CITY OF RICHMOND, MICHIGAN

SANITARY SEWER
MASTER PLAN UPDATE

August 2022

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SUMMARY AND RECOMMENDATIONS

The City of Richmond, Michigan has a substantial network of collector, trunk, and interceptor sewers providing service to the community. Sanitary sewers range in size from 6 to 30 inches and convey approximately 0.64 million gallons per day average daily flow to the Wastewater Treatment Plant.

This study evaluates the adequacy of the sanitary sewer system during times of peak flows, both at present and in the future. Existing capacities were determined for sanitary submains using available size and invert data. Sanitary sewers 12-inch or larger are defined as sanitary submains or trunks. Flows were estimated using per capita flow rates and projected peak flows from the 2005 and 2022 flow monitoring results. The future service area and estimated flows were based on planning information presented in the "Future Service Areas" section of this report.

The 2005 flow monitoring program revealed that the sewer system flow responded strongly to rainfall. The analysis shows that the existing system has capacity constraints. The City has recently completed construction or is in the process of completing many projects that will manage this wet weather response.

The 2022 flow monitoring program at the K-Mart Pump Station revealed that the existing peak flow into the station is below its rated capacity. However, the station will need improvements due to anticipated growth outside of the current service area that will exceed the rated capacity.

The projected growth in service area represents 162 percent of the existing service area. Improvements will be necessary to convey the additional sanitary flows. The magnitude of the improvements will depend on the land use and flow generation that occurs. Some new sewers will be required, as well as increased pump station capacities (for projects proposed outside of the City limits). Proposed improvement projects are presented in Map 4 in

Appendix A. There may be additional improvements not quantified in this report if the flow generated from the new growth is large. The opinion of probable cost for improvements required in the City is $471,000. The cost necessary for serving the expanded service area will be incurred by the land developers and is not included in this report.

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INTRODUCTION

The City of Richmond, Michigan, contracted Tetra Tech to prepare an update to its Sanitary Sewer System Master Plan. This report describes the analysis of the system, including an assessment of the existing system to collect peak flows, and an evaluation and recommendation of alternative improvements to service projected future flow conditions.

The following list summarizes the issues addressed in this analysis:

- Determine current system adequacy and identify necessary improvements to the system.
- Identify current and future service areas.
- Define future sanitary flows, including potential service areas outside the current City limits.
- Evaluate the ability of existing facilities to meet future flows and identify necessary improvements to meet projected future needs.
- Prepare a least-cost solution of improvements to meet existing and future system needs.

This report presents the results of the evaluation of existing and future conditions, followed by recommendations.

EXISTING CONDITIONS

SERVICE AREA

The City of Richmond is located in Macomb County, northeast of the City of Detroit. The topography is relatively flat with ground elevations ranging from 724 to 752. Currently, the City covers approximately 2,534 acres, and is serviced by a sanitary sewer collection system consisting of sewers ranging in diameter from 6 to 30 inches. A plan view of the sanitary service area and collection system is presented in Map 1 (all maps are in Appendix A).

SANITARY SYSTEM INFRASTRUCTURE

This analysis considers the sanitary sewer system infrastructure of the City of Richmond. The infrastructure list and computer map were provided to Tetra Tech by the City and have been used to develop mapping of the sanitary system. Table 1 is a summary of the current sanitary sewer system infrastructure.

Table 1

Existing Sanitary Sewer Sizes and Lengths in the City of Richmond

Sewer Diameter (inches)	Approximate Sanitary Sewer Length (feet)
4-inch	182
6-inch	3,370
8-inch	63,390
10-inch	36,875
12-inch	23,388
15-inch	8,995
18-inch	3,041
21-inch	385
24-inch	6,016
30-inch	4,089
Total	149,731 (28.36 miles)

Several pump stations transport flow to the plant. Table 2 is a summary of the existing pump stations.

Table 2

Existing Pump Stations

Station	Location	Design Duty Point
Heritage	Heritage Drive and Main Street	Q = 100 gpm; TDH = 11 ft
Division Road	Division and Skinner	Q = 1400 gpm; TDH = 18.3 feet
K-Mart	Main Street and Muttonville	Q = 400 gpm; TDH = 72 feet
Rosewood Terrace	Rosewood Lane	Q = 140 gpm; TDH = 16 feet
Swan Creek	Main Street at Swan Creek Estates	Q = 360 gpm; TDH = 34 feet
Richwood Lane	Richwood Lane and Joe Wood Drive	Q = 175 gpm; TDH = 26.7 feet

gpm = gallons per minute
TDH = total dynamic head

SYSTEM CAPACITY

The capacity of the sanitary collection system is critical to system performance. The capacity is based on hydraulic characteristics of the sewers including size, slope, and roughness. Manning's equation was used to determine these capacities with a roughness coefficient of 0.013.

Capacities were determined for each of the sanitary system submains. The submains, named after corresponding streets, include: Main Street, Richwood Lane, Skinner, South Forest, Stone, Forest, Grove, Howard, Parker, and Drain Submains (Old S-41), and are labeled on Map 1.

Inverts were available for many of the submains from previous Tetra Tech work for the City. Some additional inverts were surveyed on January 5, and 8, 1996. With this data, the submain capacities were estimated using Manning's equation. The Manning's n was assumed to be 0.013 for all sewers. The capacity tables for each submain are located in Appendix B.

SANITARY FLOWS

The use of peak sanitary sewer flow rates is necessary to evaluate the sewer system, and to project design flow rates for the development of relief alternatives where flows exceed the capacity of the pipe. Peak sewer flows vary with the size of the tributary area and type of land use. As the tributary area increases, the peak flow rate per acre decreases due to attenuation. Also, infiltration and inflow (I/I), such as through footing drains, must also be considered when evaluating flows.

The City of Richmond has been subdivided into 21 service areas. These are shown on Map 2. Flows from service areas were determined based on land use. Existing and projected land uses in the Richmond service area include single and multiple-family residential, commercial (including office use), industrial, and public (schools, parks, and open space).

Existing Residential Equivalent Units (REUs) were obtained from the 2004 Master Plan study. Recent aerial photographs were used to confirm that no significant land use changes have occurred. Existing populations were determined using the information in Table 3 for land use classification.

Table 3

Estimated Population per Residential Classification

Classification	Persons per REU
Single-Family Residential	3.5
Multiple-Family Residential	2.0
Commercial	2.0
Industrial	2.0

To evaluate the potential magnitude of peak flows during storms, flows were projected for a 25-year, 24-hour storm event. The 2005 flow monitoring data was used to project existing peak flows from the observed data to the 25-year, 24-hour storm (approximately 3.9 inches) and includes five flow meters plus measured flows at the Richmond WWTP. Meter 1 is

located near the intersection of Diane Lane and S. Forest Avenue and has a tributary area of 390 acres. Meter 2 is located near the intersection of Forest and Bartell with a tributary area of 196 acres. Meter 3 is located at Division and Stone and has 193 acres tributary to it. Meter 4 is located just north of the Division Road Pump Station on Skinner Drive with 213 tributary acres. Meter 5 is located to the east of Division Road Pump Station on Division Road and has a tributary area of 81 acres. For more detailed flow monitoring data and meter locations, see The City of Richmond South Forest Avenue Infiltration/Inflow Study, February 2006, authored by Tetra Tech.

Table 4 summarizes the results of the projections.

Table 4
Observed Flow Measurements (2005) and Projected Design Flows

		Maximum Hour Flow (cfs)					
Event Date	**Rain (in)**	**WWTP**	**Meter 1 Diane Lane and S. Forest**	**Meter 2 Forest and Bartell**	**Meter 3 Division and Stone**	**Meter 4 Skinner N. of PS**	**Meter 5 Division E. of PS**
5/14/05	0.89	1.9	0.7	0.8	0.7	0.9	0.2
6/28/05	1.59	4.3	1.1	5.9	0.9	1.2	0.7
7/16/05	3.01	N/A[1]	2.2	4.9	1.3	1.8	1.1
Projections: 25-yr., 24-hr.	3.9	13.0	1.02	4.35	1.77	2.51	2.36

[1] The peak flow exceeded the measuring capacity of the Parshall Flume

Since 2005, the City has removed I/I from multiple locations within the system. Therefore, the flows observed at present conditions could be lower than projected from the 2005 data. Additional flow monitoring was completed in 2022 with a meter installed at the K-Mart Pump Station. The K-Mart Pump Station and 2022 flow monitoring is discussed in more detail in the Future Conditions section of this report.

Projected design flows for each meter were further divided for each submain. Table 5 summarizes the existing populations and 25-year, 24-hour peak flow projections for each submain.

Table 5

Existing Population and Peak Flow Rates

Submain	Existing Population	Peak Flows Projected for Existing Conditions (cfs)
Skinner	1,323	2.00
Howard	187	1.70
Stone	2,110	1.79
Drain	301	0.80
Forest	255	0.68
Grove	804	2.61
Richwood	214	0.31
Main	1,333	2.31
Parker	438	0.90

FUTURE CONDITIONS

FUTURE SERVICE AREAS

Potential future service areas could expand the existing service area significantly, as shown on Map 3. This includes predominantly industrial and commercial, but also residential growth. The basis for defining potential future service areas was taken from the City of Richmond and Surrounding Areas Growth Projection Map, prepared by the City of Richmond in June 2008 and subsequent recommendations from the City. Growth is occurring in new locations than previously projected in 2004, including a large projected sewer area in the northeast part of the City. Table 6 summarizes the future land use areas.

Table 6
Future Service Area for Various Land Uses

Land Use	Area (acres)
Low-Density Residential	120
Mixed Residential	162
Industrial	547
Commercial	288
Total Increased Area	1,117 (162% of existing)

Northwest

To the west of the Swan Creek development, it is assumed that approximately 118 acres of open space will become mixed density residential (Subareas 11A, 11B, and 12). In addition, approximately 44 acres (Subarea 13) to the south of the Swan Creek development is also planned to be mixed residential.

East/Southeast

The Lake Angela Estates development, with approximately 120 single-family units, is located in the southeast part of town. The sanitary sewers for this development have been designed, and flows are conveyed to the existing K-Mart Street Pump Station. The additional flow from

all phases of construction will require improvements to the pump station system. In addition, approximately 270 acres (Subareas 24, 33, and 34) to the southeast of the Lake Angela Estates development is planned to be commercial development.

In addition, several landowners have expressed an interest to annex into the City, specifically in St. Clair County to the east.

Northeast

Northeast of the City limits, growth is expected south of Pound Road, north of Division Road on both east and west sides of the railroad tracks (Subareas 23, 26, 31, and 32). This area of approximately 365 acres, as shown on Map 3, is assumed to be primarily industrial with sub-area 26 being mixed residential. Peak flows from this area may need on-site (equalization) storage, or other form of retaining peak flows, until the system has sufficient capacity. See detailed capacity analysis in "Future Flows" section of this report.

