

I. Executive Summary

This study was authorized on December 19, 2012 by the Franklin Engineering Department in order to evaluate and update the expected sewer demand in the West, Mayes Creek and Watson Branch Basins. This evaluation uses data from 2011 Development Report that was compiled by the Department of Planning and Sustainability, information provided by the Engineering Department, and as-built drawings from the Water Management Department. This information was implemented to produce expected sewer flows from the West Basin, Mayes Creek Basin, and Watson Branch Basin. The findings, conclusions and recommendations for the West Drainage Basin are detailed in the following report.

II. West and Southwest No. 1 Drainage Basins

i. Description

The West Drainage Basin is located in the western sections of the City of Franklin's urban growth boundary. The borders are roughly comprised of Old Carter's Creek Pike to the south, the Harpeth River to the north and east and the West Harpeth River to the west. For the purpose of this study the City has requested we include projections from the Southwest No. 1 Basin (SW 1) with the West Basin. SW 1 Basin is located directly south of the West Basin.

The West Basin is comprised of approximately 5,871 acres, of which 2,194 acres are undeveloped. There are currently 2,463 existing developed lots with approximately 2,953 additional lots approved. There is

an additional 683,000 SF of office/retail space that is planned for this area. It is anticipated the population in the fully developed basin will reach 27,798 residents. The Southwest No. 1 Basin is comprised of approximately 2,537 acres, of which 812 acres are undeveloped. There are currently 70 existing developed lots in this basin. The fully developed basin's population is expected to be approximately 5,355 residents.

The West Basin is divided into six (6) distinct sub-basins based on natural drainage patterns. These sub-basins are classified as sub-basins 1, 2, 3, 4, 5, and 6 of the West Basin. As mentioned above, the West Basin area will also include flow from the Southwest No. 1 Basin. Sub-basins 1, 2, and 6 have sewer infrastructure in place. Sub-basins 1 and 2 flow by gravity to the Westhaven Pump Station located in Sub-basin 3. From the pump station the flows are then conveyed through a 14-inch force main to Franklin's Wastewater Treatment Plant (WWTP). Sub-basin 6 flows by gravity to the Founder's Pointe Pump Station. Sewage is then conveyed by force main to an interceptor sewer along Del Rio Pike. The northern part of the West Basin and the entire Southwest No. 1 Basin do not presently offer gravity sewer service to residents. See Exhibit A for the West Basin sub-basins areas, Southwest No. 1 Basin area, and existing sewer infrastructure.

ii. Development of Sanitary Sewer Flows

a. Rationale

The included Figure 1 lists the various areas delineated within the sub-basins of the West Basin, along with the total area of Southwest No. 1 Basin. Existing information from the 2000 West Drainage Basin Study

and the 2011 Development Report was utilized to determine land use within the Basin.

Each sub-basin was evaluated in terms of land use, and in the majority of cases, the actual number of units proposed for specific properties were used to derive an amount of commercial space, or quantity of residential units that are currently planned for the basins. Franklin Planning Department estimates and projections were used to identify the type and extent of future development for properties where no submittals have been made to the Planning Commission, but for which a land use has been designated.

FIGURE 1 – WEST & SOUTHWEST NO. 1 DRAINAGE BASINS - LAND USE

Sub-basin	Total Acres	Undeveloped	Existing Lots	Proposed Lots	Commercial / Other Space
	(acres)	(acres)	(# units)	(# units)	(sq. ft.)
1	1,483	268	950	1,800	500,000
2	1,212	493	935	129	100,000
3	755	409	10	0	83,000*
4	788	262	26	1,024	0
5	1,373	762	42	0	0
6	260	0	500	0	0
Subtotal	5,871	2,194	2,463	2,953	683,000
SW 1	2,537	812	70	0	0
Totals	8,408	3,006	2,533	2,953	683,000

**Proposed Franklin Christian Academy with an ultimate build out of 83,000 sf.*

The State of Tennessee Sewage Works Design Manual provides guidance for incremental flow for various land uses. They are listed in Figure 2 below.

