.90	1437.00

Pipe Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness	Initial Flow (cfs)	No. of Barrels
1	Link-01	323.89	694.00	0.00	693.00	0.00	1.00	0.3100	CIRCULAR	18.000	18.000	0.0120	0.00	1
2	Link-02	290.06	693.00	0.00	692.10	0.00	0.90	0.3100	CIRCULAR	18.000	18.000	0.0120	0.00	1
3	Link-03	342.39	692.10	0.00	691.00	0.00	1.10	0.3200	CIRCULAR	18.000	18.000	0.0120	0.00	1
4	Link-04	280.50	691.00	0.00	690.00	0.00	1.00	0.3600	CIRCULAR	18.000	18.000	0.0120	0.00	1
5	Link-05	380.89	690.00	0.00	688.00	0.00	2.00	0.5300	CIRCULAR	18.000	18.000	0.0120	0.00	1

Pipe Results

SN	Element ID	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Reported Condition
1	Link-01	2.69	6.32	0.43	3.43	0.68	0.46	Calculated
2	Link-02	5.13	6.34	0.81	3.99	1.02	0.68	Calculated
3	Link-03	6.93	6.45	1.07	3.99	1.50	1.00	SURCHARGED
4	Link-04	7.12	6.79	1.05	4.14	1.40	0.93	> CAPACITY
5	Link-05	8.65	8.25	1.05	5.03	1.40	0.94	> CAPACITY

Project Description

File Name ..... System 2.SPF
Description .....
S. Lamar Corridor Study

System 2 from Panther Lane to US 290

Rainfall Details

Return Period..... 25 year(s)

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Volume Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded (ac-in)	Total Time Flooded (min)
1	Jun-01	Junction	692.50	697.50	0.00	0.00	0.00	10.00	693.66	0.00	3.84	0 00:00	0.00	0.00
2	Jun-02	Junction	692.30	697.50	0.00	0.00	0.00	19.40	697.50	0.00	0.00	0 00:01	101.40	1441.00
3	Jun-03	Junction	691.35	699.00	0.00	0.00	0.00	31.74	699.00	0.00	0.00	0 00:01	145.19	1440.00
4	Jun-04	Junction	690.10	701.00	0.00	0.00	0.00	43.84	701.00	0.00	0.00	0 00:02	66.12	1440.00
5	Jun-05	Junction	688.60	702.50	0.00	0.00	0.00	60.53	691.68	0.00	10.82	0 00:00	0.00	0.00
6	Jun-06	Junction	687.30	703.00	0.00	0.00	0.00	81.03	690.66	0.00	12.34	0 00:00	0.00	0.00
7	Jun-07	Junction	685.30	702.50	0.00	0.00	0.00	101.03	688.26	0.00	14.24	0 00:00	0.00	0.00
8	Jun-08	Outfall	683.00					136.23	685.96					

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Link-01	Pipe	Jun-01	Jun-02	48.40	692.50	692.30	0.4100	24.000	0.0120	11.40	15.75	0.72	5.74	1.16	0.60	0.00	Calculated
2	Link-02	Pipe	Jun-02	Jun-03	143.18	692.30	691.85	0.3100	24.000	0.0120	13.74	13.74	1.00	4.37	2.00	1.00	1440.00	SURCHARGED
3	Link-03	Pipe	Jun-03	Jun-04	195.25	691.35	690.70	0.3300	30.000	0.0120	25.84	25.64	1.01	5.27	2.50	1.00	1439.00	SURCHARGED
4	Link-04	Pipe	Jun-04	Jun-05	312.74	690.10	689.10	0.3200	36.000	0.0120	42.53	40.86	1.04	6.21	2.79	0.93	0.00	> CAPACITY
5	Link-05	Pipe	Jun-05	Jun-06	258.31	688.60	687.80	0.3100	42.000	0.0120	60.53	60.66	1.00	7.19	2.86	0.82	0.00	Calculated
6	Link-06	Pipe	Jun-06	Jun-07	377.89	687.30	685.30	0.5300	48.000	0.0120	81.03	113.21	0.72	9.79	2.50	0.63	0.00	Calculated
7	Link-07	Pipe	Jun-07	Jun-08	439.01	685.30	683.00	0.5200	48.000	0.0120	101.03	112.64	0.90	10.13	2.96	0.74	0.00	Calculated

Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)	Minimum Pipe Cover (in)
1	Jun-01	692.50	697.50	5.00	0.00	-692.50	0.00	-697.50	0.00	36.00
2	Jun-02	692.30	697.50	5.20	0.00	-692.30	0.00	-697.50	0.00	38.40
3	Jun-03	691.35	699.00	7.65	0.00	-691.35	0.00	-699.00	0.00	61.80
4	Jun-04	690.10	701.00	10.90	0.00	-690.10	0.00	-701.00	0.00	93.60
5	Jun-05	688.60	702.50	13.90	0.00	-688.60	0.00	-702.50	0.00	124.80
6	Jun-06	687.30	703.00	15.70	0.00	-687.30	0.00	-703.00	0.00	140.40
7	Jun-07	685.30	702.50	17.20	0.00	-685.30	0.00	-702.50	0.00	158.40