Central

Just west of the Grand Trunk Western Railroad, on the north side of the City, approximately 48 acres of industrial land use is projected for growth (Subarea 19).

As stated in the "Future Service Areas" section of this report, the future growth areas are significant. Table 7 provides the population equivalent values that can be accommodated with the existing infrastructure. If development demands larger population densities, additional accommodations will need to be considered to handle increased flow rates.

Table 7

Land Use Population Equivalents

Land Use	Population Equivalent (#ppl/acre)
Low-Density Residential	2.2
Mixed Residential	3.5
Industrial	4.2
Commercial	4.2

Table 8 below summarizes results of populations from future areas.

Table 8

Future Population and Peak Flow

Submain	Future Growth Area	Future Land Use	Area Size (acre)	Growth within Existing Area (persons)	Total Future Population Equivalent Growth (persons)
Forest	N/A	N/A	N/A	5	5
Howard	21	Industrial	151	0	2,053
	23	Industrial	70.5		
	24	Commercial	69		
	26	Commercial	17		
	31	Industrial	264.7		
	32	Commercial	14.5		
Main	29	Low-Density Residential	50.1	39	371
	29A	Mixed Residential	14		
	33	Commercial	44.2	0	155
	34	Commercial	142.4	0	498
Parker	11	Mixed Residential	87.6	11	681
	12	Mixed Residential	30.6		
	13	Mixed Residential	44		
Skinner	19	Industrial	48	1	167
South Forest	N/A	N/A	N/A	7	7
Total				**63**	**3,937**

Additional Note

Future service considerations do not account for any areas not shown on Map 3.

K-MART PUMP STATION EVALUATION

To further evaluate the impact of future service areas 29, 29A, 33, and 34 on the existing K-Mart Pump Station additional flow monitoring was completed in 2022. Flow monitoring was completed at the K-Mart Pump Station in May and June and flow results are shown in Figure 1 and Figure 2. A drawdown was completed at the station in March and determined an average pumping rate of 385 gpm.

Figure 1

Measured Flow Rates at K-Mart Pump Station – May 2022

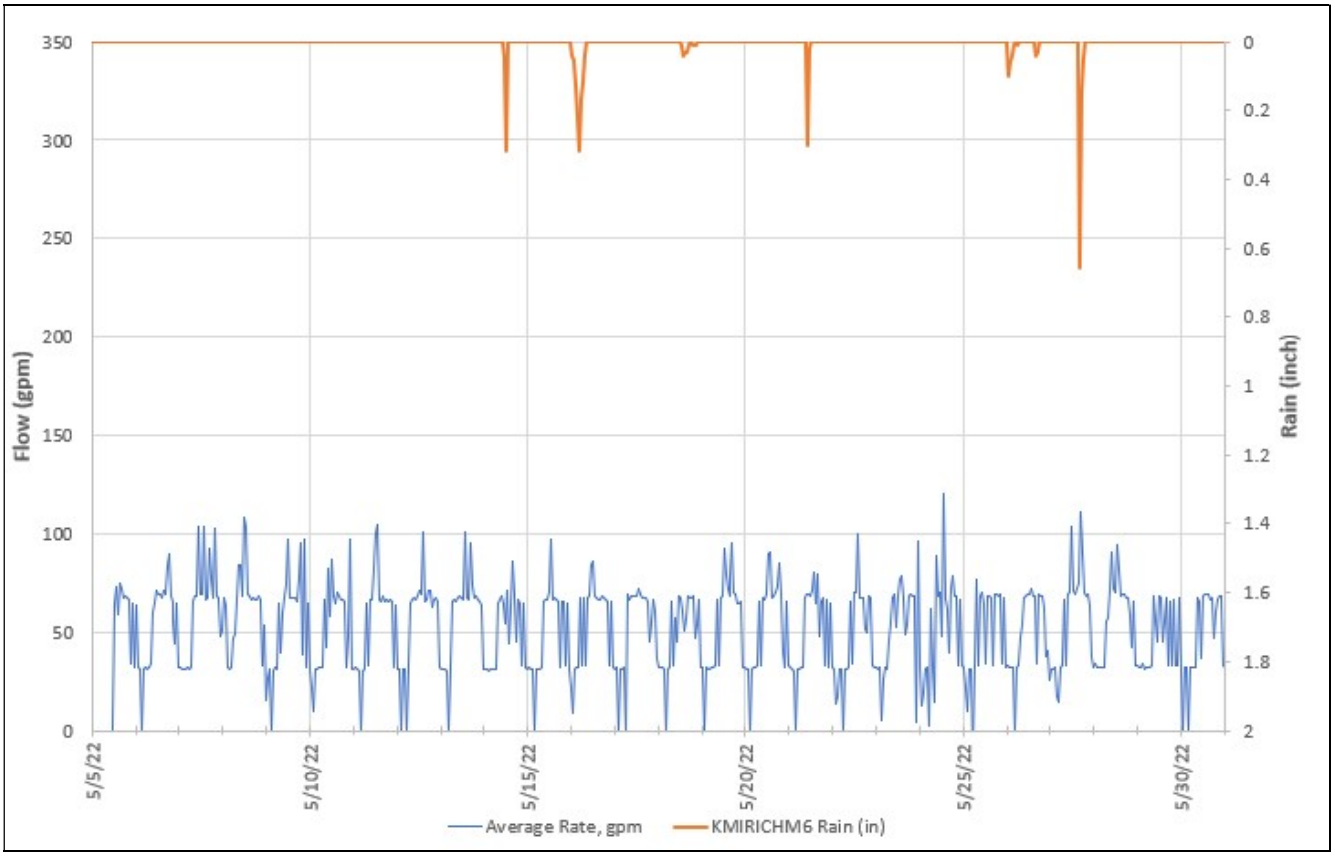
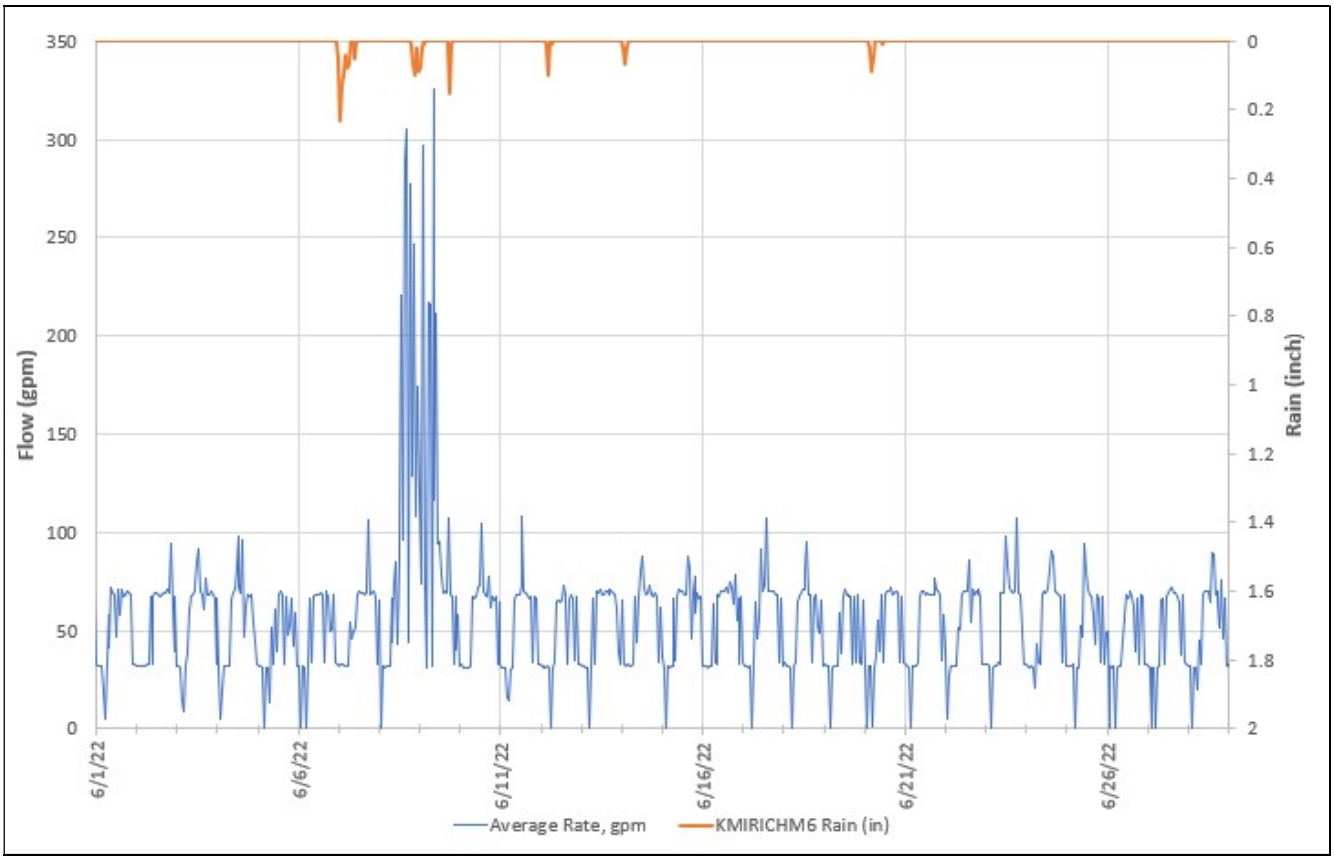


