



Sanitary Sewer Study

Lee's Summit Water Utilities

Water Utilities Facility – SE Hamblen Road

Lee's Summit, Missouri

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1 Introduction

HDR Engineering, Inc. was retained by the City of Lee's Summit Water Utilities Department to perform an evaluation of the sanitary sewer system for the proposed Water Utilities Service Facility off of SE Hamblen Road in Lee's Summit, MO. The new facility will be located west of Hamblen Road, north of Bailey Road, and south of Highway 50, as shown in the Vicinity Map below.

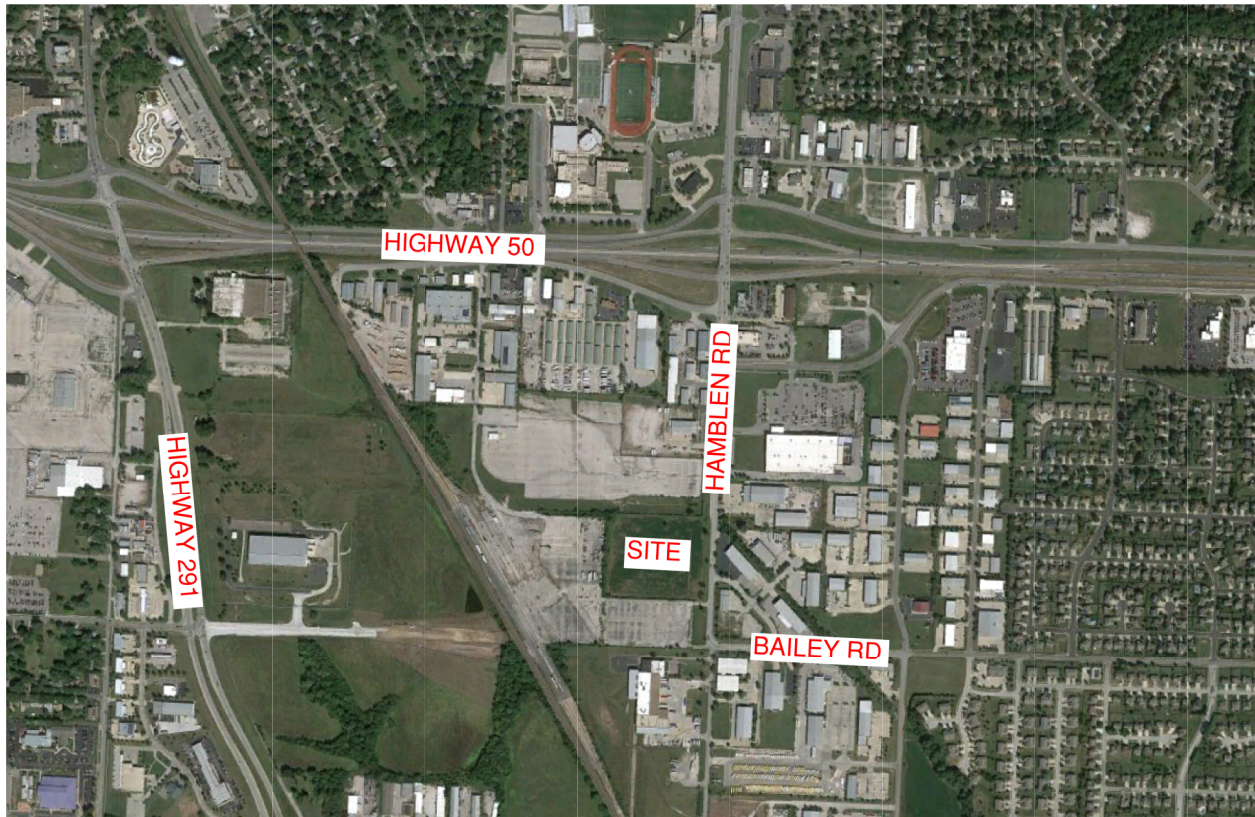


Figure 1-1 – Vicinity Map

The 9.22 acre site will contain a 42,680 square foot field services building and a paved storage area to support Water Utilities activities. Of the 42,680 square foot building, approximately 20,400 square feet is office area, 17,130 square feet is vehicle garage and shop area, and 5,150 square feet is warehouse and storage. The following discussion details the analysis for both onsite and offsite sanitary sewer.