FIGURE 2 – INCREMENTAL FLOW VALUES for VARIOUS LAND USE	
<u>Land Use</u>	<u>Incremental Flow</u>
Single Family Residence	350 gpd
Condominium/Apartment	250 gpd
Retail	0.15 gpd/sf
Office	0.10 gpd/sf

Areas inside the flood plain are considered unbuildable and were excluded from this study. A maximum of 2.5 units per acre was used for single family units unless the area has previously been zoned at a higher density. Average projected flows from each sub-basin are calculated from the general information presented in Figures 1 and 2 above. Sanitary sewer lines must be designed for the maximum flow that will be encountered in a given area within the drainage basin. Peaking factors are applied that allow for the differences in average daily flow and instantaneous sewer flow. These factors vary according to the number of people in the sub-area contributing to the flow. The following peaking factors listed in Figure 3 are taken from ASCE “Sewer Design & Construction Manuals and Reports on Engineering Practice” and are used in this report.

FIGURE 3 – POPULATION PEAKING FACTORS	
<u>Tributary Population</u>	<u>Peaking Factor</u>
0 – 500	5

500 – 1,000	4
1,000 +	3.25

b. Projected Flows

Figure 4 represents an overview of the entire known development plan for the West and Southwest No. 1 Drainage Basin. A more detailed analysis of the information contained in Figure 1 and Figure 4 is presented in Table 1 – Development of Sanitary Sewer Flows in the Appendix to this study. Table 1 contains projected flows associated with each sub-basin. The information shown in Table 1 is based on information from the 2011 Development Report, counts of actual properties on which homes have been built, or field investigations and scaled roof areas calculated from existing aerial surveys. Incremental flows and peaking factors were applied to arrive at an estimated flow for each area.

The calculations included in Table 1 project numbers of future residential units and commercial development areas and sewage flow from each sub-basin attributable to the proposed development. A majority of the information includes plan submittals for specific proposed developments, while other information was derived from population densities. A value of 2.55 residential units per acre, as reported in recent U.S. census data for the City, and a floor area ration (F.A.R) of 0.28 to 1 were used to develop the amount of residential units and commercial floor space.

FIGURE 4 – WEST & SOUTHWEST NO. 1 LAND USE and FLOW RESULTS

Description

Basin Projections

Total Acreage / with SW 1	5,871 acres / 8,408 acres
No. of Existing Residential Units	2,533 units
No. of Projected Residential Units	13,001 units
Proposed SF of Commercial / Other	683,000 sq. ft.
Population / with SW 1	27,798 / 33,153
Average Daily Sewage Flow	3.914 mgd
Average Daily Sewage Flow w/SW 1	4.649 mgd
Peak Sewage Flow	12.719 mgd
Peak Sewage Flow w/SW 1	15.108 mgd

Average daily sanitary sewer flow for the West Drainage Basin is expected to average 3.914 million gallons per day (mgd) with peaks of 12.719 mgd within the 20-year study period. If the City intends to pump flow from the Southwest No. 1 Drainage Basin into the West Drainage Basin, the total average and peak flows will increase to approximately 4.649 and 15.108 mgd respectively.

iii. Existing Interceptor Sewers

Previous sections have provided a rationale for projections of sewer flows from the study basin. With the flows from each sub-basin defined, existing sanitary sewer lines can be evaluated, areas of insufficient capacity can be identified, and specific infrastructure improvements can be recommended. To develop the southern portion of the West Basin flow will need to be conveyed through the existing Westhaven Interceptor Sewer constructed in 2007. This is also the most logical interceptor to convey flows from the Southwest No. 1 Basin. Figure 5 below shows the size and slope of the existing Westhaven Interceptor Sewer, and the

relative capacities of the line. City of Franklin record drawings provided by Heathcoat & Davis, Inc. were used to determine the full flow capacity of the line. Depending on depth, the material alternates from PVC to Ductile Iron. For PVC and DIP a Manning's roughness value of $n = 0.010$ and 0.012 was used to calculate capacity.