Figure 2

Measured Flow Rates at K-Mart Pump Station – June 2022

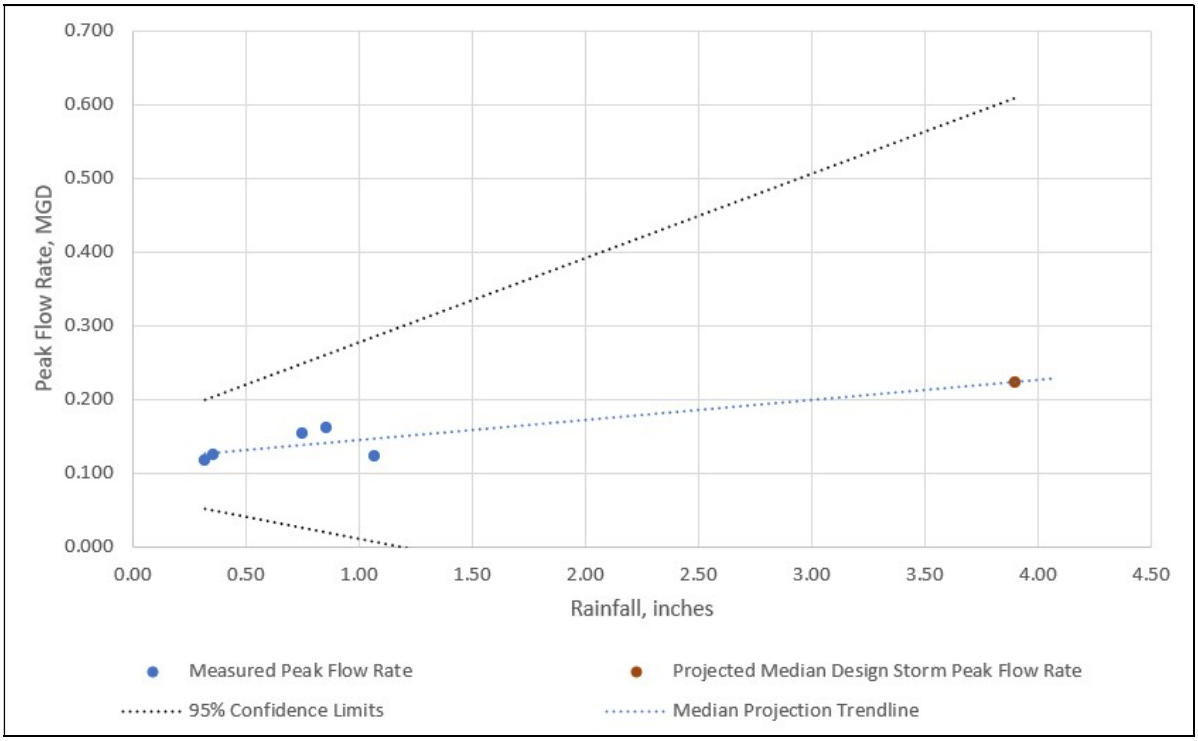


The flow and rainfall data collected was used to linearly project the peak flow rate during the 25-year, 24-hour design storm rainfall (3.90 inches) using the correlation between total rainfall and peak flow rate. The high flow rates shown between June 8h and 9th were not used for the flow projection because the high pump response on those days did not match the observed trend from all other rain events. Starting on June 9th the flow monitoring data showed pump 1 running for long periods of time between 30 minutes to over an hour until pump 2 kicked on. Since this same duration of pumping was not also observed with pump 2, it is likely that pump 1 was temporarily clogged or there was a data error for this period. Table 9 and Figure 3 summarize the results of the projection.

Table 9
Observed Flow Measurements (2022) and Projected Design Flows

		Maximum Hour Flow (cfs)	
Event Date	Rain (in)	WWTP	K-Mart PS Meter
5/14/2022	0.36	0.77	0.19
5/16/2022	1.07	1.35	0.19
5/21/2022	0.32	1.19	0.18
5/27/2022	0.86	1.82	0.25
6/7/2022	0.75	0.92	0.24
Projections: 25-yr., 24-hr.	3.9	13.0	0.35

Figure 3
Design Flow Projection



The flow monitoring period at the K-Mart Pump Station provided a 25-year, 24-hour storm projection of 0.35 cfs (155 gpm) that is below the design capacity of the station of 0.89 cfs (400 gpm). Future flow areas 29, 29A, 33 and 34 have a total projected peak flow of 0.29 cfs (260 gpm) and if this additional flow is added to the current conditions at the K-Mart Pump

Station the total peak flow to the station would be 0.93 cfs (415 gpm), which is slightly over the existing capacity of the station. To support growth in future flow areas, improvements to the K-Mart Pump Station will be needed to increase capacity at the station as detailed in the "Proposed Improvements" section of this report. We recommend that increasing K-Mart Pump Station capacity be reconsidered as future development occurs.

SANITARY FLOWS

Table 10 summarizes peak per capita flows used in the capacity analysis. The peak flows are based on predictions extrapolated for the 25-year, 24-hour storm from the 2005 and 2022 flow monitoring results. Additional future flows are based on projected future populations as discussed in the aforementioned section of this report. The peak flow for future populations was assumed to be 225 gallons per capita per day.

All flow data tables, including capacities of each submain, are presented in Appendix B.

Table 10

Peak Hour System Flows to Wastewater Treatment Plant

	Existing Flow					Future Flow					
Location Reference	**Incremental Population (persons)**	**Incremental per Capita Flow (gpcpd)**	**Incremental Flow (cfs)**	**Upstream Peak Flow (cfs)**	**Total Existing Flow (cfs)**	**Incremental Population Equivalent from Growth (persons)**	**Incremental Per Capita Flow from Growth (gpcpd)**	**Incremental Flow from Growth (cfs)**	**Upstream Flow from Growth (cfs)**	**Total Flow from Growth (cfs)**	**Total Projected Flow (cfs)**
Howard Submain											
Howard Street	187	5,979	1.73		1.73						
Division Road				1.73	1.73	2,053	225	0.71		0.71	2.44
Skinner Submain											
Skinner Drive	1,323	987	2.00		2.00	168	225	0.06		0.06	2.06
Stone Submain											
Stone Submain - all	2,110	548	1.79		1.79						1.79
Forest Submain											
Forest Submain - all	255	1,694	0.68		0.68	5	225	0.00			0.68
Drain Submain											
Up to Division Road	46	1,694	0.12		0.12						
Up to Forest Avenue (includes Forest Submain)			0.68	0.12	0.80						0.80
Grove Submain											
Grove Submain - all	804	2,106	1.99		1.99				0.24	0.24	2.23
Parker Submain											
Parker Submain - all	438	1,325	0.90		0.90	1,681	225	0.24		0.24	1.14
Richwood Submain											
Richwood Submain - all	214	1,694	0.31		0.31	44	225	0.02		0.02	0.33

	Existing Flow					Future Flow					
Location Reference	**Incremental Population (persons)**	**Incremental per Capita Flow (gpcpd)**	**Incremental Flow (cfs)**	**Upstream Peak Flow (cfs)**	**Total Existing Flow (cfs)**	**Incremental Population Equivalent from Growth (persons)**	**Incremental Per Capita Flow from Growth (gpcpd)**	**Incremental Flow from Growth (cfs)**	**Upstream Flow from Growth (cfs)**	**Total Flow from Growth (cfs)**	**Total Projected Flow (cfs)**
Main Submain											
Main Submain - all	1333	1,246	2.31		2.31	822	225	0.35		0.35	2.66
S. Forest Main											
Skinner Drive to Stone Street (Howard and Skinner Submains)			3.73		3.73			0.77		0.77	4.5
Stone Street to Bartell Street (includes Howard, Skinner, Stone, Grove, and Drain Submains)			4.58	3.73	8.31			0.24	0.77	1.01	9.32
Bartell Street to Richwood Lane (includes Howard, Skinner, Stone, Grove, Drain, and Richwood Submains and Areas 6A and 6B)			1.52	8.31	9.83	51	225	0.02	1.01	1.03	10.86
Richwood Lane to Chaskey Avenue (includes Howard, Skinner, Stone, Parker, Drain, Richwood, and Main Submains Areas 6A and 6B)			2.31	9.83	12.14			0.35	1.03	1.38	13.52

SYSTEM ADEQUACY

A set of criteria must be developed to determine the adequacy of the sanitary sewer system. Map 3 shows the potential future service areas and their connection points to the existing system provided by the City of Richmond in the "City of Richmond and Surrounding Areas" map published on June 12, 2008. The City is projecting a significant increase in sanitary sewer service area northeast and east of the City limits. The following is a summary of the criteria for identifying and prioritizing problem areas.

Criteria for Identifying and Prioritizing Problem Areas

The capacities of the trunk sanitary sewers were compared with existing and projected peak flow estimates to evaluate existing and future problems. Improvements were proposed if the sewer is projected to experience peak flows much larger than the capacity of the sewer.

Additional improvements for sewers may be warranted if other factors of the sewer's performance indicate that an unsatisfactory level of service may be expected, such as a shallow depth of sewer reach, heavy maintenance, or infiltration.

Results

Each submain was analyzed using the approach listed above. Growth was assumed to discharge to the adjacent sewers. The existing system is satisfactory in most locations to handle existing flows but needs some improvements for future flows.

For future flows, some trunk sewers will need capacity improvements. Three submains will have flows below capacity: Drain (Old S-41), Parker, and Richwood. Forest, Howard, Skinner, and Stone have sewers at capacity. Grove, Main, and South Forest have portions of sewers with projected peak flows which are greater than the sewer capacity.

The South Forest main is the main interceptor to the Wastewater Treatment Plant (WWTP). Estimated flows and capacity calculations for this main include the conservative assumption that all five tributary pump stations are in simultaneous operation.

PROPOSED IMPROVEMENTS

Due to the large potential areas of expanded service, the sanitary system cannot adequately convey all future flows. Improvements have been identified and separated into "projects." The projects have been defined based on recommended conveyance paths to the plant, such as the slope of the land, available submain capacity, and location of railroad rights-of-way.

Project cost opinions do not include sewer construction within each of the future service areas (including the proposed pump station and force main located at the east end of Division Road). The construction of sewers in future areas is assumed to be performed as part of the land development process.

A more detailed analysis should be performed when service is desired. The design should ensure that the best method of conveying the flow is used but should always consider the future condition and corresponding recommendation from this Master Plan.

Map 4 represents our recommendations for pipe conveyance improvements by increasing the pipe size and keeping the pipe slope unchanged. Based on the age of the Richmond system, pipe replacement is the most likely alternative, rather than building a relief to an older pipe.

Following is a description of each project. The associated costs are described in the next section.

- Project 1, Grove Submain: The 2,220 feet of 12-inch sanitary sewer from 450 feet west of Division and Parker to Bartel and South Forest does not adequately convey future flows. The recommendation is to replace the 12-inch sewer with 15-inch sewer. This sewer would likely be located down the streets.
- Project 2, Main Submain: Due to the increased service area, and subsequent increased peak flow rates, the existing 12- and 15-inch sewer is marginally undersized from the force main discharge on Main Street to South Forest, and Gleason, just west of the Grand

Trunk Western Railroad. The recommendation is to replace the existing 12-inch and 15-inch sewer with 15- and 18-inch sewers. However, this area has shown no history of problems, surcharging, or basement backups. Therefore, we recommend the City consider removal of I/I along this submain to perhaps eliminate this project.

- Project 3, Circle Lane Pump Station and Force Main: Flows from future service Areas 11A, 11B, 12, and 13 will be directed to Parker Subdivision. The area being very flat, a pump station will be needed at the connecting point between Area 13 and Circle Lane. Although the 18-, 12-, and 24-inch pipes of Parker submain have enough capacity to convey these future flows, the 8-inch and 10-inch pipes along Circle Lane, Ridge Street, Churchill Street, and Parker Street do not have the required available capacity. Therefore, the force main will extend all the way to Park and Parker Streets. The pump station and force main will be the responsibility of the developers of these areas.

- Project 1 and 3 Alternative: It may be possible to eliminate Projects 1 and 3 by directing some of the flow from service areas 11A, 11B, 12 and 13 to the existing Swan Creek Estates development and some of the flow south to the Richwood Pump Station. This would require an additional 12-inch gravity sewer from the future service area to 32 Mile Road and from 32 Mile Road to the to the existing cross county 12-inch gravity sewer that goes to Woodside Drive to convey flow to the Richwood Pump Station. This additional gravity sewer would be the responsibility of the developers of this area.

