WATER DISTRIBUTION SYSTEM
WATER PLANT CONSOLIDATION FEASIBILITY STUDY

CITY OF MARINE CITY AND
ST. CLAIR RIVER SEWER AND WATER AUTHORITY
ST. CLAIR COUNTY, MICHIGAN

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1.0 EXECUTIVE SUMMARY

The purpose of this Water Plant Consolidation Feasibility Study is to determine the water system's capabilities, identify deficiencies within the system caused by a potential consolidation, and develop a recommendation regarding the technical feasibility of consolidating the St. Clair River Sewer and Water Authority (SCRSWA) water supply system serving China and East China Township with that of Marine City. As part of the Feasibility Study, a hydraulic network model of China and East China Township's water system was updated to account for the entire distribution system and to accurately simulate the existing flows and characteristics of the present-day system. A new model of the Marine City water distribution system was also created and later merged with the updated China and East China Township system. The combined model was then used to identify potential effects of decommissioning the Marine City Water Treatment Plant, examine future demands, and develop recommendation on the feasibility of the water plant shutdown and the effect on the existing system. This report will assist the communities in verifying if decommissioning the Marine City Water Treatment Plant and integration of the communities' water system is feasible without negative impacts to residents and businesses.

The SCRSWA obtains their water through an intake station at the St. Clair River. This water is pumped approximately 1,000 feet (via a 24-inch main) to a water treatment plant (WTP) that is located on the southeast corner of Pointe Drive and Recor Road. Although the WTP is located in East China Township, the plant is co-owned by China and East China Townships and supplies water to both communities. The water is filtered and chemically treated to eliminate or reduce contaminants to safe levels before it is pumped into the Townships' distribution system. This WTP was constructed in 2001 to replace the original plant that was built in 1952 and expanded upon in 1966.

The hydraulic network analysis reflects the water consumption throughout the system for 2019. The water demands incorporated into the model account for billed water use and unaccounted water that may occur due to pipe losses, fire flow use, customer meter inaccuracies, and unauthorized consumption. Water use data was obtained from community billing records. The average water use was determined by calculating the average daily amount of water delivered to the communities during 2019. The minimum pressure requirements are based on the Michigan Department of Environment, Great Lakes and Energy (EGLE) generally accepted Ten States Standards for Water Systems. Fire demand requirements are based on the criteria established by each community.

Projections for future water needs throughout the system are based on estimates of population growth and projected future developments. The Southeast Michigan Council of Governments (SEMCOG) has predicted approximately 245 new people will move to the combined three communities. Since there are no large future developments planned, the projected water use of all additional residents was spread uniformly throughout the water system.

The above information was used in developing the hydraulic network model to accurately simulate flow characteristics of the existing water distribution system in Marine City, China Township, and East China Township.

Information pertinent to the water distribution system was entered into the water network computer model. The accuracy of the model has been verified through the comparison of fire hydrant flow tests (conducted by BMJ Engineers and East China/Marine City Department of Public Works staff) to computer simulations of the actual tests.

The computer model was then used to test the system's abilities to provide adequate fire flows and maintain system pressure requirements under average day, maximum day, and peak hour scenarios. The modeling indicated that pressures were maintained system-wide above the EGLE's minimum requirement of 35 psi for each scenario. The pressures across the system changed minimally between the average day and peak hour scenarios. This can be attributed to the relatively modest demands in the system and the ability of the WTP and elevated storage tanks to supply the necessary water demands.

The three communities have several existing fire flow deficiencies throughout each system. The integration of the water systems results in areas experiencing pressure changes ranging from a decrease of 3 psi to an increase of 7 psi. These changes in pressure do not resolve any of the existing fire flow deficiencies, nor do they make them any worse. The majority of Marine City will see a slight decrease in their water pressures while a majority of China and East China Townships should see an increase.

The analysis shows that the existing SCRSWA WTP can provide sufficient volume and pressure to meet the needs of the combined community water systems without the need for any capital improvements or capacity expansion. Therefore, from a technical standpoint, the combination of the two systems and decommissioning of the Marine City WTP is feasible. The most significant drawback to a potential combination of the systems is that there would no longer be any redundancy. With two treatment plants there exists the ability for one community to supply water to the other in a time of emergency or the event of a failure at one of the treatment plants. Decommissioning the Marine City Plant and combining the two water systems would leave both communities with no water supply in the event of a failure.