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Volume Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded (ac-in)	Total Time Flooded (min)
1	Jun-01	10.00	10.00	693.66	1.16	0.00	3.84	693.66	1.16	0 00:00	0 00:00	0.00	0.00
2	Jun-02	19.40	8.00	697.50	5.20	0.00	0.00	697.50	5.20	0 00:00	0 00:01	101.40	1441.00
3	Jun-03	31.74	18.00	699.00	7.65	0.00	0.00	699.00	7.65	0 00:01	0 00:01	145.19	1440.00
4	Jun-04	43.84	18.00	701.00	10.90	0.00	0.00	700.99	10.89	0 00:01	0 00:02	66.12	1440.00
5	Jun-05	60.53	18.00	691.68	3.08	0.00	10.82	691.68	3.08	0 00:21	0 00:00	0.00	0.00
6	Jun-06	81.03	20.50	690.66	3.36	0.00	12.34	690.66	3.36	0 00:21	0 00:00	0.00	0.00
7	Jun-07	101.03	20.00	688.26	2.96	0.00	14.24	688.26	2.96	0 00:21	0 00:00	0.00	0.00

Pipe Input

SN	Element	Length	Inlet	Inlet	Outlet	Outlet	Total	Average	Pipe		Pipe	Pipe	Manning's	Entrance	Exit/Bend	Additional	Initial			
	Flap		No. of Elevation	ID Offset	Invert Elevation	Invert Offset		Invert	Invert	Drop	Slope	Shape Height	Diameter or	Width	Roughness	Losses	Losses		Losses	Flow Gate	Barre
		(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(%)				(in)	(in)					(cfs)			
1	Link-01	48.40	692.50	0.00	692.30	0.00	0.20	0.4100	CIRCULAR			24.000	24.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
2	Link-02	143.18	692.30	0.00	691.85	0.50	0.45	0.3100	CIRCULAR			24.000	24.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
3	Link-03	195.25	691.35	0.00	690.70	0.60	0.65	0.3300	CIRCULAR			30.000	30.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
4	Link-04	312.74	690.10	0.00	689.10	0.50	1.00	0.3200	CIRCULAR			36.000	36.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
5	Link-05	258.31	688.60	0.00	687.80	0.50	0.80	0.3100	CIRCULAR			42.000	42.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
6	Link-06	377.89	687.30	0.00	685.30	0.00	2.00	0.5300	CIRCULAR			48.000	48.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
7	Link-07	439.01	685.30	0.00	683.00	0.00	2.30	0.5200	CIRCULAR			48.000	48.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1

Pipe Results

SN	Element ID	Peak Flow	Time of Peak Flow Occurrence	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Travel Time	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Froude Number	Reported Condition
		(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)		(min)		
1	Link-01	11.40	0 00:01	15.75	0.72	5.74	0.14	1.16	0.60	0.00		Calculated
2	Link-02	13.74	0 00:01	13.74	1.00	4.37	0.55	2.00	1.00	1440.00		SURCHARGED
3	Link-03	25.84	0 00:01	25.64	1.01	5.27	0.62	2.50	1.00	1439.00		SURCHARGED
4	Link-04	42.53	0 00:21	40.86	1.04	6.21	0.84	2.79	0.93	0.00		> CAPACITY
5	Link-05	60.53	0 00:21	60.66	1.00	7.19	0.60	2.86	0.82	0.00		Calculated
6	Link-06	81.03	0 00:21	113.21	0.72	9.79	0.64	2.50	0.63	0.00		Calculated
7	Link-07	101.03	0 00:22	112.64	0.90	10.13	0.72	2.96	0.74	0.00		Calculated

Project Description

File Name ..... System 3.SPF
Description .....
S. Lamar from Panther Trail to Westforest

Rainfall Details

Return Period..... 25 year(s)

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Jun-01	Junction	677.70	681.50	0.00	0.00	0.00	77.50	680.08	0.00	1.42	0 00:00	0.00	0.00
2	Jun-02	Junction	677.49	681.50	0.00	0.00	0.00	113.76	680.48	0.00	1.02	0 00:00	0.00	0.00
3	Jun-03	Junction	672.18	677.00	0.00	0.00	0.00	113.34	673.74	0.00	3.26	0 00:00	0.00	0.00
4	Jun-04	Outfall	669.92					113.86	671.49					

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Link-01	Pipe	Jun-01	Jun-02	54.57	677.70	677.49	0.3800	36.000	0.0120	85.16	83.18	1.02	8.14	2.38	0.90	0.00	> CAPACITY
2	Link-02	Pipe	Jun-02	Jun-03	208.30	677.49	672.18	2.5500	36.000	0.0120	113.34	214.09	0.53	18.10	1.49	0.52	0.00	Calculated
3	Link-03	Pipe	Jun-03	Jun-04	88.68	672.18	669.92	2.5500	36.000	0.0120	113.86	214.06	0.53	18.45	1.49	0.51	0.00	Calculated

Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)	Minimum Pipe Cover (in)
1	Jun-01	677.70	681.50	3.80	0.00	-677.70	0.00	-681.50	0.00	9.60
2	Jun-02	677.49	681.50	4.01	0.00	-677.49	0.00	-681.50	0.00	12.12
3	Jun-03	672.18	677.00	4.82	0.00	-672.18	0.00	-677.00	0.00	21.84