  A more detailed study should be conducted at the time of growth to determine if there is capacity at both the Swan Creek and Richwood Lane Pump Stations to accommodate this additional flow, and the developer would need to determine if this alternative is feasible considering the topography of the site and the depth of the existing sewers that would be tied into.

- Project 4. K-Mart Pump Station: The K-Mart Pump Station will require an upgrade to convey future flows. The sanitary pump station, located on Main Street and Muttonville Lane, would require an increase in capacity from 400 gpm to approximately 500 gpm. A more detailed study should be conducted at the time of growth to determine if the

existing pump station facility can accommodate additional capacity or if a new facility is warranted. Additional capacity is only projected to be needed after future areas 29, 29A, 33, and 34 are completely built out, and depending on the accuracy of the future flow predictions for this area, Project 4 may not be necessary.

Additional Notes

There are still a few locations where the projected peak flow is slightly greater than the sewer capacity (See Appendix B for detailed submain results). In many cases, these exceedances are a result of existing flows and not growth. No documented history of problems exists for these sewers and the sewers under capacity are for short pipe segments, typically one sewer reach; therefore, no improvements are recommended. It is recommended that the City consider monitoring these locations during storm events for surcharging or other obstructions to flow. Should land use differ from that assumed (i.e., higher sewer demand) additional improvements beyond those described in this report could be required. Periodic review of increases in water consumption, and land use plans from proposed development along with some strategically placed flow monitors, could be useful to determine when improvements are needed.

Substantial sanitary sewer infrastructure construction is necessary within each of the future service areas. In addition, in many of the areas, topography does not permit gravity flow to the existing submains. Therefore, pump stations should be located by the developers at lower elevations; flow will then be pumped to the existing submains. Note the arrows on Map 3 indicating the general slope of the undeveloped areas, and the proposed connection points to the existing collection system.

PLANT CAPACITY

The Richmond WWTP, located northwest of 31 Mile Road and the Grand Trunk Western Railroad, currently has an annual average daily flow of approximately 0.64 mgd (0.92 cfs). In

July 2021 to June 2022, it was observed that average daily flow increases in the spring by 12% at 0.71 mgd (1.1 cfs) and no decrease in average flow was observed in winter months.

The WWTP was designed for a population of 6,860 persons. The design average daily flow with recycle was 0.90 mgd, while the maximum daily dry weather design flow was 1.50 mgd. Thus, the plant can treat the existing average daily flows of approximately 0.64 mgd.

The future flows, however, are projected to exceed the current design capacity. The average daily flow in the future is estimated to be 1.06 mgd (1.63 cfs) from a future population equivalent of approximately 10,784. Population equivalent includes flow from commercial and industrial users (actual population will be lower). This is larger than the design flow of the current plant. Therefore, the WWTP will require an upgrade. Costs for upgrade of the WWTP are not in the scope of this project.

CONSTRUCTION PROBABLE COST OPINIONS

Construction probable cost opinions have been computed for the sewer system improvement projects. Opinions were prepared assuming connections to the existing system as proposed on Map 3. Construction probable cost opinions are summarized in Table 11 with details presented in Appendix C.

The construction probable cost opinions are based on traditional pipe installation methods and do not consider the cost-effectiveness of trenchless alternatives and do not include costs for easement acquisition. To project anticipated cost increases beyond 2022, a table of escalation factors is provided in Appendix C.

Table 11

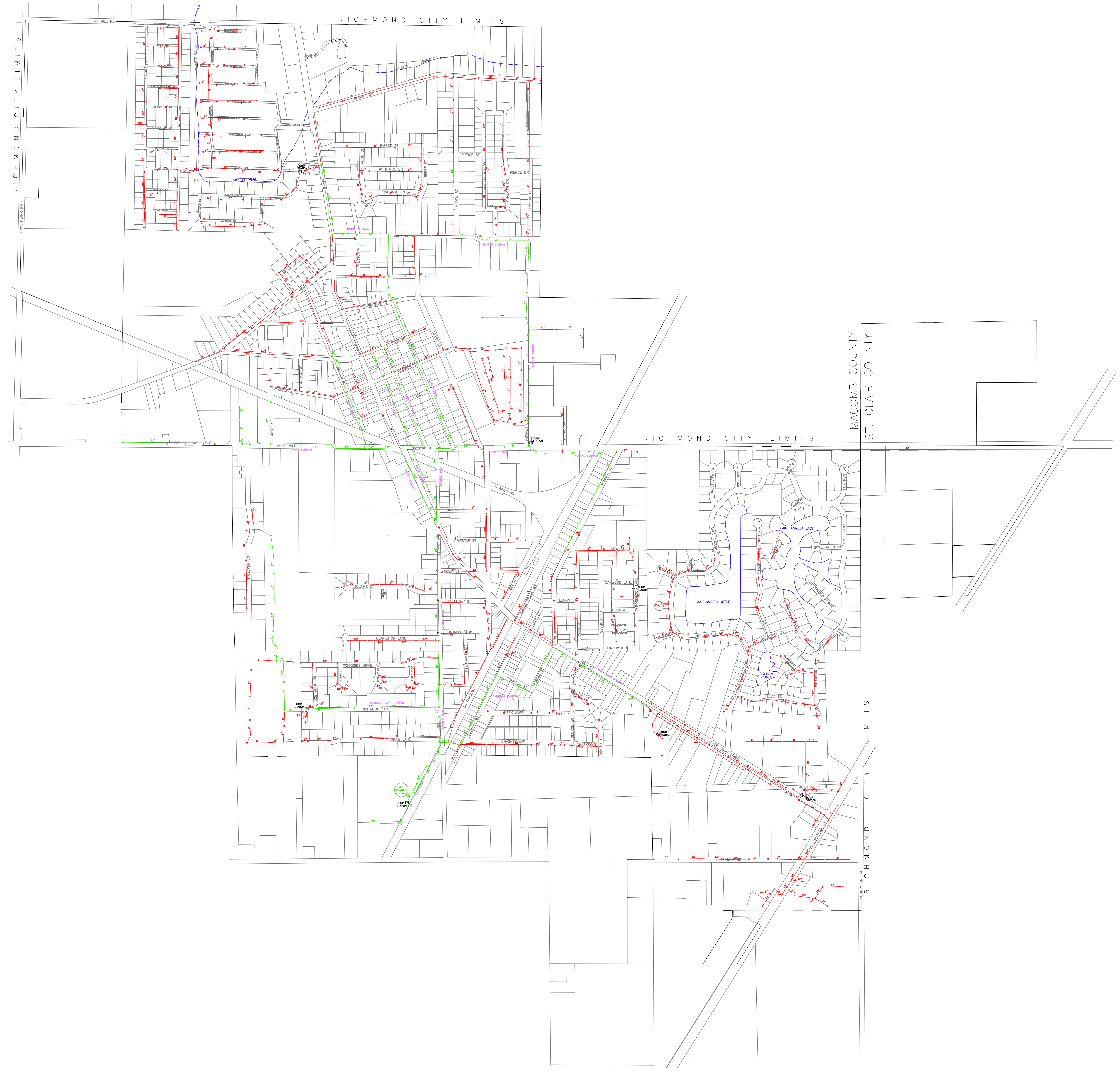
Construction Probable Cost Opinions

Project No.	Location	Reason	Street Improvement Schedule	Opinion of Probable Cost
1. Grove Submain	Division Road (from 425 feet west of Parker to Bartell and S. Forest)	Support growth from future Areas 11, 12, and 13.	2026	$471,000
2. Main Street Submain	Force main discharge to S. Forest and Gleason (west of the Grand Trunk Railroad)	Support growth from all future areas 29, 29A and existing Kroger Plaza..	Not available	Developer
3. Circle Lane Pump Station and associated force main	Pump Station: Circle Lane Force Main: From Circle Lane to Park and Parker	Support growth from future Areas 11, 12, and 13.	-	Developer
3A. Project 1 and 3 Alternative	New 12-inch gravity sewer from future areas to Stoecker Lane	Support growth from future areas 11, 12, and 13.	-	Developer
4. K-Mart Pump Station	Increased capacity to pump station on Main Street and Muttonville Lane	Support growth from future areas 29, 29A, 33, and 34	-	Developer
Total				**$471,000**

APPENDIX A

Maps

1. Existing Sanitary Sewer Collection System
2. Sanitary Sewer Submain with Subareas
3. Sanitary Sewer with Future Service Areas
4. Proposed Sanitary System Improvements



NOTES:

1. THE BASEMAP DRAWING WAS PREPARED FOR THE CITY BY WADE TRIM AND ASSOCIATES.

TETRA TECH

LEGEND

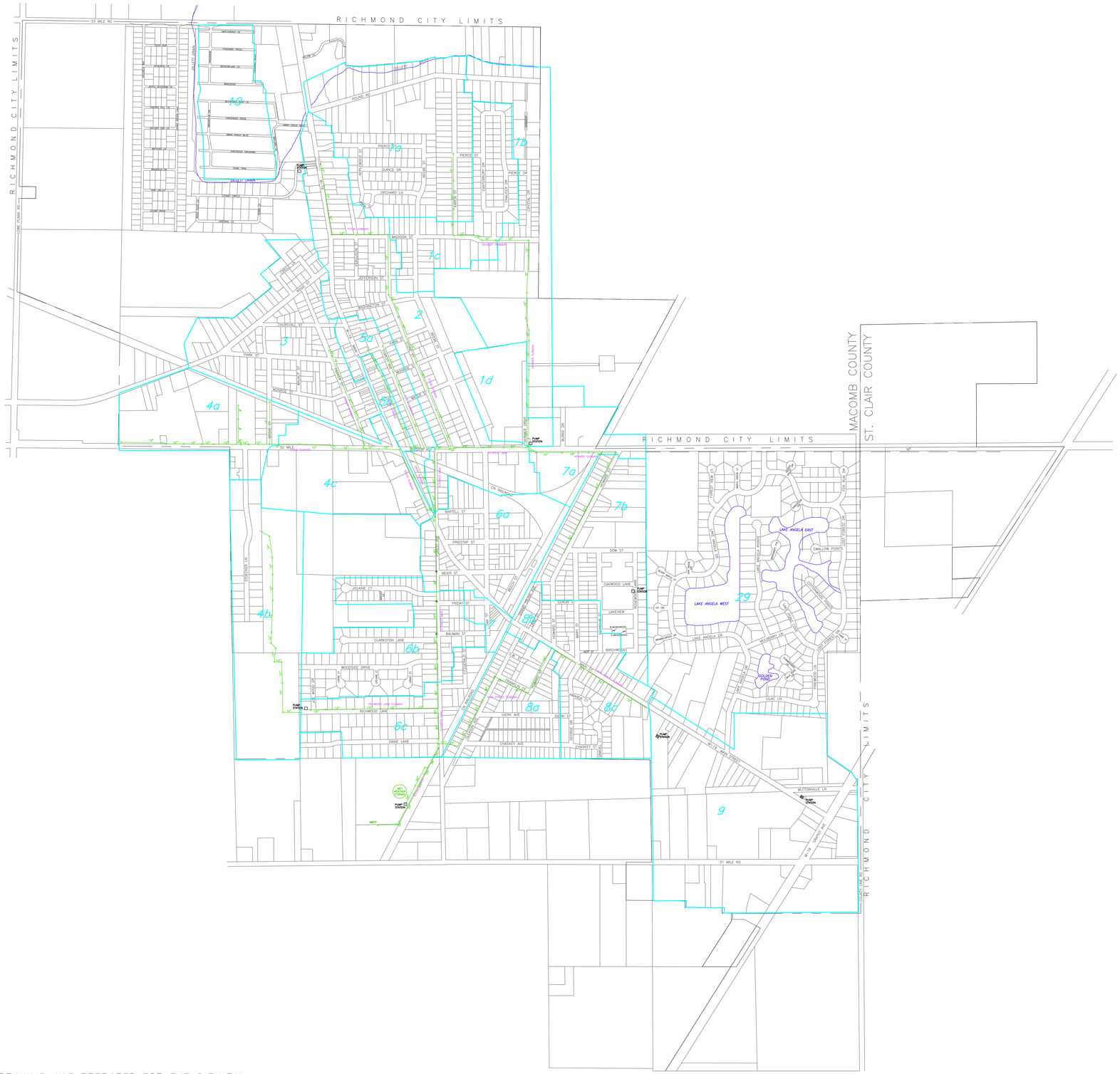
○	SANITARY MANHOLE
8"	SANITARY SEWER COLLECTORS
12"	SANITARY SEWER SUBMAINS

500' 250' 0 500' 1000'
SCALE: 1" = 500'

CITY OF RICHMOND, MACOMB COUNTY, MICHIGAN
SANITARY SYSTEM MASTER PLAN
JUNE 2022

MAP 1
EXISTING SANITARY SEWER COLLECTION SYSTEM

\\TT.LOCAL\IER\PROJECTS\PT HURON\IER\12751\200-12751-20004\DOCS\REPORTS\2022 MSTR PLAN UPDATES\SANITARY\APPENDIX\SOURCE\SEWERS.DWG



NOTES:

1. THE BASEMAP DRAWING WAS PREPARED FOR THE CITY BY WADE TRIM AND ASSOCIATES.

TETRA TECH

LEGEND

- SANITARY MANHOLE
- SUBAREA BOUNDARIES
- 12" SANITARY SEWER SUBMAINS

N

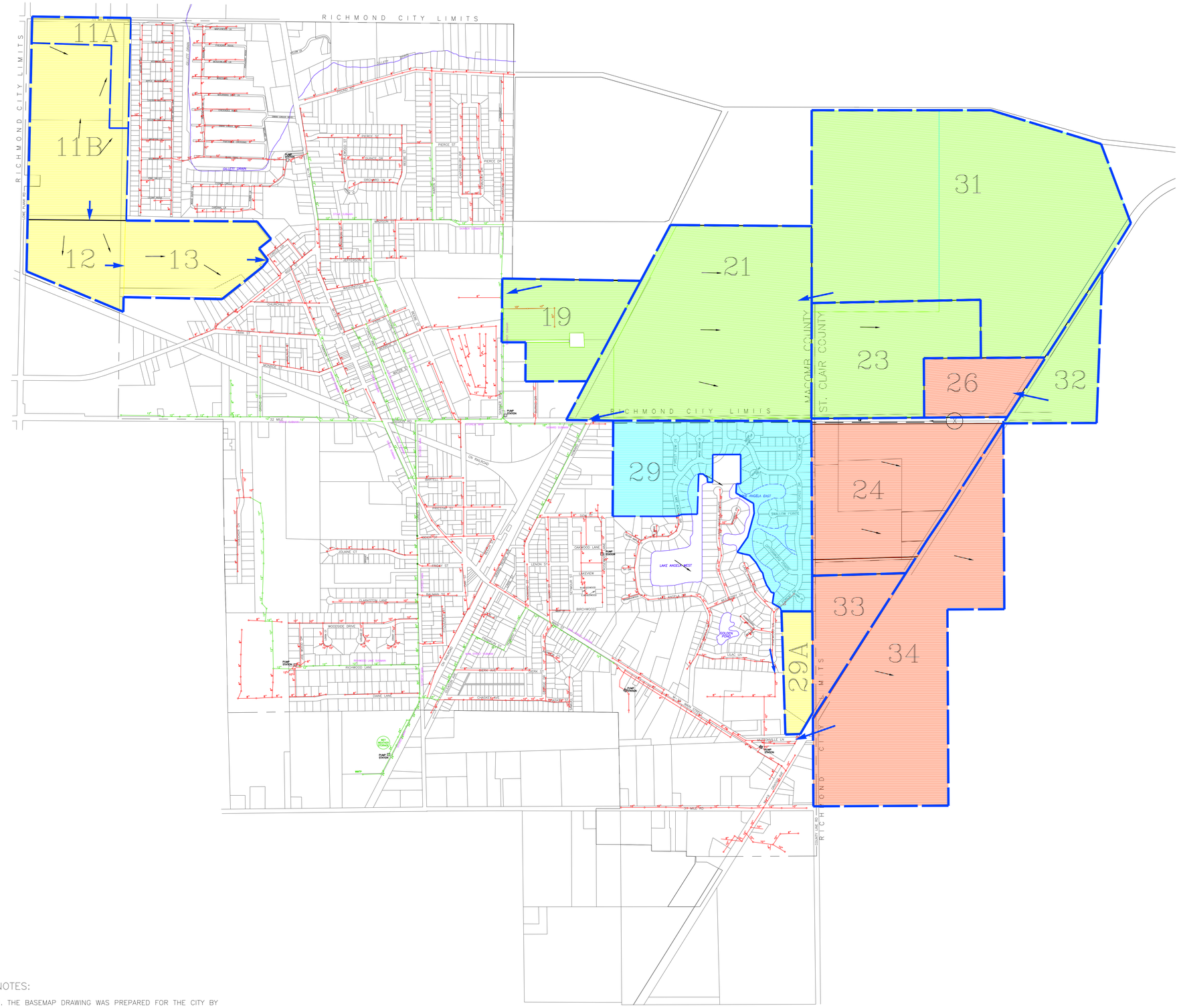
500' 250' 0 500' 1000'

SCALE: 1" = 500'

CITY OF RICHMOND, MACOMB COUNTY, MICHIGAN
SANITARY SYSTEM MASTER PLAN
JUNE 2022

MAP 2
EXISTING SANITARY SEWER SUBMAINS W/SUBAREAS

\\TT.LOCAL\ER\PROJECTS\PT HURON\ER\12751\200-12751-20004\DOCS\REPORTS\2022 MSTR PLAN UPDATES\SANITARY\APPENDIX\SOURCE\SERVAREA.DWG



NOTES:

1. THE BASEMAP DRAWING WAS PREPARED FOR THE CITY BY WADE TRIM AND ASSOCIATES.

TETRA TECH

LEGEND

- SANITARY MANHOLE
- 12" SANITARY SEWER SUBMAINS
- 10" SANITARY SEWER COLLECTORS
- FUTURE SERVICE AREA IMPROVEMENT BOUNDARIES
- PROPOSED CONNECTION POINT TO EXISTING SYSTEM
- DOWNWARD GROUND SLOPE
- X POSSSIBLE LOCATION OF FUTURE PUMP STATION
- 12" POSSIBLE SIZE AND LOCATION OF FUTURE FORCE MAIN

FUTURE SERVICE AREAS

- MIXED RESIDENTIAL
- LOW DENSITY RESIDENTIAL
- INDUSTRIAL
- COMMERCIAL

N

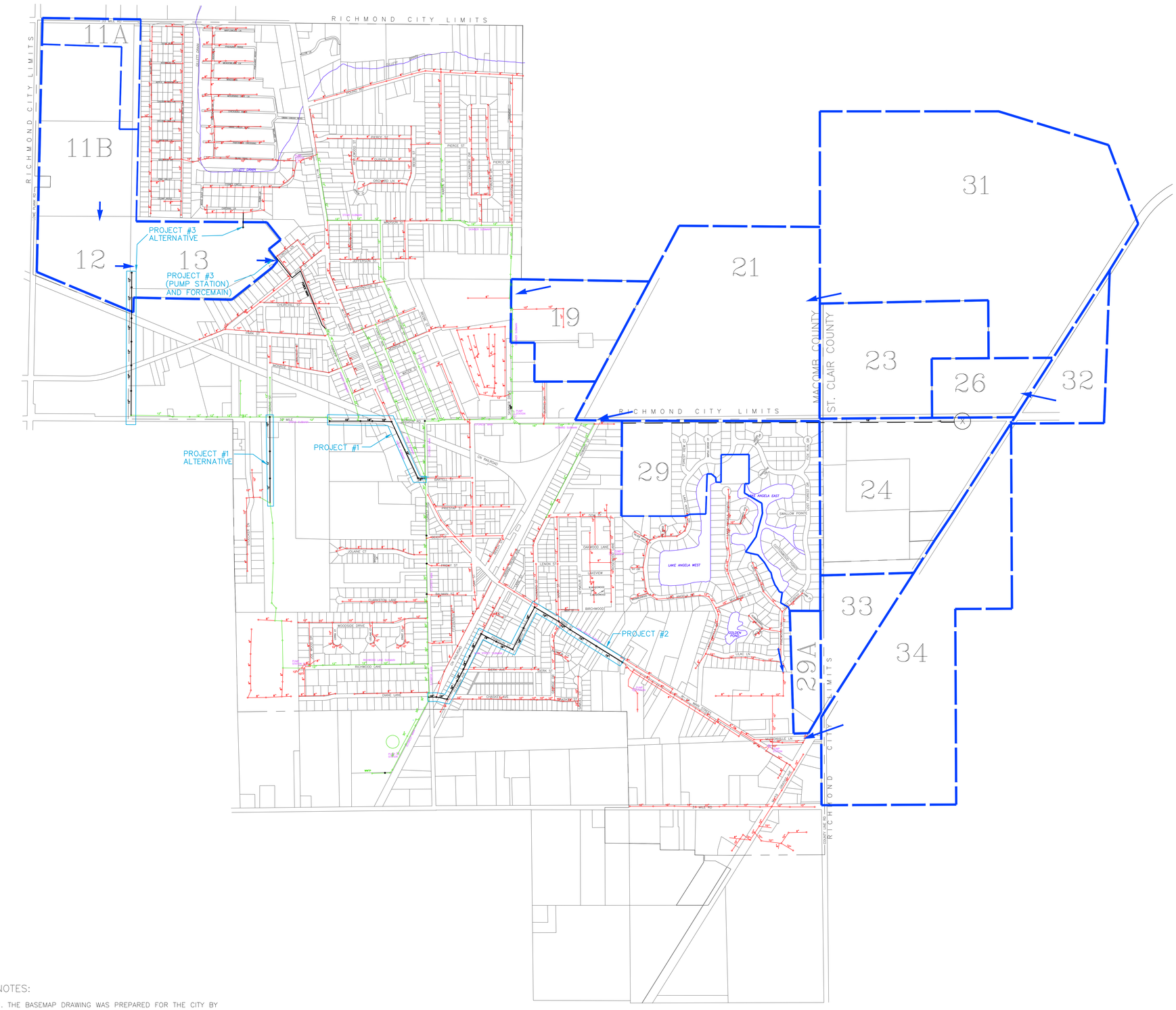
500' 250' 0 500' 1000'