2.0 INTRODUCTION

2.1 GENERAL

The Charter Townships of China, East China, and the City of Marine City are located in southeastern St. Clair County in southeast Michigan. East China Township is bordered on the north by the City of St. Clair, on the west by China Township, to the south by Marine City, and to the east by the St. Clair River. China Township is bordered by East China Township to the east, the City of St. Clair to the northeast, St. Clair Township to the north, Casco Township to the west, Cottrellville Township to the south, and Marine City to the southeast. Marine City is bordered by East China and China Township to the North and Cottrellville Township to the south and west.

Marine City contains 2.2 square miles within its limits and has an estimated population of 4,015 per SEMCOG's 2020 projection. The St. Clair River, which is a major commercial shipping channel that connects Lake Huron to Lake St. Clair, runs along the eastern border of the City. Marine City currently operates a water treatment plant, including a distribution system and an elevated storage tank. This public water system serves the majority of the community and a few residents in nearby Cottrellville Township.

East China Township contains 6.7 square miles within its limits and has a population of 3,625 per SEMCOG's 2020 projection. The St. Clair River also runs along the eastern border of the Township. The lone highway that runs through East China is River Road (M-29). East China Township is a member of the SCRSWA. The Authority operates a water treatment plant, including a distribution system and two elevated storage tanks. The majority of East China Township is served by the public water supply.

China Township contains 35 square miles and has a population of 4,097 per SEMCOG's 2020 projection. Interstate 94 is located approximately one-half mile west of the northwest corner of China Township. China Township is also a member of the SCRSWA. Only a small portion of the community is served by the public water supply.

The ground surface elevations in East China Township range from 575 feet along the St. Clair River to 628 feet near the River Road and South Hospital Drive intersection. The ground surface elevations in China Township range from 577 feet along the eastern border to a high point of 646 feet in the northeast corner of the Township. The ground surface elevations in Marine City range from 570 feet along the St. Clair River to 623 feet near the Marine City Highway and King Road intersection. All three communities generally experience a rise in elevation from southeast to northwest.

2.2 PURPOSE

The purpose of this Water Plant Consolidation Feasibility Study is to develop a comprehensive model for determining the existing systems capabilities, identifying deficiencies within each system, and developing a recommendation on whether it is technically feasible to consolidate the water supply systems for Marine City and the SCRSWA.

This report is intended to assist all three communities to determine if decommissioning the Marine City Water Treatment Plant will adequately address the present and projected needs of the combined systems. The Consolidation Study meets the water system requirements of EGLE and complies with the Michigan Safe Drinking Water Act (PA 399).

The Safe Drinking Water Act requires ten-year projections of water use to be performed, evaluation of the existing water supply system for its ability to supply these needs, and identification of cost-effective system improvements to eliminate system deficiencies in the water supply system. To comply with these requirements, a hydraulic network analysis of the existing water distribution systems for the City of Marine City and SCRSWA was performed. The hydraulic network analysis included development of a comprehensive computer model of the combined communities' water distribution systems. The model was then used to evaluate the ability of the combined system to meet both the existing and future water demands of each community.

2.3 SCOPE

The scope of the Consolidation Study consisted of six major components. These components are summarized as follows:

1. Data Collection

   The communities' water use records and water treatment plant records were reviewed, analyzed, and organized for use in the Water System Model. Water billing records were obtained for 2016-2019.

2. Evaluate Source Water Pressure

   Supply pressures from the WTPs and elevated storage tanks were evaluated and incorporated into the model.

3. Develop and Calibrate the Water Distribution System Model

   Using existing water system maps, water use records, and the United States Geological Survey (USGS) elevation data available, the water distribution system model was developed and calibrated. As part of the calibration effort, 12 hydrants were flow tested and flow test data from recent years was used to supplement the 2020 flow testing.

4. Run the Model for Existing Water Uses and Identify System Improvements

   The calibrated model was run to evaluate the ability of the water system to meet existing and future water needs. Average day, maximum day, peak hour, and maximum day plus fire flow scenarios were evaluated for existing conditions. Options for consolidation were developed.