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Jun-01	77.50	77.50	680.08	2.38	0.00	1.42	680.08	2.38	0 00:00	0 00:00	0.00	0.00
2	Jun-02	113.76	28.60	680.48	2.99	0.00	1.02	679.87	2.38	0 00:01	0 00:00	0.00	0.00
3	Jun-03	113.34	0.00	673.74	1.56	0.00	3.26	673.67	1.49	0 00:01	0 00:00	0.00	0.00

Pipe Input

SN	Element	Length (ft)	Inlet Flap	Inlet No. of Elevation (ft)	Inlet ID Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop	Average Pipe Slope (%)	Invert Shape	Pipe Height (in)	Pipe Diameter or Width (in)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses (cfs)	Initial	Barrels
1	Link-01	54.57	677.70	0.00	677.49	0.00	0.21	0.3800	Rectangular	36.000	48.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
2	Link-02	208.30	677.49	0.00	672.18	0.00	5.31	2.5500	Rectangular	36.000	48.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
3	Link-03	88.68	672.18	0.00	669.92	0.00	2.26	2.5500	Rectangular	36.000	48.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Link-01	85.16	0 00:01	83.18	1.02	8.14	0.11	2.38	0.90	0.00		> CAPACITY
2	Link-02	113.34	0 00:01	214.09	0.53	18.10	0.19	1.49	0.52	0.00		Calculated
3	Link-03	113.86	0 00:01	214.06	0.53	18.45	0.08	1.49	0.51	0.00		Calculated

Project Description

File Name ..... System 4.SPF
Description .....
S. Lamar from Westforest to Barton Skyway

Rainfall Details

Return Period..... 2 year(s)

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Jun-01	Junction	659.70	665.50	0.00	0.00	0.00	48.70	665.50	0.00	0.00	0 00:21	356.77	1441.00
2	Jun-02	Junction	660.00	665.00	0.00	0.00	0.00	14.40	661.30	0.00	3.70	0 00:00	0.00	0.00
3	Jun-03	Junction	658.30	664.00	0.00	0.00	0.00	33.71	664.00	0.00	0.00	0 00:01	175.36	1440.00
4	Jun-04	Junction	657.72	663.00	0.00	0.00	0.00	26.34	659.97	0.00	3.03	0 00:00	0.00	0.00
5	Jun-05	Junction	654.00	661.00	0.00	0.00	0.00	26.64	661.00	0.00	0.00	0 00:00	0.00	0.00
6	Jun-06	Junction	665.00	668.00	0.00	0.00	0.00	3.20	665.56	0.00	2.44	0 00:00	0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Design Flow (cfs)	Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Link-01	Pipe	Jun-06	Jun-01	436.67	665.00	659.70	1.2100	15.000	0.0120	3.20	7.71	0.42	5.99	0.56	0.45	0.00	Calculated
2	Link-02	Pipe	Jun-01	Jun-03	243.28	659.70	658.30	0.5800	30.000	0.0120	33.71	33.71	1.00	6.87	2.50	1.00	1440.00	SURCHARGED
3	Link-03	Pipe	Jun-03	Jun-04	94.11	658.30	657.72	0.6200	27.000	0.0120	26.34	26.34	1.00	6.62	2.25	1.00	1440.00	SURCHARGED
4	Link-04	Pipe	Jun-04	Jun-05	160.96	657.72	654.00	2.3100	24.000	0.0120	26.64	37.26	0.72	12.94	1.24	0.62	0.00	Calculated
5	Link-05	Pipe	Jun-02	Jun-01	70.09	660.00	659.70	0.4300	24.000	0.0120	16.24	20.41	0.80	5.95	1.30	0.68	0.00	Calculated

Junction Input

SN	Element	Invert Elevation (ft)	Ground/Rim (Max) (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Surcharge Depth (ft)	Surcharge Depth (ft)	Ponded Area (ft²)	Minimum Pipe Cover (in)	ID
1	Jun-01	659.70	665.50	5.80	0.00	-659.70	0.00	-665.50	0.00	39.60		
2	Jun-02	660.00	665.00	5.00	0.00	-660.00	0.00	-665.00	0.00	36.00		
3	Jun-03	658.30	664.00	5.70	0.00	-658.30	0.00	-664.00	0.00	38.40		
4	Jun-04	657.72	663.00	5.28	0.00	-657.72	0.00	-663.00	0.00	36.36		
5	Jun-05	654.00	661.00	7.00	0.00	-654.00	0.00	-661.00	0.00	60.00		
6	Jun-06	665.00	668.00	3.00	0.00	-665.00	0.00	-668.00	0.00	21.00		

Junction Results

SN	Element	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded Attained (min)	ID
1	Jun-01	48.70	31.10	665.50	5.80	0.00	0.00	665.50	5.80	0 00:00	0 00:21	356.77	1441.00	
2	Jun-02	14.40	14.40	661.30	1.30	0.00	3.70	661.30	1.30	0 00:00	0 00:00	0.00	0.00	
3	Jun-03	33.71	0.00	664.00	5.70	0.00	0.00	664.00	5.70	0 00:01	0 00:01	175.36	1440.00	
4	Jun-04	26.34	0.00	659.97	2.25	0.00	3.03	659.97	2.25	0 00:01	0 00:00	0.00	0.00	
5	Jun-05	26.64	0.00	661.00	7.00	0.00	0.00	661.00	7.00	0 00:00	0 00:00	0.00	0.00	
6	Jun-06	3.20	3.20	665.56	0.56	0.00	2.44	665.56	0.56	0 00:00	0 00:00	0.00	0.00	