2 Proposed Conditions

The projected sanitary sewer flows generated by the Water Utilities Services Facility were calculated utilizing the criteria in the City of Lee's Summit Design and Construction Manual. The peak wastewater flows consist of three components: Peak Base Flow, Peak Infiltration, and Peak Inflow.

Peak Base Flow:

$$\begin{aligned} &= 300 \text{ gpd} * \text{EDU} * \text{Building Area} \\ &= 300 \text{ gpd} * [(0.3 * 20,400/1,000 \text{ sf}) + (0.2 * 17,130/1,000 \text{ sf}) + (0.1 * 5,150/1,000 \text{ sf})] \\ &= 3,020 \text{ gpd} \end{aligned}$$

Peak Infiltration:

$$\begin{aligned} &= 250 \text{ gpd per area (acre)} \\ &= 250 \text{ gpd} * 9.22 \text{ acres} \\ &= 2,305 \text{ gpd} \end{aligned}$$

Peak Inflow:

$$\begin{aligned} Q &= kiA \\ \text{where } i &= 4.84 \text{ iph (rain intensity chart LSD\&C: } T_c = 18.56 * A^{0.2524}, T_c = 32.51 \text{ min)} \\ k &= 0.003 \\ A &= 9.22 \text{ acres} \\ Q &= (0.003 * 4.84 * 9.22) \\ &= 0.134 \text{ cfs} \\ &= 86,525 \text{ gpd} \end{aligned}$$

$$\begin{aligned} \text{Total Flow} &= \text{Peak Base Flow} + \text{Peak Infiltration} + \text{Peak Inflow} \\ &= 3,020 \text{ gpd} + 2,305 \text{ gpd} + 86,525 \text{ gpd} \\ &= 91,850 \text{ gpd} \end{aligned}$$

3 Collection System Analysis

An analysis was completed to determine the effect of the projected flow from the Services Facility on the existing sanitary sewer system. Previous studies utilized for this report include the 2007 Wastewater Master Plan and the 2013 Wastewater Master Plan Update. The 2007 Wastewater Master Plan evaluated the collection system capacity based upon the City of Lee's Summit Design Criteria for a 15-year and ultimate design condition. The 2013 Wastewater Master Plan Update established revised k factors utilizing flow monitoring data for an existing and 10-year design condition. For the purposes of this evaluation, flows within the existing collection system were calculated using the City of Lee's Summit Design Criteria with the revised k factors for the Big Creek Watershed established in the 2013 Wastewater Master Plan Update. However, any recommendations for improvement will be compared against the 2007 Wastewater Master Plan ultimate condition recommendations.

It was assumed that flow would enter the existing collection system between Manholes 39-185 and 39-184 and would discharge to Greenwood's portion of the Big Creek Interceptor. Sanitary sewer segments from MH 39-184 to MH 54-001 were evaluated using the flow projections. Sanitary sewer segments beyond the City Limits were not considered for this evaluation. The extent of the analysis is indicated on Figure 3-1, located at the end of this section.

The focus of this analysis is to identify the minimum improvements required to accommodate the additional flow from the Services Facility without significantly raising the hydraulic grade within the conveyance system. The intent of this exercise was to determine what, if any, improvements would be required to adequately convey the projected flow without causing significant negative impacts to the Big Creek Interceptor. The initial analysis indicated a number of segments could be considered as overcapacity. Table 3-1 summarizes the segments that were indicated as overcapacity, or segments that don't have the capacity to accommodate additional flow.

Table 3-1 - Overcapacity Segments

Segment	Existing Pipe Diameter (in)
54-003 to 54-002	15
54-004 to 54-003	15
54-005 to 54-004	15
54-006 to 54-005	15
54-010 to 54-009	15
54-011 to 54-010	15
54-013 to 54-012	15
54-014 to 54-013	15
47-017 to 47-018	12
47-006 to 47-007	10
47-005 to 47-006	10

Further evaluation was completed on the overcapacity segments to review the hydraulic grade, or surcharge conditions. The 2007 Wastewater Master Plan recommended improvement plan included the construction of an excess flow holding basin (EFHB) on the north branch of the Big Creek Interceptor. The proposed location of the excess flow holding basin is upstream of segments 54-006 to 54-002.

Under the ultimate condition scenario, those segments should have sufficient capacity with the construction of the EFHB and it is therefore recommended that these segments be eliminated from further consideration. Additionally, the hydraulic grade line was not greatly affected for the remaining segments and upsizing certain segments will allow the system's hydraulic grade to be reduced to approximately the same elevation as it was prior to the additional flow from the development. Table 3-2 compares the surcharge depth from the manhole top under the existing condition versus the surcharge depth from the manhole top with the additional flow from the Services Facility for the segments upstream of the future EFHB.