5. Review the Findings and Recommendations with the Townships

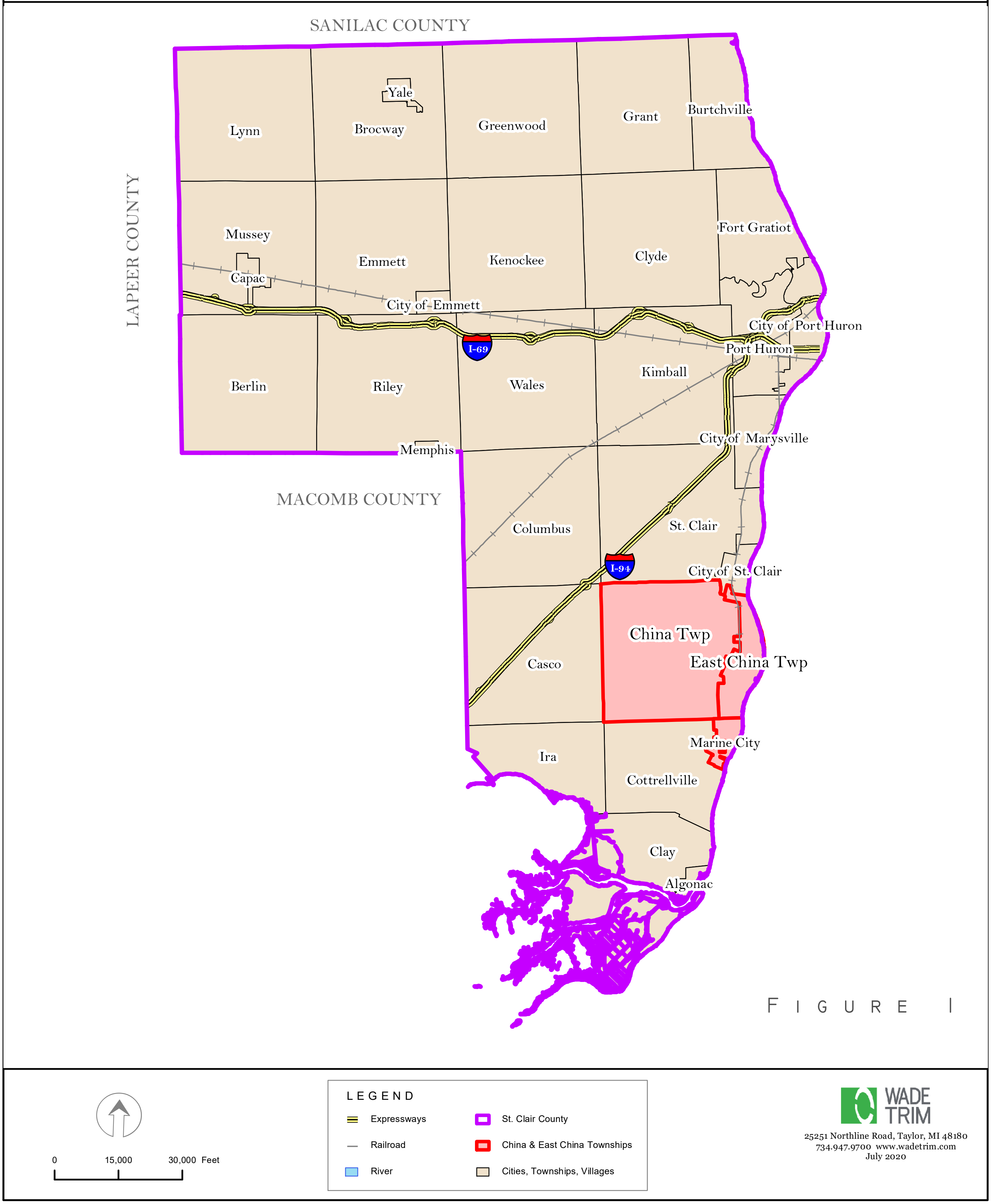
   The findings and options of the study were shared with all three communities prior to releasing the final version of the report.

6. Submit Final Report to EGLE

   The purpose of this report is to determine the feasibility of decommissioning the Marine City Water Treatment Plant and combining that system with the water treatment and distribution systems owned by China and East China Townships. Should the communities proceed with a consolidation of the two systems, the final report will be submitted to EGLE as the basis of that decision.

St. Clair River Sewer and Water Authority and Marine City

St. Clair County, Michigan



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3.0 EXISTING WATER SYSTEM

3.1 ST. CLAIR RIVER SEWER AND WATER AUTHORITY WATER TREATMENT PLANT

The SCRSWA serving the Charter Townships of China and East China obtains their water through an intake in the St. Clair River. This water is pumped approximately 1,000 feet (via a 24-inch main) to a WTP that is located on the southeast corner of Pointe Drive and Recor Road. The WTP is jointly owned by China and East China Townships and supplies water to both communities. The water is filtered and chemically treated to eliminate or reduce contaminants to safe levels before it is pumped into the Townships' distribution system.

The current WTP was constructed in 2001 to replace the original WTP that was built in 1952. This plant had a rated capacity of 500,000 gallons per day (gpd). The plant underwent several expansions and had a capacity of one million gallons per day (mgd) when it was replaced in 2001. The new WTP was designed with a maximum treatment capacity of 2.7 mgd. Additional microfiltration membranes were installed into the existing treatment trains (with no physical alterations required at the plant), thereby increasing the capacity of the treatment process to 3.0 mgd, with a firm capacity of 1.94 mgd (with Train No. 1 out of service).