Pipe Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate	No. of Barrels
1	Link-01	436.67	665.00	0.00	659.70	0.00	5.30	1.2100	CIRCULAR	15.000	15.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
2	Link-02	243.28	659.70	0.00	658.30	0.00	1.40	0.5800	CIRCULAR	30.000	30.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
3	Link-03	94.11	658.30	0.00	657.72	0.00	0.58	0.6200	CIRCULAR	27.000	27.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
4	Link-04	160.96	657.72	0.00	654.00	0.00	3.72	2.3100	CIRCULAR	24.000	24.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
5	Link-05	70.09	660.00	0.00	659.70	0.00	0.30	0.4300	Rectangular	24.000	24.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Link-01	3.20	0 00:21	7.71	0.42	5.99	1.21	0.56	0.45	0.00		Calculated
2	Link-02	33.71	0 00:01	33.71	1.00	6.87	0.59	2.50	1.00	1440.00		SURCHARGED
3	Link-03	26.34	0 00:01	26.34	1.00	6.62	0.24	2.25	1.00	1440.00		SURCHARGED
4	Link-04	26.64	0 00:01	37.26	0.72	12.94	0.21	1.24	0.62	0.00		Calculated
5	Link-05	16.24	0 00:01	20.41	0.80	5.95	0.20	1.30	0.68	0.00		Calculated

Project Description

File Name ..... System 5.SPF
Description .....
S. Lamar from La Casa to Bluebonnet System 5

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Jun-01	Junction	643.00	647.00	0.00	0.00	0.00	36.00	647.00	0.00	0.00	0 00:01	307.26	1441.00
2	Jun-02	Junction	639.69	643.50	0.00	0.00	0.00	68.09	643.50	0.00	0.00	0 00:01	1072.34	1441.00
3	Jun-03	Junction	637.36	642.00	0.00	0.00	0.00	29.68	639.57	0.00	2.43	0 00:00	0.00	0.00
4	Jun-04	Junction	628.40	634.00	0.00	0.00	0.00	34.37	629.62	0.00	4.38	0 00:00	0.00	0.00
5	Jun-05	Junction	617.51	626.00	0.00	0.00	0.00	38.03	622.15	0.00	3.85	0 00:00	0.00	0.00
6	Jun-06	Junction	614.72	619.00	0.00	0.00	0.00	55.43	616.11	0.00	2.89	0 00:00	0.00	0.00
7	Jun-07	Junction	619.00	625.00	0.00	0.00	0.00	18.30	619.38	0.00	5.62	0 00:00	0.00	0.00
8	Jun-08	Junction	640.00	647.00	0.00	0.00	0.00	5.80	640.22	0.00	6.78	0 00:00	0.00	0.00
9	Out-01	Outfall	609.88					56.75	611.29					

Junction Input

SN	Element	Invert (Max) (ft)	Ground/Rim (Max) (ft)	Ground/Rim Water (ft)	Initial Water Elevation (ft)	Initial Offset (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)	Minimum Pipe (ft)	ID	Elevation Cover (in)
1	Jun-01	643.00	647.00	4.00	0.00	-643.00	0.00	-647.00	0.00	30.00		
2	Jun-02	639.69	643.50	3.81	0.00	-639.69	0.00	-643.50	0.00	27.72		
3	Jun-03	637.36	642.00	4.64	0.00	-637.36	0.00	-642.00	0.00	29.16		
4	Jun-04	628.40	634.00	5.60	0.00	-628.40	0.00	-634.00	0.00	43.20		
5	Jun-05	617.51	626.00	8.49	0.00	-617.51	0.00	-626.00	0.00	36.96		
6	Jun-06	614.72	619.00	4.28	0.00	-614.72	0.00	-619.00	0.00	21.36		
7	Jun-07	619.00	625.00	6.00	0.00	-619.00	0.00	-625.00	0.00	54.00		
8	Jun-08	640.00	647.00	7.00	0.00	-640.00	0.00	-647.00	0.00	66.00		

Junction Results

SN	Element	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded Attained (min)	ID
36.00	36.00		647.00	4.00	0.00	0.00	647.00	4.00	0	00:00	0 00:01	307.26		1441.00	1 Jun-01
2	Jun-02	68.09	45.00	643.50	3.81	0.00	0.00	643.50	3.81	0	00:00	0 00:01	1072.34	1441.00	
3	Jun-03	29.68	0.00	639.57	2.21	0.00	2.43	639.57	2.21	0	00:00	0 00:00	0.00	0.00	
4	Jun-04	34.37	3.40	629.62	1.22	0.00	4.38	629.57	1.17	0	00:01	0 00:00	0.00	0.00	
5	Jun-05	38.03	3.40	622.15	4.64	0.00	3.85	622.09	4.58	0	00:01	0 00:00	0.00	0.00	
6	Jun-06	55.43	0.00	616.11	1.39	0.00	2.89	616.09	1.37	0	00:01	0 00:00	0.00	0.00	
7	Jun-07	18.30	18.30	619.38	0.38	0.00	5.62	619.38	0.38	0	00:00	0 00:00	0.00	0.00	
8	Jun-08	5.80	5.80	640.22	0.22	0.00	6.78	640.22	0.22	0	00:00	0 00:00	0.00	0.00	