Table 3-2 – Hydraulic Grade Comparison under Differing Scenarios

Segment	Existing Pipe Diameter (in)	Existing Condition Surcharge Depth vs Manhole Top (feet)	9.22 Acre Development Surcharge Depth vs Manhole Top (feet)
54-010 to 54-009	15	-9.84	-9.65
54-011 to 54-010	15	-9.22	-8.86
54-013 to 54-012	15	-9.46	-8.82
54-014 to 54-013	15	-4.85	-4.05
47-017 to 47-018	12	-5.34	-3.35
47-006 to 47-007	10	-11.36	-11.10
47-005 to 47-006	10	-11.30	-10.96

Upsizing segment 47-017 to 47-018 is one potential improvement that could improve the system's hydraulic grade and minimize the impact of the sanitary flows from the Services Facility. Figure 3-2, located at the end of this section indicates where this segment is located. Table 3-3 contains the parallel pipe size diameter and pipe replacement size diameter for upsizing segment 47-017 to 47-018, both calculated based upon the projected flow for ultimate buildout, as recommended in the 2007 Wastewater Master Plan.

Table 3-3 – Potential Improvements (Future)

Segment	Existing Pipe Diameter (in)	Parallel Pipe Size Diameter (in)	Pipe Replacement Size Diameter (in)
47-017 to 47-018	12	18	24

Additional analysis was completed based upon flow monitoring data collected within the Big Creek Watershed.

The City has been collecting flow data in the Big Creek Watershed, specifically in Manhole 54-004, since June 2014. This data was obtained to compare it to the previous evaluation. The hourly flow data spanned from June 24, 2014 through October 29, 2014. Rain data was also collected for the same time period to establish the relationship between precipitation and sewer system flows. Figure 3-3 illustrates the flow and rain hydrograph