Subrule 3 of Rule 1006 of the Michigan Safe Drinking Water Act (Act 399) states that the rated capacity of a complete treatment system is the smallest of the following rated capacities for each element or unit of the system:

1. <u>Intake</u> - The rated capacity of the intake is the lesser of the intake capacity of the 100-year drought elevation, or the intake capacity at the time of the lowest recorded elevation of the surface water at the point of intake.

2. <u>Raw Water Supply</u> - The rated capacity of the raw water supply is the firm capacity of the raw water pumping units, or the total flow from a system supplying raw water by gravity under minimum source water elevation conditions.

3. <u>Treatment Process</u> - The rated capacity of a treatment process including coagulation, precipitation, sedimentation, and filtration is the established maximum allowable treatment rate. Where less than four filters are provided, the rated capacity of the filters is the maximum allowable treatment rate with the largest filter removed from service.

4. <u>Finished Water Supply</u> - The rated capacity of the finished water supply to the distribution system or storage is the firm capacity of pumping systems, or the total flow from a system supplying finished water by gravity under the limiting head condition.

The current capacity of each element of the SCRSWA WTP is as follows:

- Intake: 3.0 MGD
- Raw water supply: Low service pumps total capacity 3.0 MGD, firm capacity 2.0 MGD
- Treatment process: Membranes total capacity 3.14 MGD, firm capacity 1.94 MGD
- Finished water supply: High service pumps total capacity 4.75 MGD, firm capacity 3.17 MGD

Based on these rated elements of the treatment process, the firm capacity of the SCRSWA WTP is currently 1.94 MGD.

Currently, the WTP operates daily as needed to supply water to the system users, as well as a 530,000 gallon ground storage tank at the treatment plant and two elevated storage tanks located at the northern and southern ends of the distribution system. The WTP then ceases production until the following day, thus relying on the storage tanks to meet all water demands in the system.

The Authority use variable-speed pumps at the WTP to supply water to the distribution system. Three high service pumps supply water to the ground storage tank and distribution system at pressures typically between 45 psi and 55 psi. Each pump is capable of pumping 1,400 gpm (2.0 mgd); however, each pump is designed with a Best Efficiency Point (BEP) flow of 1,130 gpm at 120 feet of total head (an efficiency of 88.5%). Generally, only the lead pump is operating at a given time, with the lag and standby pumps in reserve.

3.2 MARINE CITY WATER TREATMENT PLANT

The existing WTP was initially constructed in 1936 with an addition in 1968. The plant has also seen a rehabilitation in 2005 which modernized much of the facility. The Marine City WTP is located at an elevation of approximately 580, which is 3 feet lower than the SCRSWA treatment plant in East China. The current capacity of each element of the Marine City WTP is as follows:

- Intake: 4.25 MGD
- Raw water supply: Low service pumps total capacity 4.0 MGD, firm capacity 2.3 MGD
- Treatment process: Filtration total capacity 2.1 MGD, firm capacity 1.4 MGD
- Finished water supply: High service pumps total capacity 3.2 MGD, firm capacity 2.0 MGD

Based on these rated elements of the treatment process, the firm capacity of the Marine City WTP is currently 1.4 MGD.

3.3 TRANSMISSION SYSTEM

China and East China Township's flow is delivered to the water distribution system via a 16-inch diameter water main from the WTP. This 16-inch main runs along Recor Road from the WTP to King Road, and then extends north along King Road to Fred W. Moore Highway (although a small portion of the line south of St. Clair Highway is actually 12-inch diameter pipe). Many of the arterial roads within the distribution network also have 10-inch and/or 12-inch mains existing within the rights-of-way.

Marine City's flow is delivered to the water distribution system via 12 and 10-inch mains branching off from the WTP. A 16-inch main also follows South Parker Street to supply the southern portion of the City. One 10-inch main and two 12-inch mains extend to East China Township where interconnects are placed in case of emergency or maintenance. These interconnects are typically closed.

3.4 DISTRIBUTION SYSTEM

The existing Marine City, China, and East China Township water distribution systems consist of approximately 68 miles of water main that range from 4 inches to 16 inches in diameter. The water system consists primarily of 10-inch, 12-inch, and 16-inch mains along arterial roads, and 6-inch and 8-inch pipes in residential areas.

There are currently no valves known to be closed in the water distribution system; however, closed or partially closed valves may still exist throughout the system.