Pipe Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Pipe Slope (%)	Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate	No. of Barrels
1	Link-01	80.38	643.00	0.00	639.69	0.00	3.31	4.1200	CIRCULAR	18.000	18.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
2	Link-02	39.50	639.69	0.00	638.07	0.71	1.62	4.1000	CIRCULAR	18.000	18.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
3	Link-03	217.80	637.36	0.00	628.40	0.00	8.96	4.1100	CIRCULAR	24.000	24.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
4	Link-04	182.16	628.40	0.00	620.92	3.41	7.48	4.1100	CIRCULAR	24.000	24.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
5	Link-05	53.59	617.51	0.00	614.72	0.00	2.79	5.2100	CIRCULAR	30.000	30.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
6	Link-06	109.98	614.72	0.00	609.88	0.00	4.84	4.4000	CIRCULAR	30.000	30.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
7	Link-07	100.33	619.00	0.00	614.72	0.00	4.28	4.2700	Rectangular	18.000	48.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
8	Link-08	100.31	640.00	0.00	637.36	0.00	2.64	2.6300	Rectangular	18.000	48.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Link-01	23.09	0 00:00	23.09	1.00	13.07	0.10	1.50	1.00	1441.00		SURCHARGED
2	Link-02	23.05	0 00:00	23.05	1.00	13.04	0.05	1.50	1.00	1441.00		SURCHARGED
3	Link-03	30.97	0 00:01	49.71	0.62	16.95	0.21	1.09	0.56	0.00		Calculated
4	Link-04	34.63	0 00:01	49.66	0.70	17.57	0.17	1.17	0.60	0.00		Calculated
5	Link-05	38.33	0 00:01	101.39	0.38	19.26	0.05	1.02	0.43	0.00		Calculated
6	Link-06	56.75	0 00:01	93.22	0.61	20.08	0.09	1.37	0.56	0.00		Calculated
7	Link-07	21.18	0 00:01	102.45	0.21	13.21	0.13	0.38	0.27	0.00		Calculated
8	Link-08	6.63	0 00:01	80.47	0.08	7.38	0.23	0.22	0.15	0.00		Calculated

Project Description

File Name ..... System 6.SPF
Description .....
S. Lamar from Del Curto to Kinney

Rainfall Details

Return Period..... 25 year(s)ode Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Jun-01	Junction	600.00	605.00	0.00	0.00	91.90	605.00	0.00	0.00	0 00:01	331.59	1441.00
2	Jun-02	Junction	596.20	601.00	0.00	0.00	77.97	601.00	0.00	0.00	0 00:01	206.43	1440.00
3	Jun-03	Junction	592.10	597.00	0.00	0.00	93.82	597.00	0.00	0.00	0 00:02	482.99	1440.00
4	Jun-04	Junction	589.38	594.00	0.00	0.00	100.76	594.00	0.00	0.00	0 00:01	649.25	1440.00
5	Jun-05	Junction	586.20	590.00	0.00	0.00	69.42	590.00	0.00	0.00	0 00:01	567.12	1440.00
6	Jun-06	Junction	584.90	589.00	0.00	0.00	54.98	589.00	0.00	0.00	0 00:01	168.63	1440.00
7	Jun-07	Junction	584.47	588.00	0.00	0.00	47.73	588.00	0.00	0.00	0 00:01	377.91	1440.00
8	Jun-08	Junction	584.32	588.00	0.00	0.00	44.32	585.82	0.00	2.18	0 00:00	0.00	0.00
9	Out-01	Outfall	579.50				44.35	580.62					

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Design Flow (cfs)	Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Total Depth Ratio	Time Reported Surcharged Depth (min)	Condition
1	Link-01	Pipe	Jun-01	Jun-02	150.17	600.00	596.20	2.5300	24.000	0.0120	77.97	77.97	1.00	12.41	2.00	1.00	1440.00	SURCHARGED
2	Link-02	Pipe	Jun-02	Jun-03	205.13	596.20	592.10	2.0000	24.000	0.0120	73.52	69.30	1.06	11.76	2.00	1.00	1439.00	SURCHARGED
3	Link-03	Pipe	Jun-03	Jun-04	136.07	592.10	589.38	2.0000	24.000	0.0120	73.36	69.30	1.06	11.73	2.00	1.00	1440.00	SURCHARGED
4	Link-04	Pipe	Jun-04	Jun-05	158.54	589.38	586.20	2.0100	24.000	0.0120	69.42	69.42	1.00	11.05	2.00	1.00	1440.00	SURCHARGED
5	Link-05	Pipe	Jun-05	Jun-06	150.29	586.20	584.90	0.8600	24.000	0.0120	46.28	45.59	1.02	7.67	2.00	1.00	1440.00	SURCHARGED
6	Link-06	Pipe	Jun-06	Jun-07	46.37	584.90	584.47	0.9300	24.000	0.0120	47.73	47.20	1.01	7.92	2.00	1.00	1440.00	SURCHARGED
7	Link-07	Pipe	Jun-07	Jun-08	96.12	584.47	584.32	0.1600	18.000	0.0120	31.32	31.32	1.00	3.48	1.50	1.00	1440.00	SURCHARGED
8	Link-08	Pipe	Jun-08	Out-01	141.87	584.32	579.50	3.4000	42.000	0.0120	44.35	200.90	0.22	16.77	1.12	0.32	0.00	Calculated

Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)	Minimum Pipe Cover (in)
1	Jun-01	600.00	605.00	5.00	0.00	-600.00	0.00	-605.00	0.00	36.00
2	Jun-02	596.20	601.00	4.80	0.00	-596.20	0.00	-601.00	0.00	33.60
3	Jun-03	592.10	597.00	4.90	0.00	-592.10	0.00	-597.00	0.00	34.80
4	Jun-04	589.38	594.00	4.62	0.00	-589.38	0.00	-594.00	0.00	31.44
5	Jun-05	586.20	590.00	3.80	0.00	-586.20	0.00	-590.00	0.00	21.60
6	Jun-06	584.90	589.00	4.10	0.00	-584.90	0.00	-589.00	0.00	25.20
7	Jun-07	584.47	588.00	3.53	0.00	-584.47	0.00	-588.00	0.00	18.36
8	Jun-08	584.32	588.00	3.68	0.00	-584.32	0.00	-588.00	0.00	2.16

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Volume (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded (ac-in)	Total Time Flooded (min)
1	Jun-01	91.90	91.90	605.00	5.00	0.00	0.00	605.00	5.00	0 00:00	0 00:01	331.59	1441.00
2	Jun-02	77.97	0.00	601.00	4.80	0.00	0.00	601.00	4.80	0 00:01	0 00:01	206.43	1440.00
3	Jun-03	93.82	20.30	597.00	4.90	0.00	0.00	597.00	4.90	0 00:01	0 00:02	482.99	1440.00
4	Jun-04	100.76	27.40	594.00	4.62	0.00	0.00	594.00	4.62	0 00:01	0 00:01	649.25	1440.00
5	Jun-05	69.42	0.00	590.00	3.80	0.00	0.00	590.00	3.80	0 00:01	0 00:01	567.12	1440.00
6	Jun-06	54.98	8.70	589.00	4.10	0.00	0.00	589.00	4.10	0 00:01	0 00:01	168.63	1440.00
7	Jun-07	47.73	0.00	588.00	3.53	0.00	0.00	588.00	3.53	0 00:01	0 00:01	377.91	1440.00
8	Jun-08	44.32	13.00	585.82	1.50	0.00	2.18	585.82	1.50	0 00:01	0 00:00	0.00	0.00

Pipe Input

SN	Element	Length	Inlet No. of Elevation	Inlet ID Offset	Outlet Invert Elevation	Outlet Invert Offset	Total Invert Drop	Average Pipe Slope	Pipe Shape	Pipe Height or Diameter	Pipe Width	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow	Flap	Barrels
		(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(%)		(in)	(in)					(cfs)		
1	Link-01	150.17	600.00	0.00	596.20	0.00	3.80	2.5300	CIRCULAR	24.000	24.000	0.0120	0.5000	0.5000	0.0000	0.00	No	2
2	Link-02	205.13	596.20	0.00	592.10	0.00	4.10	2.0000	CIRCULAR	24.000	24.000	0.0120	0.5000	0.5000	0.0000	0.00	No	2
3	Link-03	136.07	592.10	0.00	589.38	0.00	2.72	2.0000	CIRCULAR	24.000	24.000	0.0120	0.5000	0.5000	0.0000	0.00	No	2
4	Link-04	158.54	589.38	0.00	586.20	0.00	3.18	2.0100	CIRCULAR	24.000	24.000	0.0120	0.5000	0.5000	0.0000	0.00	No	2
5	Link-05	150.29	586.20	0.00	584.90	0.00	1.30	0.8600	CIRCULAR	24.000	24.000	0.0120	0.5000	0.5000	0.0000	0.00	No	2
6	Link-06	46.37	584.90	0.00	584.47	0.00	0.43	0.9300	CIRCULAR	24.000	24.000	0.0120	0.5000	0.5000	0.0000	0.00	No	2
7	Link-07	96.12	584.47	0.00	584.32	0.00	0.15	0.1600	Rectangular	18.000	72.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
8	Link-08	141.87	584.32	0.00	579.50	0.00	4.82	3.4000	CIRCULAR	42.000	42.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1

Pipe Results

SN	Element ID	Peak Flow	Time of Peak Flow Occurrence	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Travel Time	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Froude Number	Reported Condition
		(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)		(min)		
1	Link-01	77.97	0 00:01	77.97	1.00	12.41	0.20	2.00	1.00	1440.00		SURCHARGED
2	Link-02	73.52	0 00:01	69.30	1.06	11.76	0.29	2.00	1.00	1439.00		SURCHARGED
3	Link-03	73.36	0 00:01	69.30	1.06	11.73	0.19	2.00	1.00	1440.00		SURCHARGED
4	Link-04	69.42	0 00:01	69.42	1.00	11.05	0.24	2.00	1.00	1440.00		SURCHARGED
5	Link-05	46.28	0 00:01	45.59	1.02	7.67	0.33	2.00	1.00	1440.00		SURCHARGED
6	Link-06	47.73	0 00:01	47.20	1.01	7.92	0.10	2.00	1.00	1440.00		SURCHARGED
7	Link-07	31.32	0 00:01	31.32	1.00	3.48	0.46	1.50	1.00	1440.00		SURCHARGED
8	Link-08	44.35	0 00:02	200.90	0.22	16.77	0.14	1.12	0.32	0.00		Calculated