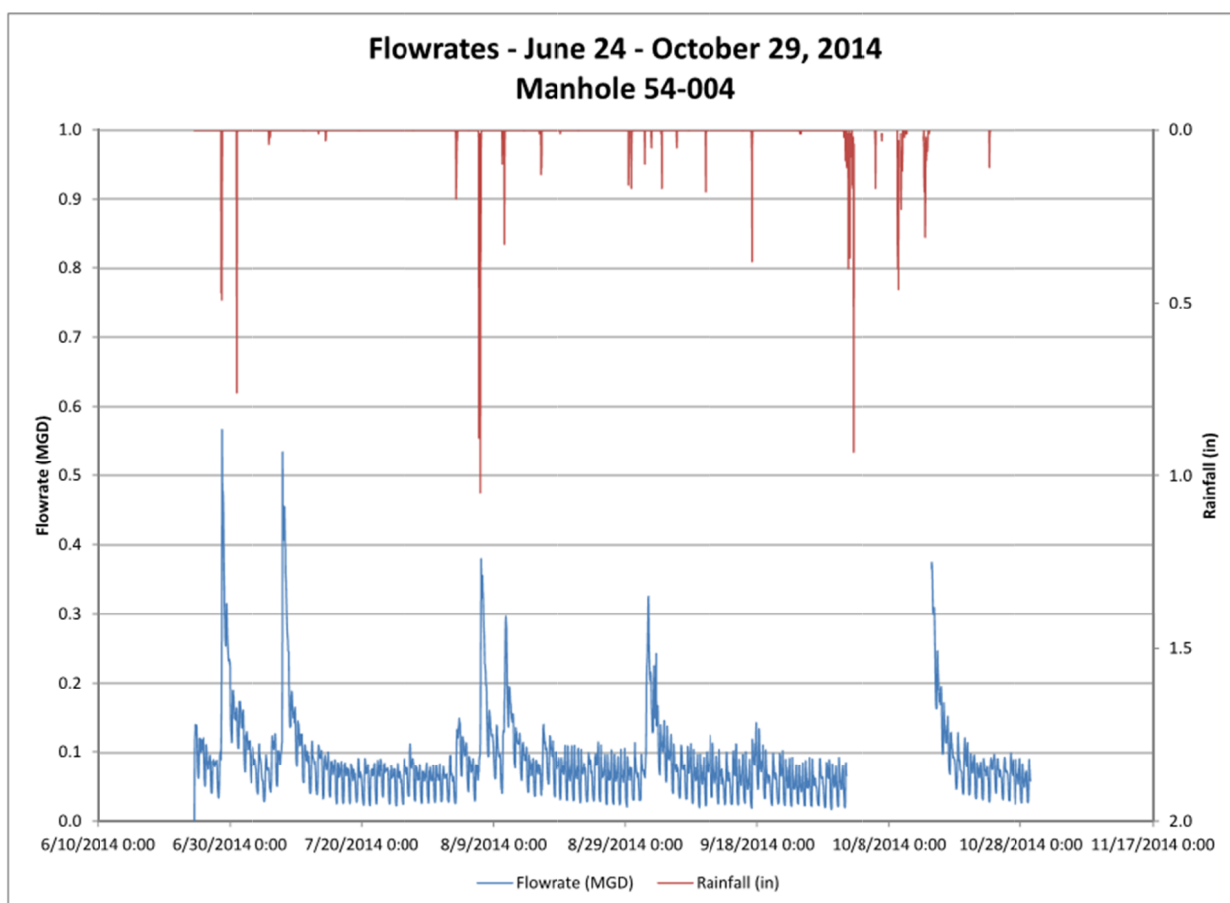


Figure 3-3 – Flow and Rain Hydrograph

The rainfall data was analyzed to determine the measured rainfall intensity-duration relationship. While there were a number of rainfall events recorded, most of them were short in duration and low on depth. These equated to a less than one year storm. On August 6 and 7, rainfall data was recorded at a depth of 2.96 inches over ten hours, which equates to a two-year storm. The Lee's Summit Design Criteria is based upon a 50-year storm.

The flow meter recorded data was analyzed to define the average daily dry weather flow, infiltration, and inflow components of the total flow. This information was used to recalculate the k coefficient for the study area, as shown in Table 3-4. At least two storms were evaluated and an average inflow coefficient value was used.

Table 3-4 – Inflow Coefficient Calculation

Storm Date	Delta TC (min)	Rain Intensity (in/hr)	Peak Flow Rate (mgd)	ADDF	Peak Inflow (mgd)	Peak Inflow (cfs)	Inflow Coefficient k
6/28/14	99	0.63	0.567	0.053	0.328	0.507	0.0010
8/6/2014	99	1.25	0.380	0.053	0.276	0.428	0.0004

Area 773

The previous evaluation was repeated with the revised k coefficient calculated from actual rain and flow data, as shown in Table 3-4. A revised k coefficient of 0.0007 was utilized, which is an average of the two storm events. With the revised k coefficient, no capacity constraints were indicated and no negative impact to the existing hydraulic grade line was apparent. Table 3-5 compares the surcharge depth from the manhole top under the assumptions of the Updated Master Plan versus the surcharge depth from the manhole top calculated using the revised k coefficient utilizing actual rain and flow data.