3.5 STORAGE TANKS

Three storage tanks exist in East China Township. One ground storage tank exists at the WTP on Recor Road and two elevated storage tanks also exist within the Township. One elevated storage tank is located on the northwest corner of the Margaret Street and Glendale Street intersection. The second elevated storage tank is located on the south side of Springborn Road, west of Belle River Road. The storage tanks provide a readily available source of water to meet fire demands, emergency storage, and supply needs during peak periods and when the WTP is not in operation. The elevated storage tanks also provide the benefit of pressure equalization in the water distribution system.

The elevated storage tank on Margaret Street is a six-column torospherical structure that was built by Pittsburg DesMoine Steel in 1967. The storage tank has a diameter of approximately 45 feet and a storage volume of 300,000 gallons. The fill pipe to the tank is 12 inches in diameter. The storage tank consists of a 5-foot diameter standpipe that extends approximately 69 feet above the ground. The top elevation of the tank is approximately 100 feet above the ground surface.

The elevated storage tank on Springborn Road is a spheroid structure that was constructed in 1992. The storage tank has a diameter of approximately 48 feet and a storage volume of 500,000 gallons. The fill pipe to the tank is 12 inches in diameter.

The storage tank also consists of a 12-inch diameter standpipe that extends approximately 82 feet above the ground. The top elevation of the tank is approximately 127 feet above the ground surface.

The ground storage tank at the WTP was constructed in 2001. The tank has a diameter of 62 feet and a storage volume of 530,000 gallons. The fill pipe to the tank is 12 inches in diameter and the outlet pipe is 16 inches in diameter. The maximum storage elevation at the tank is 23 feet above the finished floor elevation.

The three storage tanks combine to hold 1.33 million gallons of water. Accounting for an average water demand of 445,500 gpd in 2008, using these numbers, the WTP would need to produce no water for approximately three days for the tanks to empty. As the WTP is operated daily, water is continuously cycled in the tank.

One water tower exists in Marine City which adds approximately 0.98 million gallons of water to the storage capacity of the combined system. The water tower is approximately 127 feet in height with about 40 feet included in that is the head range for storage. The tower is also 64.67 feet wide.

4.0 WATER CONSUMPTION

There are several components that affect the distribution of water consumption within the water system. These components are water usage, system peaking factors, system losses, and fire protection demands. The proper representation of these components throughout the network is vital to the analysis. Each of these components is discussed in the following sections.

4.1 EXISTING WATER USE

Water billing records obtained for SCRSWA were evaluated for the communities' present-day water demands. For China Township, the meter reading on Bree Road had its water use equally distributed among all nodes in northwest corner of the system (i.e., along St. Clair Highway, King Road, and northwest of this intersection). Top water users were also applied where applicable in the system. The remaining water demands in the system were equally distributed among the remaining nodes in the model. However, any open space areas that are believed to be devoid of water service were not given water demands.

Water billing records were also obtained for Marine City for a three-year period from 2016-2019. Water demands were applied equally in each of Marine City's three billing sections. A portion of Cottrellville Township is also serviced by Marine City, and a separate higher flow was applied at the intersection of Chartier and King Roads where Cottrellville is connected. Top water users were also obtained for Marine City, but upon analysis of the data had a negligible impact on the model so a uniform demand was utilized for each section.

4.2 FUTURE WATER USE

Water system hydraulic analyses typically extrapolate historical population growth as a method of estimating future water demands. Since significant development is not anticipated within the water system network, the projected water use of future residents was the principal factor in determining future water use. The populations of China Township, East China Township, and Marine City were 4,097, 3,625, and 4,051 respectively, per SEMCOG population forecast data for 2020. The projected 2045 populations are 4,399 for East China Township, 3,835 for China Township, and 3,783 for Marine City.

Since China Township is not fully serviced by the water distribution system, the number of current and future residents serviced had to be determined. Approximately 150 homes in China Township are currently serviced by the water system. Approximately 2.81 people per home live in China Township per SEMCOG records; this equates to 422 people currently serviced in China Township. To calculate the future number of users on the system, it was assumed that the same proportion of users would remain on the system as China Township's population changed. Currently, China Township has 11.9% of residents served by the existing system, this results with a total 457 people being serviced in 2045.

Over all three communities, the population is expected to increase by 245 people. Using the generally accepted water demand of 100 gpd per person, this results in an approximately an 18 gpm increase over the current demands for the year 2045.