Project Description

File Name ..... System 15.SPF
Description .....
S. Lamar Corridor System 15

Rainfall Details

Return Period..... 25 year(s)

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Volume Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded (ac-in)	Total Time Flooded (min)
1	Jun-06	Junction	450.00	454.00	0.00	0.00	0.00	8.00	450.93	0.00	3.07	0 00:00	0.00	0.00
2	Jun-07	Junction	449.39	454.00	0.00	0.00	0.00	9.11	450.41	0.00	3.59	0 00:00	0.00	0.00
3	Jun-08	Junction	449.12	454.10	0.00	0.00	0.00	8.97	450.15	0.00	3.95	0 00:00	0.00	0.00
4	Jun-09	Junction	448.98	454.10	0.00	0.00	0.00	18.48	454.10	0.00	0.00	0 00:01	0.00	1.00
5	Out-02	Outfall	443.00					18.72	444.29					

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Link-06	Pipe	Jun-06	Jun-07	61.10	450.00	449.39	1.0000	18.000	0.0120	9.11	11.37	0.80	7.52	0.93	0.65	0.00	Calculated
2	Link-07	Pipe	Jun-07	Jun-08	27.30	449.39	449.12	0.9900	18.000	0.0120	8.97	11.32	0.79	7.06	0.93	0.68	0.00	Calculated
3	Link-08	Pipe	Jun-08	Jun-09	15.02	449.12	448.98	0.9300	18.000	0.0120	8.78	10.99	0.80	6.87	0.95	0.68	0.00	Calculated
4	Link-09	Pipe	Jun-09	Out-02	238.08	448.98	443.00	2.5100	18.000	0.0120	18.72	18.04	1.04	11.89	1.21	0.84	0.00	> CAPACITY

Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)	Minimum Pipe Cover (in) 1
	Jun-06	450.00	454.00	4.00	0.00	-450.00	0.00	-454.00	0.00	30.00
2	Jun-07	449.39	454.00	4.61	0.00	-449.39	0.00	-454.00	0.00	37.32
3	Jun-08	449.12	454.10	4.98	0.00	-449.12	0.00	-454.10	0.00	41.76
4	Jun-09	448.98	454.10	5.12	0.00	-448.98	0.00	-454.10	0.00	43.44

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Jun-06	8.00	8.00	450.93	0.93	0.00	3.07	450.93	0.93	0 00:00	0 00:00	0.00	0.00
2	Jun-07	9.11	0.00	450.41	1.02	0.00	3.59	450.32	0.93	0 00:01	0 00:00	0.00	0.00
3	Jun-08	8.97	0.00	450.15	1.03	0.00	3.95	450.07	0.95	0 00:01	0 00:00	0.00	0.00
4	Jun-09	18.48	9.70	454.10	5.12	0.00	0.00	450.19	1.21	0 00:01	0 00:01	0.00	1.00

Pipe Input

SN	Element	Length	Inlet Elevation (ft)	Inlet No. of ID	Inlet Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total	Average Slope (%)	Pipe Invert	Pipe Invert	Drop	Pipe Shape	Pipe Height (in)	Pipe Diameter or Width (in)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses (cfs)	Initial Flap	Barrels
1	Link-06	61.10	450.00	0.00	449.39	0.00	0.61		1.0000	CIRCULAR			18.000	18.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
2	Link-07	27.30	449.39	0.00	449.12	0.00	0.27		0.9900	CIRCULAR			18.000	18.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
3	Link-08	15.02	449.12	0.00	448.98	0.00	0.14		0.9300	CIRCULAR			18.000	18.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
4	Link-09	238.08	448.98	0.00	443.00	0.00	5.98		2.5100	CIRCULAR			18.000	18.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Link-06	9.11	0 00:01	11.37	0.80	7.52	0.14	0.93	0.65	0.00		Calculated
2	Link-07	8.97	0 00:01	11.32	0.79	7.06	0.06	0.93	0.68	0.00		Calculated
3	Link-08	8.78	0 00:01	10.99	0.80	6.87	0.04	0.95	0.68	0.00		Calculated
4	Link-09	18.72	0 00:01	18.04	1.04	11.89	0.33	1.21	0.84	0.00		> CAPACITY