FIGURE 5

EXISTING WESTHAVEN INTERCEPTOR SEWER

<u>Description</u>	<u>Diameter</u>	<u>Slope</u>	<u>Full Flow Capacity</u>
Sheet C-6	16-inch DIP	0.32%	3.04 mgd
	15-inch PVC	0.30%	2.97 mgd
	15-inch PVC	0.33%	3.12 mgd
Sheet C-5	15-inch PVC	0.33%	3.12 mgd
	16-inch DIP	0.29%	2.89 mgd
	16-inch DIP	0.42%	3.48 mgd
Sheet C-4	15-inch PVC	0.26%	2.77 mgd
	15-inch PVC	0.44%	3.60 mgd
	18-inch PVC	1.83%	11.94 mgd
Sheet C-3	18-inch PVC	0.20%	3.95 mgd
	18-inch PVC	0.16%	3.53 mgd
	18-inch PVC	1.00%	8.83 mgd
Sheet C-2	18-inch PVC	0.18%	3.74 mgd
	18-inch PVC	0.14%	3.30 mgd
	18-inch PVC	0.20%	3.95 mgd

iv. Results

What was originally proposed by Smith Seckman Reid, Inc and detailed in the West Drainage Basin study dated September 25, 2000 still appears to be the best overall option for the City of Franklin. Due to existing infrastructure and updated flow projections, sewer alignments and diameters have been modified accordingly. As detailed in the original study, sanitary sewer service by gravity flow centers on the construction of an interceptor sewer located along the West Harpeth River. This interceptor sewer would take flow from the Westhaven Interceptor Sewer, remove the Westhaven Pump Station, and run north along the West Harpeth River. The interceptor sewer would need to be constructed to a point downstream on the river to allow flows from smaller gravity sewer lines to enter the system. From this point a proposed pump station capable of handling the total peak flow of the basin would convey sewage back to the Franklin Wastewater Plant for treatment and disposal. Three locations have been evaluated for the proposed primary West Basin Pump Station. Exhibits B-1, B-2, and B-3 show all three options, along with gravity improvements to the West Drainage Basin based on minimum grades required to produce a velocity of 2 feet per second.

As discussed earlier the City of Franklin intends to pump flow from the Southwest No. 1 Basin into the West Basin. This flow would be pumped to the southwestern part of the West Basin where it will then flow by gravity to the Westhaven Interceptor Sewer. Using the peak flows from the SW No. 1 Basin and surrounding sub-basins, a hydraulic model of the sewer was constructed to evaluate the capacity of the interceptor. After modeling the interceptor with SewerGems, the sewer was shown to surcharge at approximately 10 manholes and the interceptor was 100% full except for the last three segments of pipe. It is safe to say the

Westhaven Interceptor Sewer will not be capable of conveying the theoretical flows from the SW No. 1 Basin.

v. Recommendations

After reviewing all the three options for the primary West Basin Pump Station, Option 1 (Exhibit B-1) appears to be the most feasible location. The driving factor for this decision is the steep bluff located on the Rogers Farm development. We feel it will be extremely challenging to construct an interceptor gravity sewer along this bluff, and if constructed, there would be irritable ecological damage to the river bank and buffers. Also, the northern part of the basin bounded by Cotton Lane, Del Rio Pike, the West Harpeth River and the Harpeth River consisting mainly of large single-family estate lots or floodplain will never be developed and the tracts are large enough to remain on septic systems. Should there be a future need to provide sanitary sewers to this area, a low pressure sanitary sewer system appears to be the most feasible method for providing service to this portion of the West Basin. Should this area ever be proposed to redevelop with a greater density, there will have to be a reevaluation of the sanitary service to be provided and the West Basin Study will require updating.

One negative aspect of the proposed primary pump station location is collecting flows from the eastern portion of the basin, or Sub-basins 5 and 6. These areas will not drain naturally to the proposed primary pump station. A smaller secondary pump station and 12-inch force main will need to be constructed to convey flows from the eastern portion of the basin to the proposed primary West Basin Pump Station. The proposed primary pump station will then convey flows to the City's WWTP by

utilizing a portion of the existing 14-inch Westhaven force main. In an attempt to keep velocities below 8 ft/s the existing 14-inch force main would be capable of handling flows up to 5.4 mgd. Based on the total peak flow in Table 1 the 14-inch force main would be adequate until the West Drainage Basin is approximately 42.2% developed. An additional parallel 20-inch force main will be needed once the West and Southwest No. 1 Basins are approximately 35.6% developed. The City can plan accordingly and purchase additional easement space to accommodate both force mains from the proposed primary pump station to the tie-in point at the existing 14-inch force main. The proposed 20-inch force main will then follow the existing 14-inch force main route to the City's WWTP. See Exhibit B-1 for proposed pump station locations and improvements.