4.3 PEAKING FACTORS

Maximum day and peak hour conditions were evaluated for this Feasibility Study. The demands associated with maximum day scenario were characterized by applying a multiplication factor to the average daily use. For China and East China Townships, the WTP reports were evaluated to determine the maximum day water use and its corresponding peak factor. Hourly data was not available to determine the peak hour water use in the system; therefore, the peaking factor had to be estimated. In our previous work with the SCRSWA Water Reliability Study, a peaking factor of 4.0 was developed in coordination with the State of Michigan. The 4.0 peaking factor was used for both the SCRSWA and Marine City portions of the model.

In all three communities, the day experiencing the largest water use was factored over the average day water use during the same year to determine the maximum day factor (1.83) used in this study.

4.4 SYSTEM LOSSES

System losses in a water distribution system are defined as any unmetered discharge of water due to firefighting, flushing of hydrants, inaccurate meters, system leakage, water main breaks, and other unknown uses. Typical system losses generally range from 10-15 percent. The American Water Works Association (AWWA) recommends that unaccounted for water be limited to less than ten percent of total usage. Water loss is calculated based on the difference between the quantity of water produced at the WTP and the quantity of water sold to the consumers. The percentage of total water loss is calculated as follows:

$$\text{System Losses} = \frac{\text{Water Treated} - \text{Water Billed}}{\text{Water Treated}} \times 100\%$$

The calculated water system losses for SCRSWA are shown in the following table.

Table 1. SCRSWA System Losses				
Year	Amount of Treated Water (mil gal)	Amount Sold to Township Users (mil gal)	Amount of Unaccounted for Water (mil gal)	Loss Percentage
2010	155.96	141.52	14.44	9.3%
2011	162.26	143.26	18.99	11.7%
2012	150.88	134.99	15.89	10.5%
2013	144.21	131.19	13.02	9.0%
2014	149.27	126.51	22.76	15.3%
2015	161.7	128.0	33.7	20.8%
2016	169.04	124.98	44.06	26.1%
2017	169.07	122.47	43.60	25.8%
2018	183.7	121.2	62.5	34.0%
2019	163.3	145.0	48.3	29.6%

Table 1 indicates that the yearly water loss for the system has been increasing from 2010 through 2019, with a variation of 24.7%. This is due to a significant water leak that was found and corrected in 2019. With this leak corrected, we anticipate that the water loss will return to values similar to those experienced prior to 2014.

For the computer model database, it is assumed that the common water loss during the 2004-2009 period mirrors the water loss of today. The system losses were equally distributed over the system in addition to the billed customer demands for all three communities.

4.5 FIRE PROTECTION

The criteria for establishing deficiencies due to fire flow demand was reviewed and discussed with water plant operators from both water plants. A minimum flow value of 1,000 gpm was established for residential areas and a minimum flow of 2,500 gpm was desired for commercial and industrial areas. These are common fire flow requirements that are used by many communities in southeast Michigan. The residential flow values exceed the minimum value of 500 gpm recommended by EGLE.

Currently, Marine City has 8.6% of hydrants fail to meet the fire flow requirements, while China and East China Townships have 21.1% of hydrants that do not comply with the fire flow standard.

Table 2. Fire Demands	
Structural Type	Water System Minimum Criteria (GPM)
Residential	1,000
Commercial	2,500
Industrial	2,500

5.0 HYDRAULIC NETWORK MODEL

5.1 COMPUTER PROGRAM

The computer software utilized for this Water Plant Consolidation Feasibility Study is WaterGEMS, CONNECT Edition Update 2. WaterGEMS is a water network analysis program developed by Bentley Systems, Inc. to perform water distribution system studies. This program is capable of analyzing fluid flows in a complex distribution network containing pumps, check valves, pressure-regulating valves, storage tanks, meters, fittings, etc. for a number of different scenarios including average day water usage, fire flow simulations, and extended period simulations. Complete output can be generated which includes pressures, demands, elevations, and hydraulic grade lines at all junctions, head losses, flows, velocities in water main lines, and various pump information. Output can be presented in numerous formats such as tabular, numerical, or graphical.

5.2 BASE MODEL PREPARATION

For this study, a hydraulic model of the SCRSWA and the Marine City water systems was needed. The Water Model for SCRSWA was updated from the model created for the 2010 Reliability Study, including updated demands and model calibration. Marine City's water model distribution network was created by using a developed water system map generated by Geographical Information System (GIS) software. Shapefiles were created to incorporate pipe locations, diameters, materials, as well as hydrant locations, were imported into WaterGEMS to form the base map for the model. The pipe materials were used to determine the initial roughness coefficients (C-factors) for the model.

The water supply point is represented in the model as a reservoir at a fixed hydraulic grade, providing an infinite amount of water at the desired pressure. While the model assumes an infinite supply of water, the model results are verified against the capacity of the treatment plant to verify that the results are valid.