APPENDIX E

Proposed Improvements Calculations and Data

Table 22. Proposed Pipe Size Calculations

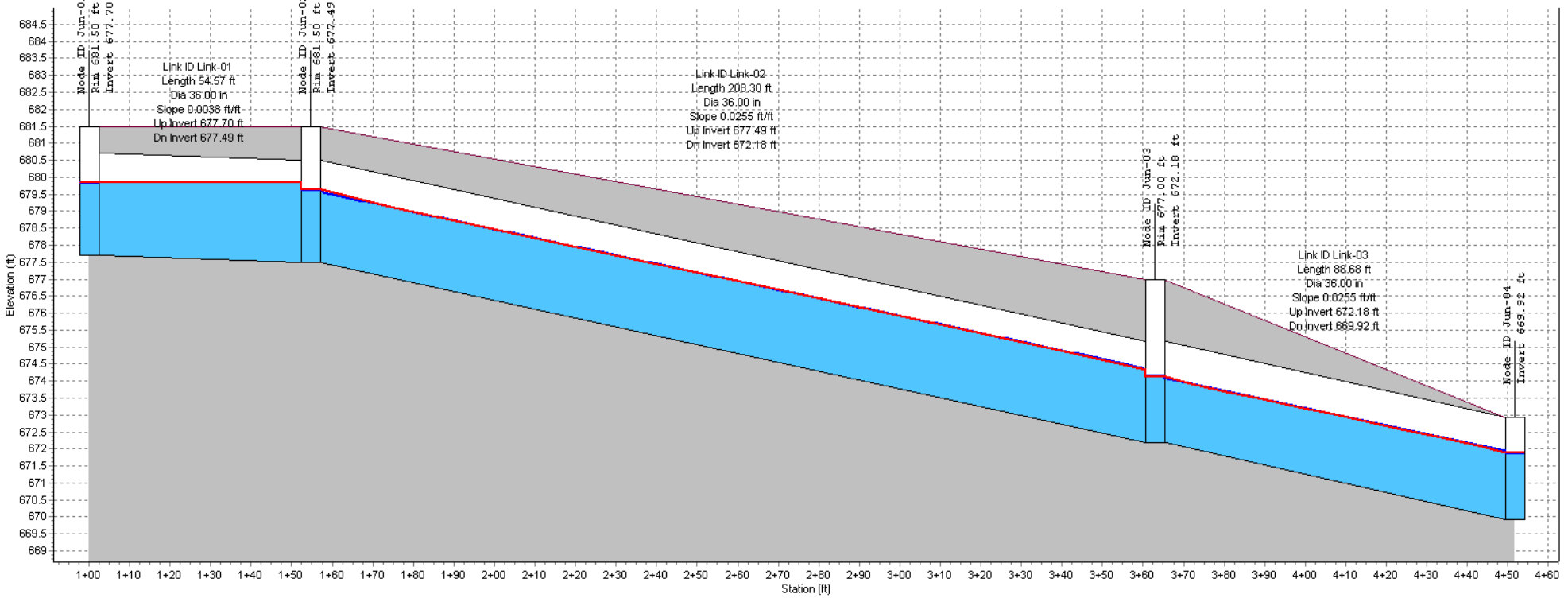
Storm Sewer Pipe Calculations							
System	Pipe I.D.	Prop. Pipe Dia (inches)	Mannings n	Slope (ft/ft)	Q(Prop.) (cfs)	Prop. Capacity (cfs)	V (fps)
1	3	24	0.012	0.0032	8.02	13.86	4.41
	4	24	0.012	0.0036	8.9	14.70	4.68
	5	24	0.012	0.0036	10.7	14.70	4.68
2	2	30	0.012	0.0031	13.74	24.74	5.04
	3	36	0.012	0.0032	25.84	40.87	5.78
	4	42	0.012	0.0031	42.53	60.69	6.31
	5	48	0.012	0.0053	60.53	113.29	9.02
5	1	24	0.012	0.0411	36	49.68	15.82
	2	30	0.012	0.0411	81	90.08	18.35
	3	30	0.012	0.0411	86.8	90.08	18.35
	4	30	0.012	0.0411	90.2	90.08	18.35
	6	36	0.012	0.0404	108.5	145.23	20.55
6*	1	30	0.012	0.0253	91.9	141.36	14.40
	2	30	0.012	0.02	91.9	125.68	12.80
	3	30	0.012	0.02	112.2	125.68	12.80
	4	30	0.012	0.02	139.6	125.68	12.80
	5	30	0.012	0.025	139.6	140.52	14.31
	6	30	0.012	0.03	148.3	153.93	15.68
9	13834	30	0.012	0.02	61.38	62.84	12.80
	13840	36	0.012	0.02	85.05	102.19	14.46
	13841	42	0.012	0.02	105.05	154.14	16.02
10	94388	30	0.012	0.025	68.3	70.26	14.31
11	23216	42	0.012	0.0291	135.78	185.93	19.33
* System 6 proposed pipes are dual barrel							

Table 23. Proposed Box Culvert Size Calculations

Storm Sewer Box Culvert Calculations									
System	Pipe I.D.	Height (inches)	Width (inches)	Hydraulic Radius (feet)	Mannings n	Slope (ft/ft)	Q(Prop.) (cfs)	Prop. Capacity (cfs)	V (fps)
6	7	30	72	0.88	0.012	0.0101	148.3	171.73	11.45
8	14167.1	48	48	1.00	0.012	0.0031		110.32	6.89
8	14167.1	48	48	1.00	0.012	0.004		125.31	7.83
				Combined Q - 4 barrels @ 4'x4'			451.6	471.25	

System 3 100-Year Event

S. Lamar from Panther Trail to Westforest



Node ID:	Jun-01	Jun-02	Jun-03	Jun-04
Rim (ft):	681.50	681.50	677.00	
Invert (ft):	677.70	677.49	672.18	669.92
Min Pipe Cover (ft):	0.80	1.01	1.82	
Max HGL (ft):	679.84	679.83	674.28	671.96

Link ID:	Link-01	Link-02	Link-03
Length (ft):	54.57	208.30	88.68
Dia (in):	36.00	36.00	36.00
Slope (ft/ft):	0.0038	0.0255	0.0255
Up Invert (ft):	677.70	677.49	672.18
Dn Invert (ft):	677.49	672.18	669.92
Max Q (cfs):	129.69	169.08	162.56
Max Vel (ft/s):	9.64	20.10	20.28
Max Depth (ft):	2.14	1.96	1.96