From the information presented in this report, we also recommend considering upgrades to the Westhaven Interceptor Sewer. Based on our projected peak flows the Westhaven Interceptor Sewer would need to be upsized or a parallel interceptor would need to be installed. If we utilize the same slopes, the existing 15-inch and 16-inch pipe segments will need to be increased to 18-inches in diameter. The existing 18-inch would need to be increased to 24-inches in diameter. To our knowledge the area surrounding the Westhaven Interceptor Sewer is relatively undeveloped and can be potentially relayed with minimal disruption to the nearby residents. This will not hold true for very long based on preliminary development information provided by the City of Franklin. Another option would be to parallel the existing alignment of the Westhaven Interceptor Sewer with a new 18-inch diameter interceptor sewer. This interceptor would strictly take the proposed flows from the Southwest No. 1 Basin. See Exhibit B-1 for proposed pump station locations and improvements.

An Engineer's Opinion of Probable Cost for each option is shown in Figures 7 – 9 below.

FIGURE 7 - ENGINEER'S OPINION OF PROBABLE COST			
OPTION 1 – CONSTRUCT PUMP STATION SOUTH OF BLUFF			
<u>Description</u>	<u>Quantity/Unit</u>	<u>Unit Cost</u>	<u>Total</u>
<i>Parallel Westhaven Interceptor with 18" Gravity Interceptor Sewer</i>			
<i>12-inch Gravity Sewer</i>	20,081 LF	\$110.00	\$2,208,910.00
<i>18-inch Gravity Sewer</i>	15,210 LF	\$200.00	\$3,042,000.00
<i>24-inch Gravity Sewer</i>	8,480 LF	\$225.00	\$1,908,000.00
<i>36-inch Gravity Sewer</i>	3,447 LF	\$265.00	\$913,455.00
<i>42-inch Gravity Sewer</i>	4,107 LF	\$300.00	\$1,232,100.00
<i>Manholes</i>	165 EA	\$4,250.00	\$701,250.00
<i>15.2 MGD Pump Station</i>	1 LS	\$7,000,000.00	\$7,000,000.00
<i>14-inch Force Main</i>	10,758 LF	\$165.00	\$1,721,280.00
<i>20-inch Future Force Main</i>	25,360 LF	\$200.00	\$5,072,000.00
<i>2.8 MGD Pump Station</i>	1 LS	\$1,400,000.00	\$1,400,000.00
<i>12-inch Force Main</i>	7,010 LF	\$140.00	\$981,400.00
<i>10% Misc. Allow. for Bypass, Mobilization, etc.</i>	1 LS	\$2,618,039.50	\$2,618,040.00
<i>15% Contingency Allow. for Legal, Engineering, Admin. & Esmts.</i>	1 LS	\$3,988,428.68	\$4,319,765.00
TOTAL →			\$33,118,200.00
<i>Replace Existing Westhaven Interceptor Sewer</i>			
<i>18-inch Gravity Sewer</i>	10,000 LF	\$200.00	\$2,000,000.00
<i>24-inch Gravity Sewer</i>	13,690 LF	\$225.00	\$3,080,250.00

15% Misc. Allow. for Bypass, Mobilization, etc.	1 LS	\$3,932,352.75	\$3,932,353.00
15% Contingency Allow. for Legal, Engineering, Admin. & Esmts.	1 LS	\$3,988,428.68	\$4,522,206.00
TOTAL →			\$34,670,244.00