Water is supplied to the SCRSWA distribution system at operating pressures typically between 35 psi and 55 psi. These pressures result in hydraulic grades varying between 690 feet and 709 feet. Table 3 displays the modeled hydraulic grade at the SCRSWA WTP.

Water is supplied to the Marine City distribution system at operating pressures typically between 45 psi and 55 psi. These pressures result in hydraulic grades varying between 699 feet and 701 feet. Table 3 displays the modeled hydraulic grade at the Marine City.

The elevations of the water main used in the model are important since they affect the predicted pressures. Water main constructed across uneven terrain will show higher pressures at low points and lower pressures at more elevated locations in the system. Since determining the exact profiles of the existing water main is often difficult and time consuming, it is common practice to assume that the water main profile mirrors that of the ground above it.

The node elevations in the model were generated from a digital elevation model (DEM) file for St. Clair County that was obtained from the Michigan Geographic Data Library on the official State of Michigan website. The latest DEM file was generated in 2000 and provides horizontal elevations at 30-meter (98.4 feet) intervals. The vertical accuracy of the data is approximately ± two feet, which would correspond to approximately ± 0.9 psi.

Both models were then merged into one model and connected at the three interconnect locations located on North Main Street, Mary Street, and Belle River Avenue along the Marine City and East China border. This model assumes that all three interconnect locations are functioning and that they will not restrict flow between the two systems.

Once the components of the system were represented, the final model development step was assigning demands to each node. The model representation of the water consumption and water loss throughout the communities were previously explained in Sections 4.1 through 4.4.

Steady state and extended period simulations (EPS) were conducted to analyze all the scenarios for the combined water distribution system. A steady state simulation analyzes a system's ability to meet certain average demands. It is primarily used for master planning, fire flow analyses, and extreme or representative conditions such as maximum day and peak hour. Under steady state conditions, flow rates and hydraulic grades remain constant over time (i.e., the operating behavior of the system is determined at a specific point in time). Extended period simulations (EPS) are another method of analyzing a water system. They analyze a water system over a period. EPS allows for control mechanisms and flow conditions to vary from one state to another. An extended period simulation is a series of steady state simulations conducted in sequence. This type of analysis is ideal for demand variations, variable pumping, storage, and water quality simulations. These components are necessary to evaluate the levels in the water tanks throughout the system. Both EPS and Steady State were used for this analysis.

5.3 CALIBRATION

A water model must be calibrated before the computer program can be used to confidently analyze the various effects simulated conditions will have on the distribution system. Calibration is the process of making the WaterGEMS hydraulic computer model mimic the actual behavior of the water system. To calibrate the model, strategic locations throughout the system were selected to test fire hydrant flows and obtain pressures at each testing location. The field test data allowed the model to be verified by simulating the same flow conditions measured in the field with the computer program.

Hydrant flow tests were performed on June 16, 2020 by BMJ Engineers as part of the SCRSWA Reliability Study and provided to Wade Trim. Flow tests were completed under the following guidelines:

1. Locations for testing were chosen based on their accessibility, diameter of pipe, and location within the system. The locations were selected so that a variety of common pipe sizes and materials were tested. Figure 2 shows the locations of the hydrant flow tests.

2. The objective of each hydrant test is to measure the static pressure at each location, as well as the residual pressures when a neighboring hydrant is being flowed at a known rate.

3. Each test site was chosen so three consecutive hydrants existed along a stretch of water main where no lateral water main connections occurred (i.e., no other mains were either providing or drawing water between the three hydrants).

4. At the start of the hydrant flow test, the three hydrants were flushed to clear the line of sediments. Once the line was cleared, a static pressure reading was taken and recorded at the two outside hydrants while the middle hydrant remained closed. Once the static pressure readings were obtained, the middle hydrant was fully opened. After the system stabilized, the flow rate from the middle hydrant and the residual pressures at the end hydrants were recorded.