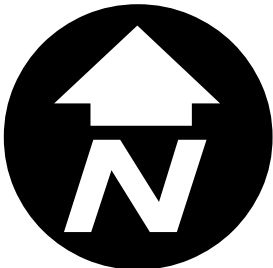
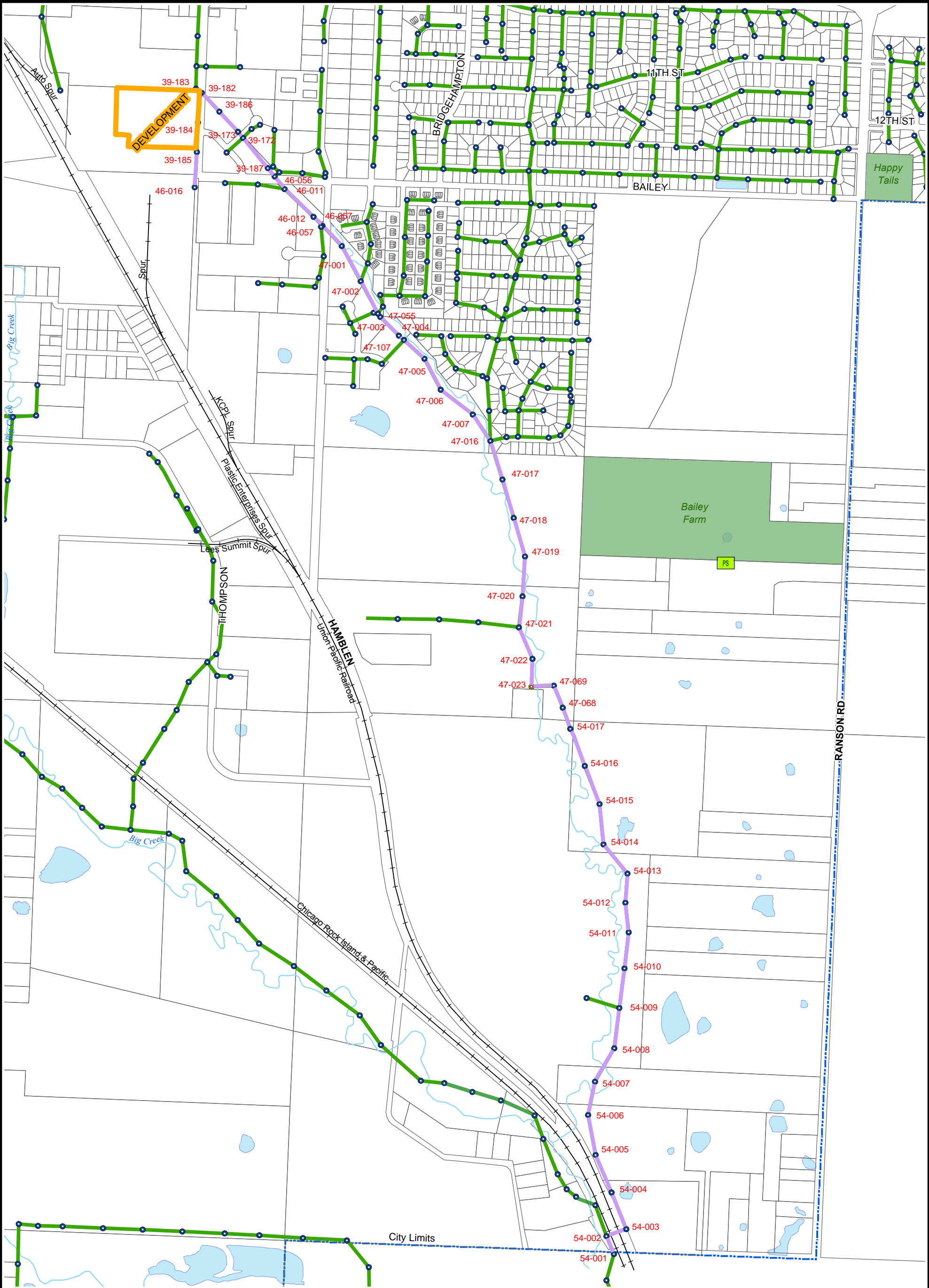
Table 3-5 – Hydraulic Grade Comparison under Differing Scenarios

Segment	Existing Pipe Diameter (in)	9.22 Acre Development at Updated Master Plan k Coefficient Surcharge Depth vs Manhole Top (feet)	9.22 Acre Development at 2014 Revised k Coefficient Surcharge Depth vs Manhole Top (feet)
54-010 to 54-009	15	-9.65	-10.62
54-011 to 54-010	15	-8.86	-10.68
54-013 to 54-012	15	-8.82	-11.47
54-014 to 54-013	15	-4.05	-7.58
47-017 to 47-018	12	-3.35	-7.11
47-006 to 47-007	10	-11.10	-11.14
47-005 to 47-006	10	-10.96	-11.04

From the revised k factors calculated based upon recent flow monitoring data, actual current conditions indicate that the existing sanitary sewer system can accept the flow from the new facility without negatively impacting the existing hydraulic grade line. As future growth occurs beyond this project, the City will have to reevaluate the conditions within the Big Creek Watershed to determine when to implement the recommended improvements from the 2007 Wastewater Master Plan.