**FIGURE 8 - ENGINEER'S OPINION OF PROBABLE COST
OPTION 2 – CONSTRUCT PUMP STATION NORTH OF BLUFF**

<u>Description</u>	<u>Quantity/Unit</u>	<u>Unit Cost</u>	<u>Total</u>
Parallel Westhaven Interceptor with 18" Gravity Interceptor Sewer			
12-inch Gravity Sewer	20,081 LF	\$110.00	\$2,208,910.00
18-inch Gravity Sewer	20,114 LF	\$200.00	\$4,022,800.00
24-inch Gravity Sewer	8,480 LF	\$225.00	\$1,908,000.00
36-inch Gravity Sewer	3,447 LF	\$265.00	\$913,455.00
42-inch Gravity Sewer	9,540 LF	\$300.00	\$2,862,000.00
Manholes	193 EA	\$4,250.00	\$820,250.00
15.2 MGD Pump Station	1 LS	\$7,000,000.00	\$7,000,000.00
14-inch Force Main	12,835 LF	\$165.00	\$2,117,775.00
20-inch Future Force Main	27,435 LF	\$200.00	\$5,487,000.00
2.8 MGD Pump Station	1 LS	\$1,400,000.00	\$1,400,000.00
12-inch Force Main	5,797 LF	\$140.00	\$811,580.00
10% Misc. Allow. for Bypass, Mobilization, etc.	1 LS	\$2,955,177.00	\$2,955,177.00
15% Contingency Allow. for Legal, Engineering, Admin. & Esmts.	1 LS	\$4,544,705.55	\$4,876,042.00

SUBTOTAL →			\$37,382,989.00
Replace Existing Westhaven Interceptor Sewer			
18-inch Gravity Sewer	14,904 LF	\$200.00	\$2,980,800.00
24-inch Gravity Sewer	13,690 LF	\$225.00	\$3,080,250.00
15% Misc. Allow. for Bypass, Mobilization, etc.	1 LS	\$4,429,990.50	\$4,429,991.00
15% Contingency Allow. for Legal, Engineering, Admin. & Esmts.	1 LS	\$4,544,705.55	\$5,094,489.00
SUBTOTAL →			\$39,057,750.00

**FIGURE 9 - ENGINEER'S OPINION OF PROBABLE COST
OPTION 3 – CONSTRUCT PUMP STATION @ CONFLUENCE OF RIVERS**

<u>Description</u>	<u>Quantity/Unit</u>	<u>Unit Cost</u>	<u>Total</u>
Parallel Westhaven Interceptor with 18" Gravity Interceptor Sewer			
12-inch Gravity Sewer	23,165 LF	\$110.00	\$2,584,150.00
18-inch Gravity Sewer	20,114 LF	\$200.00	\$4,022,800.00
24-inch Gravity Sewer	16,753 LF	\$225.00	\$3,769,425.00
36-inch Gravity Sewer	3,447 LF	\$265.00	\$913,455.00
42-inch Gravity Sewer	11,610 LF	\$300.00	\$3,483,000.00
Manholes	215 EA	\$4,250.00	\$913,750.00
15.2 MGD Pump Station	1 LS	\$7,000,000.00	\$7,000,000.00
14-inch Force Main	13,861 LF	\$165.00	\$2,287,065.00
20-inch Future Force Main	28,461 LF	\$200.00	\$5,692,200.00
10% Misc. Allow. for Bypass, Mobilization, etc.	1 LS	\$3,062,984.50	\$3,062,985.00

15% Contingency Allow. for Legal, Engineering, Admin. & Esmts.	1 LS	\$4,671,701.93	\$5,053,924.00
SUBTOTAL →			\$38,746,754.00
Replace Existing Westhaven Interceptor Sewer			
18-inch Gravity Sewer	21,250 LF	\$200.00	\$4,250,000.00
24-inch Gravity Sewer	21,963 LF	\$225.00	\$4,941,675.00
15% Misc. Allow. for Bypass, Mobilization, etc.	1 LS	\$4,677,816.50	\$4,677,817.00
15% Contingency Allow. for Legal, Engineering, Admin., etc.	1 LS	\$4,671,701.93	\$5,379,489.00
SUBTOTAL →			\$41,232,751.00