SCALE: 1" = 500'

CITY OF RICHMOND, MACOMB COUNTY, MICHIGAN
SANITARY SYSTEM MASTER PLAN
JUNE 2022

MAP 3
SANITARY SEWERS W/ FUTURE SERVICE AREAS

\\TT-LOCAL\IER\PROJECTS\PT HURON\IER\12751\200-12751-20004\DOCS\REPORTS\2022 MSTR PLAN UPDATES\SANITARY\APPENDIX\SOURCE\FUTAREA.DWG



NOTES:

1. THE BASEMAP DRAWING WAS PREPARED FOR THE CITY BY WADE – TRIM / ASSOCIATES.

TETRA TECH

LEGEND

- 12" — EXISTING SUBMAINS (WITH DIAMETERS)
- 12" — PROPOSED SUBMAINS IMPROVEMENTS (WITH DIAMETERS)
- 12" — EXISTING SANITARY SEWERS (WITH DIAMETERS)
- ○ SANITARY MANHOLE
- PROPOSED CONNECTION POINT TO EXISTING SYSTEM
- FUTURE SERVICE AREA IMPROVEMENT BOUNDARIES
- (X) POSSIBLE LOCATION OF NEW PUMP STATION
- 12" — POSSIBLE SIZE AND LOCATION OF NEW FORCE MAIN

N

500' 250' 0 500' 1000'

SCALE: 1" = 500'

CITY OF RICHMOND, MACOMB COUNTY, MICHIGAN
SANITARY SEWER MASTER PLAN UPDATE
JUNE 2022

MAP 4
PROPOSED SANITARY SYSTEM IMPROVEMENTS

\\TT.LOCAL\IER\PROJECTS\PT HURON\IER\12751\200-12751-20004\DOCS\REPORTS\2022 MSTR PLAN UPDATES\SANITARY\APPENDIX\SOURCE\MAP4.DWG

APPENDIX B

Flow/Capacity Computation Sheets

1. Drain Submain (Old S-41)
2. Forest Submain
3. Grove Submain
4. Howard Submain
5. Main Street Submain
6. Parker Submain
7. Richwood Lane Submain
8. Skinner Submain
9. South Forest Main
10. Stone Submain

DRAIN SUBMAIN

Subarea		Number of Units				Number of Persons				Subarea	Pump	Pk Flows
Number		SFR	MFR	Comm	Ind	SFR	MFR	Comm	Ind	Population	Flow (cfs)	(cfs)
5b	Existing	13	0	0	0	46	0	0	0	46	0.00	0.12
	Future	0	0	0	0	0	0	0	0	0		0.00
	Projected	13	0	0	0	46	0	0	0	46	0.00	0.12
Forest	Existing	67	0	10	0	235	0	20	0	255	0.00	0.68
	Future	0	0	3	0	0	0	5	0	5		0.00
	Projected	67	0	13	0	235	0	25	0	260	0.00	0.68

DRAIN SUBMAIN

	Population						Existing	Future	Future % Cap
Location Reference	Existing	Projected	Seg. Length (ft)	Size (in)	Slope (%)	Capacity (cfs)	Peak. (cfs)	Peak (cfs)	Used
Park btwn Forest & Main									
	46	46	380	18	1.50	12.88	0.12	0.12	1
Monroe btwn Forest & Main									
	46	46	380	18	0.26	5.39	0.12	0.12	2
Water btwn Forest & Main									
	46	46	585	18	0.09	3.16	0.12	0.12	4
Division btwn Forest & Main									
	306	306	770	18	0.11	3.53	0.80	0.80	23
	306	306	40	18	25.45	52.99	0.80	0.80	2
Bartell & S. Forest									

Note: Future % Capacity is the percent of the capacity which will be used in the future.
Peak Future Flows represent existing peak plus future peak flows.
Existing Peak Flows: 1,694 gal/capita/day

FOREST SUBMAIN

Subarea Number		Number of Units				Number of Persons				Subarea Population	Cumulative Population	Pump Flow (cfs)	Pk Flows (cfs)
		SFR	MFR	Comm	Ind	SFR	MFR	Comm	Ind				
5a	Existing	67	0	10	0	235	0	20	0	255	255	0.00	0.68
	Future	0	0	3	0	0	0	5	0	5	5		0.00
	Projected	67	0	13	0	235	0	25	0	260	260	0.00	0.68

FOREST SUBMAIN

	Population						Existing	Future	Future % Cap
Location Reference	Existing	Projected	Seg. Length (ft)	Size (in)	Slope (%)	Capacity (cfs)	Peak (cfs)	Peak (cfs)	Used
Park & Forest									
	255	260	375	12	0.11	1.20	0.68	0.68	56
Monroe & Forest									
	255	260	380	12	0.11	1.20	0.68	0.68	57
Water & Forest									
	255	260	690	12	0.03	0.64	0.68	0.68	107
Division & Forest									
	255	260	210	12	0.50	2.52	0.68	0.68	27

Note: Future % Capacity is the percent of the capacity which will be used in the future.
Peak Future Flows represent existing plus future peak flows.
Existing Peak Flows: 1,694 gal/capita/day

Grove Submain

Subarea		Number of Units				Number of Persons				Subarea	Pump	Pk Flows
Number		SRF	MFR	Comm	Ind	SRF	MFR	Comm	Ind	Population	Flow (cfs)	(cfs)
4a	Existing	6	0	5	25	23	0	10	50	83	0.00	0.28
	Future	0	0	0	0	0	0	0	0	83	0.00	0.00
	Projected	6	0	5	25	23	0	10	50	166	0.00	0.28
Future 14A, 14B	Existing	0	0	0	0	0	0	0	0	0	0.00	0.00
	Future	139	0	0	0	626	0	0	0	0	0.00	0.10
	Projected	139	0	0	0	626	0	0	0	0	0.00	0.10
4c	Existing	0	0	6	50	0	0	12	100	113	0.62	0.39
	Future	0	0	0	0	0	0	0	0	0	0.00	0.00
	Projected	0	0	6	50	0	0	12	100	113	0.62	0.39
PARKER SUBMAIN	Existing	120	0	9	0	420	0	18	0	438	0.62	0.90
	Future	432	0	0	0	1,957	0	0	0	1,957	0.00	1.21
	Projected	552	0	9	0	2,377	0	18	0	2,395	0.62	2.11

Grove Submain

Location Reference	Population		Segment Length (ft)	Size (in)	Slope (%)	Capacity (cfs)	Existing Peak (cfs)	Future Peak (cfs)	Proposed Size (in)	Future Capacity (cfs)	Future % Capacity Used
	Existing	Projected									
Division Street (at City Limits)											
	83	709	820	12	0.22	1.67	0.28	0.38			23
	83	709	50	12	0.22	1.67	0.28	0.38			23
	83	709	175	12	0.22	1.67	0.28	0.38			23
	83	709	150	12	0.22	1.67	0.28	0.38			23
	83	709	270	12	0.22	1.67	0.28	0.38			23
	83	709	110	12	0.22	1.67	0.28	0.38			23
	83	709	300	12	0.22	1.67	0.28	0.38			23
Division & Grove											
	196	882	385	12	0.23	1.71	0.67	0.77			45
Division & Walnut											
	196	882	370	12	0.23	1.72	0.67	0.77			45
	196	882	40	12	3.93	7.06	0.67	0.77			11
	196	882	425	12	0.16	1.40	0.67	0.77			55
Division & Parker											
	634	3,277	160	12	0.16	1.41	1.57	2.88	18.00	4.15	69
	634	3,277	255	12	0.20	1.59	1.57	2.88	18.00	4.70	61
	634	3,277	415	12	0.21	1.63	1.57	2.88	18.00	4.81	60
	634	3,277	415	12	0.20	1.59	1.57	2.88	18.00	4.70	61
	634	3,277	100	12	0.21	1.63	1.57	2.88	18.00	4.81	60
Bartel & S. Forest											

Note: Future % Capacity is the percent of the capacity that will be used in the future.
Peak Future Flows represent existing plus future peak flows.
Existing Peak Flows: 2,106 gal/capita/day (for areas 4a and 4c)

HOWARD SUBMAIN

Subarea Number		Number of Units				Number of Persons				Subarea Population	Pump Flow (cfs)	Pk Flows (cfs)
		SFR	MFR	Comm	Ind	SFR	MFR	Comm	Ind			
7b	Existing	50	0	0	0	175	0	0	0	175	0.00	1.59
	Future	0	0	0	0	0	0	0	0	0		0.00
	Projected	50	0	0	0	175	0	0	0	175	1.59	1.59
Fut Dev 21,23,24, 26,31,32	Existing	0	0	0	0	0	0	0	0	0	0.31	0.00
	Future	0	0	430	1061	0	0	1005	4862	5867		0.91
	Projected	0	0	430	1061	0	0	1005	4862	5867	2.50	0.91
7a	Existing	0	0	0	6	0	0	0	12	12	0.31	0.11
	Future	0	0	0	0	0	0	0	0	0		0.00
	Projected	0	0	0	6	0	0	0	12	12	2.61	0.11

HOWARD SUBMAIN

	Population						Existing	Future	Future % Cap
Location Reference	Existing	Projected	Seg. Length (ft)	Size (in)	Slope (%)	Capacity (cfs)	Peak (cfs)	Peak (cfs)	Used
Howard & Dow									
	187	187	365	12	0.22	1.67	1.70	1.70	102
	187	187	375	12	0.30	1.96	1.70	1.70	87
	187	187	370	12	0.21	1.61	1.70	1.70	105
	187	6,054	330	12	0.82	3.23	1.70	2.61	81
Howard & Division									
	187	6,054	360	15	0.34	3.75	1.70	2.61	70
	187	6,054	350	15	0.15	2.49	1.70	2.61	105
	187	6,054	370	15	0.18	2.73	1.70	2.61	96
Burke Dr. & Division									
	187	6,054	90	15	0.18	2.72	1.70	2.61	96
Skinner & Division									
	187	6,054	60	15	0.18	2.72	1.70	2.61	96
Lift Station									

Note:

Future % Capacity is the percent of the capacity which will be used in the future.
Peak Future Flows represent existing plus future peak flows.
Existing Peak Flows: 5,979 gal/capita/day
Future Population Peak Flows: 400 gal/capita/day
Future peak flows account for 100 gpcpd for proposed development subareas #21, 23, 24, 26, 31, and 32; it is assumed all additional flows above 100 gpcpd coming from these subareas will be stored or pumped directly to the WWTP.
*For planning purposes, assume 18-inch will be adequate. Capacity could be increased through various means such as smoother pipe (plastic) or a steeper slope.