Figure 3-1 – Sanitary Sewer Evaluation Limits

Figure 3-2 – Evaluation Results



Legend

Access Tee

Drop

Standard

Manholes Buried

PS Pump Stations

Future EFHB

Forced Mains

Gravity Mains

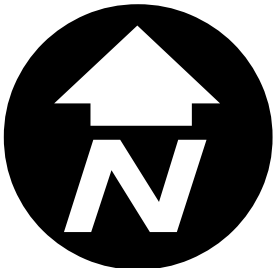
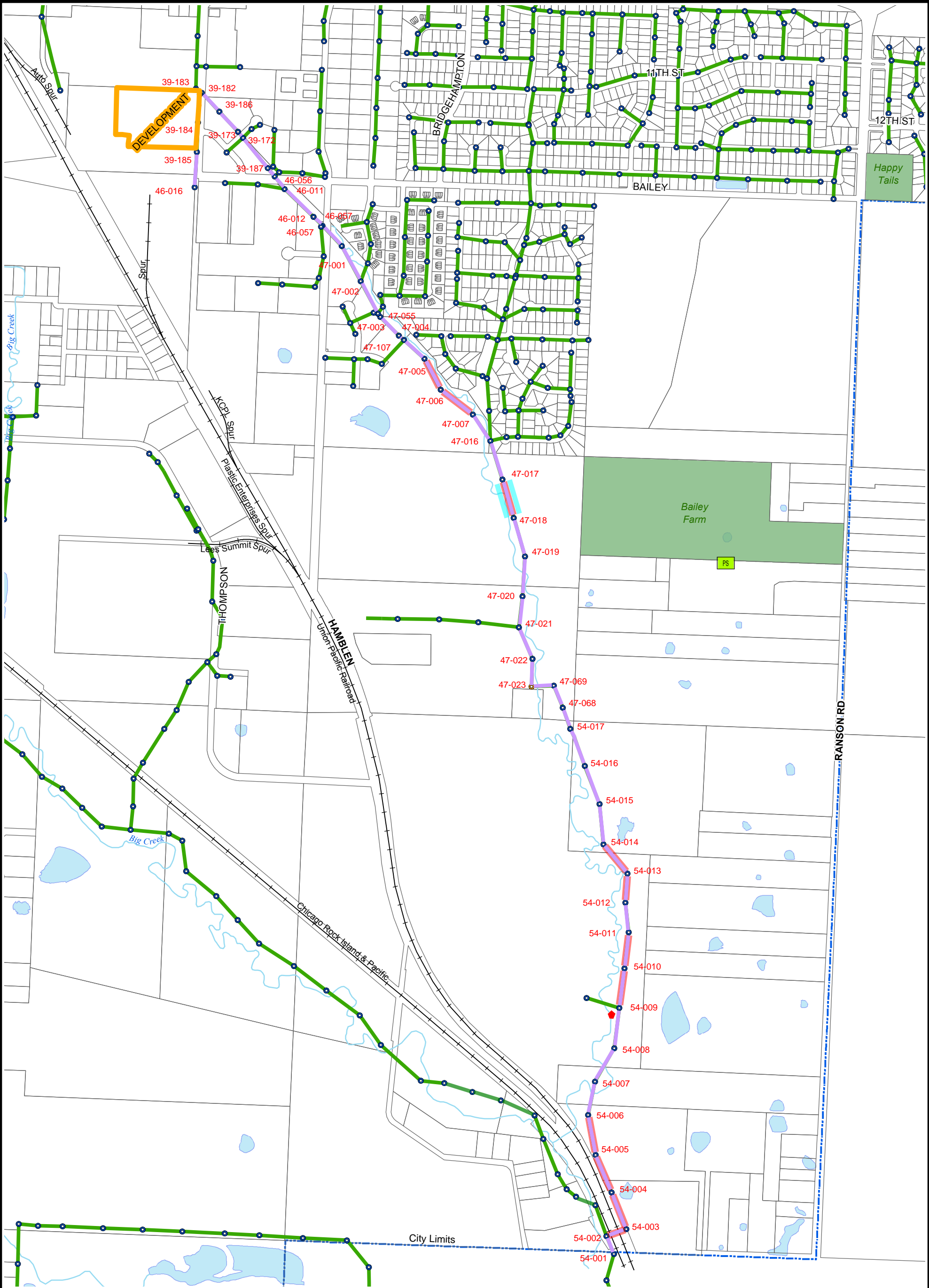
Capacity Impacted Segments

Analyzed Sections

Unanalyzed Sections

**City of Lee's Summit, Missouri
Big Creek Watershed**

**Figure 3-1
Sewer Evaluation Limits**



Legend

Access Tee

Drop

Standard

Manholes Buried

Pump Stations

Future EFHB

Forced Mains

Gravity Mains

Capacity Impacted Segments

Analyzed Sections

Unanalyzed Sections

Recommended Improvements

**City of Lee's Summit, Missouri
Big Creek Watershed**

**Figure 3-2
Evaluation Results**