As shown in Figures 7 – 9 above, Option 1 appears to be the most cost effective solution for a fully developed West and Southwest No. 1 Drainage Basin. The estimated cost to construct a sanitary sewer system with an interceptor sewer parallel to the Westhaven Interceptor Sewer is **\$33,118,200.00**. This estimate includes a 10% allowance for miscellaneous activities associated with open cut installations, such as but not limited to mobilization, by-pass pumping, etc. A 15% contingency is also included for engineering, legal and construction administration services. If the City elects to replace the Westhaven Interceptor Sewer the cost increases to **\$34,670,244.00**. For this alternative we increased the miscellaneous allowance to 15% to account for bypass pumping, reinstatement of services laterals, etc. A 15% contingency is also included for engineering, legal and construction administration services.

vi. Equalization Basin Option

At the request of the City another option for handling flows in the basin was briefly examined. This option focuses on the construction of a smaller pump station south of the bluff with an equalization basin to account for difference in average and peak flows. This would allow the City to use a portion of the existing 14-inch Westhaven Force Main without constructing a future 20-inch force main. With limited information provided we assumed the equalization basin would be 10 million gallons in size and approximately 20-feet deep. Using these parameters the approximate diameter would be 290 feet. If you include a 50-foot buffer around the site the City would need to acquire a 2.75 acre plot of land. Please note a detailed design analysis will need be conducted to determine if an equalization basin is feasible for the West Drainage Basin. Cost was derived from \$0.75 per gallon and \$30.00 per cubic yard of excavation, plus a 15% contingency allowance was added for aeration, etc... An Engineer's Opinion of Probable Cost to construct a smaller 5.0 mgd pump station in conjunction with a 20 foot deep 10 million gallon equalization basin is shown in Figure 10 below.

**FIGURE 10 - ENGINEER'S OPINION OF PROBABLE COST
EQUALIZATION OPTION – CONSTRUCT PUMP STATION SOUTH OF BLUFF**

<u>Description</u>	<u>Quantity/Unit</u>	<u>Unit Cost</u>	<u>Total</u>
<i>Parallel Westhaven Interceptor with 18" Gravity Interceptor Sewer</i>			
<i>12-inch Gravity Sewer</i>	20,081 LF	\$110.00	\$2,208,910.00
<i>18-inch Gravity Sewer</i>	15,210 LF	\$200.00	\$3,042,000.00
<i>24-inch Gravity Sewer</i>	8,480 LF	\$225.00	\$1,908,000.00
<i>36-inch Gravity Sewer</i>	3,447 LF	\$265.00	\$913,455.00
<i>42-inch Gravity Sewer</i>	4,107 LF	\$300.00	\$1,232,100.00

**Sewer System Study Update
West Drainage Basin
City of Franklin, Tennessee**



Manholes	165 EA	\$4,250.00	\$701,250.00
5.0 MGD Pump Station	1 LS	\$2,350,000.00	\$2,350,000.00
14-inch Force Main	10,758 LF	\$165.00	\$1,721,280.00
10 MG Equalization Basin	1 LS	\$10,100,000.00	\$10,100,000.00
2.8 MGD Pump Station	1 LS	\$1,400,000.00	\$1,400,000.00
12-inch Force Main	7,010 LF	\$140.00	\$981,400.00
10% Misc. Allow. for Bypass, Mobilization, etc.	1 LS	\$2,655,840.00	\$2,655,840.00
15% Contingency Allow. for Legal, Engineering, Admin. & Esmts.	1 LS	\$4,382,135.00	\$4,382,135.00
TOTAL →			\$33,596,370.00
Replace Existing Westhaven Interceptor Sewer			
18-inch Gravity Sewer	10,000 LF	\$200.00	\$2,000,000.00
24-inch Gravity Sewer	13,690 LF	\$225.00	\$3,080,250.00
15% Misc. Allow. for Bypass, Mobilization, etc.	1 LS	\$3,989,053.00	\$3,989,053.00
15% Contingency Allow. for Legal, Engineering, Admin. & Esmts.	1 LS	\$4,587,411.00	\$4,587,411.00
TOTAL →			\$35,170,149.00



APPENDIX