MAIN SUBMAIN

Subarea Number		Number of Units				Number of Persons				Subarea Population	Pump Flow (cfs)	Pk Flows (cfs)
		SFR	MFR	Comm	Ind	SFR	MFR	Comm	Ind			
KROGER Plaza	Existing	0	0	4	0	0	0	74	0	74	0.00	0.14
	Future	0	0	0	0	0	0	0	0	0		0.00
	Projected	0	0	4	0	0	0	74	0	74	0.00	0.14
Area 29	Existing	135	0	0	0	351	0	0	0	351	0.00	0.62
Lk Angela, 29a	Future	120	0	0	0	312	168	0	0	480		0.29
	Projected	255	0	0	0	663	168	0	0	831	0.00	0.91
9	Existing	0	0	40	40	0	0	80	80	160	0.00	0.28
	Future	0	0	10	0	0	0	20	0	20		0.01
	Projected	0	0	50	40	0	0	100	80	180	0.00	0.29
33	Existing	0	0	0	0	0	0	0	0	0	0.00	0.00
	Future	0	0	192	0	0	0	442	0	442		0.07
	Projected	0	0	192	0	0	0	442	0	442	0.00	0.07
34	Existing	0	0	0	0	0	0	0	0	0	0.00	0.00
	Future	0	0	619	0	0	0	1424	0	1424		0.22
	Projected	0	0	619	0	0	0	1424	0	1424	0.00	0.22
K-Mart	Existing	0	0	0	0	0	0	0	0	0	1.04	1.04
Pump Sta	Projected	0	0	0	0	0	0	0	0	0	1.63	0.00
8c	Existing	59	0	4	0	206	0	8	0	214	1.04	0.37
	Future	0	0	1	0	0	0	2	0	2		0.00
	Projected	59	0	5	0	206	0	10	0	216	1.63	0.37
8b	Existing	19	0	10	0	67	0	20	0	87	1.04	0.14
	Future	0	0	3	0	0	0	5	0	5		0.00
	Projected	19	0	13	0	67	0	25	0	92	1.63	0.14
8a	Existing	114	0	14	0	399	0	28	0	427	1.04	0.73
	Future	0	0	4	0	0	0	7	0	7		0.00
	Projected	114	0	18	0	399	0	35	0	434	1.63	0.73
7	Existing	0	0	10	0	0	0	20	0	20	1.04	0.03
	Future	0	0	3	0	0	0	5	0	5		0.00
	Projected	0	0	13	0	0	0	25	0	25	1.63	0.03

MAIN STREET SUBMAIN

	Population						Existing	Future	Proposed	Future	Future % Cap
Location Reference	Existing	Projected	Seg. Length (ft)	Size (in)	Slope (%)	Capacity (cfs)	Peak (cfs)	Peak (cfs)	Size (inch)	Cap. (cfs)	Used
Main St @ FM discharge											
	886	1,393	420	12	0.25	1.80	1.55	2.43			
	886	1,393	430	12	0.13	1.29	1.55	2.43	15	2.33	104
	886	1,393	210	12	0.13	1.28	1.55	2.43	15	2.33	104
Mary & Main											
	1,313	1,538	370	12	0.13	1.27	1.79	2.67	18	3.74	71
Howard & Main											
	1,313	1,538	320	15	0.15	2.48	1.79	2.67	18	4.03	66
G.H. & O.W.											
	1,313	1,538	330	15	0.08	1.85	1.79	2.67	18	3.00	89
G.H. & Franklin											
	1,333	1,563	245	15	0.19	2.80	1.82	2.70	18	4.55	59
	1,333	1,563	235	15	0.10	2.02	1.82	2.70	18	3.29	82
Gleason & Franklin											
	1,333	1,708	345	15	0.14	2.38	2.06	2.94	18	3.88	76
	1,333	1,708	185	15	0.16	2.56	2.06	2.94	18	4.16	71
Gleason & Gierk											
	1,333	1,852	155	15	0.09	1.94	2.31	2.94	18	3.16	93
	1,333	1,852	300	15	0.11	2.11	2.31	2.94	18	3.43	86
	1,333	1,852	35	15	0.11	2.18	2.31	2.94	18	3.55	83

Note:

Future % Capacity is the percent of the capacity which will be used in the future.
Peak Future Flows represent existing plus future peak flows.
Existing Peak Flows: 1,246 gal/capita/day
Future Population Peak Flows: depends on location

PARKER SUBMAIN

Subarea Number		Number of Units				Number of Persons				Subarea Population	Pump Flow (cfs)	Pk Flows (cfs)
		SFR	MFR	Comm	Ind	SFR	MFR	Comm	Ind			
3	Existing	120	0	9	0	420	0	18	0	438	0.00	0.90
11, 12 and 13	Future	432	0	0	0	1,957	0	0	0	1,957		1.21
	Projected	552	0	9	0	2,377	0	18	0	2,395	0.00	2.11

PARKER SUBMAIN

	Population						Existing	Future	Future % Cap
Location Reference	Existing	Projected	Seg. Length (ft)	Size (in)	Slope (%)	Capacity (cfs)	Peak (cfs)	Peak (cfs)	Used
Park & Parker									
	438	2,395	125	18	0.40	6.68	0.90	2.11	32
	438	2,395	360	18	0.40	6.66	0.90	2.11	32
Monroe & Parker									
	438	2,395	380	21	0.19	6.99	0.90	2.11	30
Water & Parker									
	438	2,395	335	24	0.12	7.72	0.90	2.11	27
	438	2,395	60	24	0.12	7.73	0.90	2.11	27
Division & Parker									

Note:

Future % Capacity is the percent of the capacity used in the future.
Peak Future Flows represent existing plus future peak flows.
Existing Peak Flows: 2,106 gal/capita/day
Future Population Peak Flows: 400 gal/capita/day

Richwood Lane Submain

Subarea		Number of Units				Number of Persons				Subarea	Pump	Pk Flows
Number		SRF	MFR	Comm	Ind	SRF	MFR	Comm	Ind	Population	Flow (cfs)	(cfs)
6c	Existing	25	0	0	0	88	0	0	0	88	0.00	0.23
	Future	0	0	0	0	0	0	0	0	0	0.00	0.00
	Projected	25	0	0	0	88	0	0	0	88	0.00	0.23
4b	Existing	41	20	5	50	146	40	10	100	296	0.00	0.50
	Future	36	0	0	0	126	0	0	0	126	0.00	0.08
	Projected	77	20	5	50	272	40	10	100	422	0.00	0.58

Richwood Lane Submain

Location Reference	Population		Segment Length (ft)	Size (in)	Slope (%)	Capacity (cfs)	Existing Peak (cfs)	Future Peak (cfs)	Future % Capacity Used
	Existing	Projected							
Richwood Lane & Joe Wood Drive									
	384	510	150	12	0.14	1.35	0.73	0.81	60
	384	510	360	12	0.14	1.35	0.73	0.81	60
	384	510	360	12	0.23	1.71	0.73	0.81	47
	384	510	360	12	0.23	1.70	0.73	0.81	48
	384	510	360	12	0.20	1.60	0.73	0.81	51
Richwood Lane & S. Forest									

Note:
Future % Capacity is the percent of the capacity that will be used in the future.
Peak Future Flows represent existing plus future peak flows.
Existing Peak Flows: 1,694 gal/capita/day
Future Population Peak Flows: 400 gal/capita/day

SKINNER SUBMAIN

Subarea		Number of Units				Number of Persons				Subarea	Pump	Pk Flows
Number		SFR	MFR	Comm	Ind	SFR	MFR	Comm	Ind	Population	Flow (cfs)	(cfs)
30	Existing	48	0	0	0	168	0	0	0	168	0.00	0.09
	Future	0	0	0	0	0	0	0	0	0		
	Projected	48	0	0	0	168	0	0	0	168	0.00	0.09
1a	Existing	84	0	0	0	294	0	0	0	294	0.00	0.49
	Future	0	0	0	0	0	0	0	0	0		
	Projected	84	0	0	0	294	0	0	0	294	0.00	0.49
1c	Existing	108	0	0	0	378	0	0	0	378	0.00	0.62
	Future	0	0	0	0	0	0	0	0	0		
	Projected	108	0	0	0	378	0	0	0	378	0.00	0.62
1b	Existing	20	0	0	0	70	0	0	0	70	0.00	0.12
35	Future	852	0	0	0	2982	0	0	0	2982		0.46
19	Future	137	0	0	0	480	0	0	0	480		0.29
	Projected	157	0	0	0	3532	0	0	0	3532	0.00	0.87
1d	Existing	118	0	0	0	413	0	0	0	413	0.00	0.68
	Future	0	0	0	0	0	0	0	0	0		
	Projected	118	0	0	0	413	0	0	0	413	0.00	0.68

SKINNER SUBMAIN

	Population						Existing	Future	% Cap
Location Reference	Existing	Projected	Seg. Length (ft)	Size (in)	Slope (%)	Capacity (cfs)	Peak (cfs)	Peak (cfs)	Used
Karen & Pierce St.									
	462	462	345	12	0.25	1.77	0.58	0.58	33
	462	462	350	12	0.25	1.79	0.58	0.58	32
	462	462	340	12	0.26	1.82	0.58	0.58	32
Karen & Madison									
	840	840	230	12	0.10	1.10	1.20	1.20	109
	840	840	110	12	0.21	1.63	1.20	1.20	74
	840	840	210	12	0.33	2.03	1.20	1.20	59
Canterbury & Madison									
	910	4372	105	12	0.33	2.04	1.32	2.07	101
	910	4372	315	12	0.27	1.86	1.32	2.07	111
	910	4372	200	15	0.22	3.03	1.32	2.07	68
	910	4372	430	15	0.13	2.29	1.32	2.07	90
	910	4372	335	15	0.13	2.31	1.32	2.07	89
	910	4372	330	15	0.14	2.44	1.32	2.07	85
	1323	4785	340	15	0.20	2.87	2.00	2.75	96
Skinner @ Well Field									
	1323	4785	335	15	0.24	3.16	2.00	2.75	87
	1323	4785	20	15	0.20	2.89	2.00	2.75	95
	1323	4785	350	15	0.20	2.89	2.00	2.75	95
Skinner & Division									

Note:

Future % Capacity is the percent of the capacity which will be used in the future.
Peak Future Flows represent existing plus future peak flows.
Existing Peak Flows: 987 gal/capita/day
Future Population Peak Flows: depends on location

STONE SUBMAIN

Subarea		Number of Units				Number of Persons				Subarea	Pump	Pk Flows
Number		SFR	MFR	Comm	Ind	SFR	MFR	Comm	Ind	Population	Flow (cfs)	(cfs)
Area 10	Existing	380	0	0	0	1330	0	0	0	1330	0.00	1.13
Swan Ck	Future	0	0	0	0	0	0	0	0	0		0.00
	Projected	380	0	0	0	1330	0	0	0	1330	0.00	1.13
Swan Ck	Existing	0	0	0	0	0	0	0	0	0	0.80	0.00
Pump Sta	Projected	0	0	0	0	0	0	0	0	0		
2	Existing	223	0	0	0	780	0	0	0	780	0.80	0.66
	Future	0	0	0	0	0	0	0	0	0		0.00
	Projected	223	0	0	0	780	0	0	0	780	0.80	0.66

STONE SUBMAIN

Location Reference	Population Existing	Population Projected	Seg. Length (ft)	Size (in)	Slope (%)	Capacity (cfs)	Existing Peak (cfs)	Future Peak (cfs)	Future % Cap Used
Main St., near Pound Road									
	6	6	310	10	0.96	2.15	0.01	0.01	1
	1,312	1,312	310	12	0.20	1.58	1.15	1.15	73
	1,312	1,312	310	12	0.20	1.59	1.15	1.15	72
Main & Madison									
	1,335	1,335	295	12	1.84	4.84	1.15	1.15	24
Ferguson & Madison									
	1,469	1,469	235	12	0.16	1.41	1.26	1.26	89
	1,494	1,494	195	12	0.74	3.06	1.27	1.27	41
Stone & Madison									
	1,546	1,546	260	12	0.20	1.58	1.33	1.33	84
	1,659	1,659	260	12	0.18	1.51	1.43	1.43	94
Stone & Jefferson									
	1,684	1,684	240	12	0.17	1.45	1.43	1.43	98
	1,686	1,686	70	12	0.30	1.95	1.43	1.43	73
Stone & Washington									
	1,786	1,786	230	15	2.95	11.10	1.59	1.59	14
	1,801	1,801	250	15	0.14	2.42	1.59	1.59	66
Stone & Park									
	2,001	2,001	370	15	0.14	2.42	1.72	1.72	71
Stone & Monroe									
	2,026	2,026	385	15	0.14	2.44	1.73	1.73	71
	2,056	2,056	240	15	0.14	2.40	1.77	1.77	74
	2,110	2,110	250	15	0.14	2.38	1.79	1.79	75
	2,110	2,110	250	15	0.14	2.38	1.79	1.79	75
Stone & Division									
	2,110	2,110	50	15	0.20	2.89	1.79	1.79	62
Stone & Division									

Note:

Future % Capacity is the percent of the capacity which will be used in the future.
Peak Future Flows represent existing plus future peak flows.
Existing Peak Flows: 548 gal/capita/day
Future Population Peak Flows: 400 gal/capita/day

South Forest Submain

Subarea		Number of Units				Number of Persons				Subarea	Pump	Pk Flows
Number		SRF	MFR	Comm	Ind	SRF	MFR	Comm	Ind	Population	Flow (cfs)	(cfs)
Skinner	Existing	378	0	0	0	1,323	0	0	0	1,323	0.00	2.00
	Future	1,150	0	0	0	3,462	0	0	0	3,462	0.00	0.75
	Projected	1,528	0	0	0	4,785	0	0	0	4,785	0.00	2.75
Howard	Existing	50	0	0	6	175	0	0	12	187	0.31	1.73
	Future	0	0	430	2,431	0	0	1,005	4,862	5,867	0.00	0.91
	Projected	50	0	430	2,437	175	0	1,005	4,874	6,054	0.31	2.64
Division	Existing	0	0	0	0	0	0	0	0	0	1.56	1.56
Pump Station	Future	0	0	0	0	0	0	0	0	0	3.83	3.83
	Projected	0	0	0	0	0	0	0	0	0	5.39	5.39
Stone	Existing	603	0	0	0	2,110	0	0	0	2,110	0.80	1.79
	Future	0	0	0	0	0	0	0	0	0	0.00	0.00
	Projected	603	0	0	0	2,110	0	0	0	2,110	0.80	1.79
Drain	Existing	80	0	10	0	280	0	20	0	300	0.00	0.80
	Future	0	0	3	0	0	0	5	0	5	0.00	0.00
	Projected	80	0	13	0	280	0	25	0	305	0.00	0.80
Grove	Existing	126	0	20	75	443	0	40	150	633	1.24	1.57
	Future	571	0	0	0	2,583	0	0	0	2,583	0.00	1.31
	Projected	697	0	20	75	3,026	0	40	150	3,216	1.24	2.88
6a	Existing	80	0	14	0	280	0	28	0	308	0.00	0.81
	Future	0	0	4	0	0	0	7	0	7	0.00	0.00
	Projected	80	0	18	0	280	0	35	0	315	0.00	0.81
6b	Existing	46	0	0	0	161	0	0	0	161	0.00	0.40
	Future	0	0	0	0	0	0	0	0	0	0.00	0.00
	Projected	46	0	0	0	161	0	0	0	161	0.00	0.40
Richwood	Existing	66	20	5	50	234	40	10	100	384	0.00	0.73
	Future	36	0	0	0	126	0	0	0	126	0.00	0.08
	Projected	102	20	5	50	360	40	10	100	510	0.00	0.81
Main Street	Existing	327	0	82	0	1,023	0	230	80	1,333	0.00	2.31
	Future	120	84	832	40	312	168	1,905	0	2,385	0.00	0.61
	Projected	447	84	914	40	1,335	168	2,135	80	3,718	0.00	2.92

South Forest Submain

Location Reference	Population		Segment Length (ft)	Size (in)	Slope (%)	Capacity (cfs)	Existing Peak (cfs)	Future Peak (cfs)	Future % Capacity Used
	Existing	Projected							
Lift Station									
Forcemain	1,510	10,359	95	8			3.73	5.39	
Skinner & Division									
	1,510	10,359	300	24	0.20	10.20	3.73	5.39	53
Florence & Division									
	1,510	10,359	295	24	0.09	6.72	3.73	5.39	80
Oak & Division									
	1,510	10,359	35	24	0.10	7.15	3.73	5.39	75
Beebe & Division									
	1,510	10,359	325	24	0.10	7.15	3.73	5.39	75
	1,510	10,359	85	24	2.18	33.37	3.73	5.39	16
Stone & Division									
	3,620	12,469	185	30	0.16	16.24	5.52	7.18	44
S. Forest & Division									
	3,620	12,469	250	30	0.09	12.17	5.52	7.18	59
	3,620	12,469	215	30	0.09	12.51	5.52	7.18	57
	3,620	12,469	300	30	0.22	19.38	5.52	7.18	37
S. forest & Bartell St									
	4,553	15,990	271	30	0.26	20.91	7.89	10.86	52
	4,553	15,990	33	30	0.94	39.75	7.89	10.86	27
	4,553	15,990	431	30	0.18	17.44	7.89	10.86	62
S. Forest & Beier St									
	5,022	16,466	265	30	0.15	15.74	9.10	12.07	77
	5,022	16,466	130	30	0.28	21.58	9.10	12.07	56
S. Forest & Friday									
	5,022	16,466	395	30	0.17	16.89	9.10	12.07	71
S. Forest & Bauman									
	5,022	16,466	90	30	0.32	23.28	9.10	12.07	52
	5,022	16,466	246	30	0.09	12.27	9.10	12.07	98
S. Forest & Woodside Dr									
	5,022	16,466	340	30	0.18	17.23	9.10	12.07	70
	5,022	16,466	304	30	0.13	15.06	9.10	12.07	80
S. Forest & Richwood Ln									
	5,406	16,976	390	30	0.12	14.24	9.83	12.88	90
S. forest & Diane									
	5,406	16,976	57	30	0.18	17.18	9.83	12.88	75
S. Forest & GTRR									
	6,740	18,829	39	30	0.28	12.01	12.40	15.80	132
	6,740	18,829	159	24	2.62	36.59	12.40	15.80	43
Flow Split									
Existing 24" to WWTP	6,740	18,829	200	24	0.24	23.15	12.40	15.80	68
Existing 24" to WWTP	6,740	18,829	400	24	0.09	16.98	12.40	15.80	93
Ex 24" to WWTP Influent	6,740	18,829	375	24	0.02	13.50	12.40	15.80	117

Note:
Future % Capacity is the percent of the capacity that will be used in the future.
Peak Future Flows represent existing plus future peak flows.
Existing Peak Flows: Depends on Location
Future Population Peak Flow: Depends on Location
Combined capacity and peak flows of parallel 24" pipes, conveyed to WWTP and Storage F

APPENDIX C

Construction Probable Cost Opinion Data

OPINION OF PROBABLE CONSTRUCTION COST

TETRA TECH

710 Avis Drive Ann Arbor, Michigan 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT	RICHMOND SANITARY SEWER SYSTEM STUDY	DATE:	6/17/2022
LOCATIO	RICHMOND, MICHIGAN	PROJECT NO.	200-12751-20004
BASIS FOR ESTIMATE: [X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL		ESTIMATOR:	SNB
WORK:	PROJECT 1 - GROVE SUBMAIN	CHECKED BY:	
	From 450-Ft. West of Division and Parker to Bartel and S. Forest	CURRENT ENR:	13004

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1	Audiovisual Tape Coverage	1	LS	$2,300.00	$2,300.00
2	Traffic Control	1	LS	$3,000.00	$3,000.00
3	Mobilization	1	LS	$15,000.00	$15,000.00
4	15" RCSP CL IV Sanitary Sewer (12' - 16' dp.)	1,185	LF	$70.00	$82,950.00
5	15" RCSP CL IV Sanitary Sewer (8'-12' dp.)	1,035	LF	$70.00	$72,450.00
6	Granular Backfill, CL II (12'-16' dp.)	1,185	LF	$45.00	$53,325.00
7	Granular Backfill, CL II (8'-12' dp.)	1,035	LF	$30.00	$31,050.00
8	Reuse / rehabilitate existing manhole (or PS wetwell)	6	EA	$3,000.00	$18,000.00
9	Sanitary Lateral Reconnection	13	EA	$2,000.00	$26,000.00
10	Abandon existing 12" sewer	2,220	LF	$5.00	$11,100.00
11	Driveway Restoration	100	LF	$75.00	$7,500.00
12	Concrete Curb and Gutter Replacement	100	LF	$40.00	$4,000.00
13	Landscaping Restoration	2,220	LF	$10.00	$22,200.00
	SUBTOTAL CONSTRUCTION COST				**$348,875.00**
	ENGINEERING, LEGAL AND CONTINGENCIES (35%)				**$122,100.00**
	TOTAL PROJECT COST				**$471,000.00**