St. Clair River Sewer and Water Authority

St. Clair County, Michigan

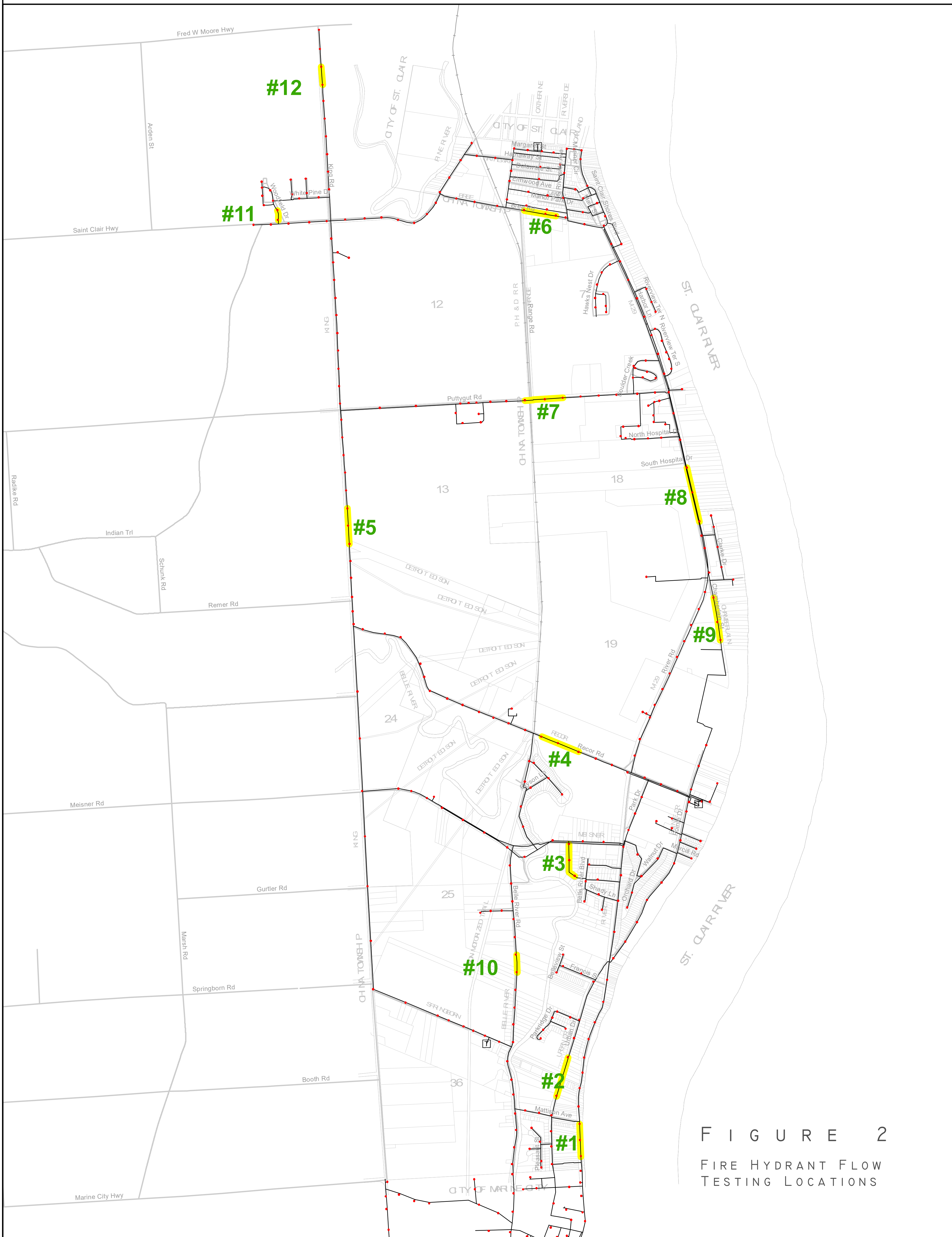

FIGURE 2

FIRE HYDRANT FLOW TESTING LOCATIONS

0.5 Miles

LEGEND

- Roads
- Railroad
- Water Main
- Flow Test Location
- WTP Water Treatment Plant
- T Storage Tank
- River
- Hydrant
- Gate Valve & Well

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August 2020

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Twelve locations were chosen for fire hydrant flow tests in order to calibrate the model. These areas reflected locations evenly distributed throughout the water network. The results of the hydrant flow testing are presented in Table 3.

Table 3: Hydrant Flow Tests

No.	Location	Flow Hydrant (gpm)	Hydrant A Static Pressure (psi)	Hydrant A Residual Pressure (psi)	Hydrant B Static Pressure (psi)	Hydrant B Residual Pressure (psi)
1	River - South of Mattison	890	48	32	48	32
2	Urban - North of Mattison	890	48	32	48	32
3	Vista Belle - South of Meisner	845	46	29	46	29
4	Recor - West of River Road	800	48	26	48	26
5	King - South of Puttygut	800	44	26	44	26
6	Bree - West of Riverside	905	44	33	44	33
7	Puttygut - East of Range	670	44	18	44	18
8	River - South of hospital at Puttygut	785	44	25	44	25
9	Chamberlain - South of Remer	670	46	18	46	18
10	Belle River – North of Springborn	890	48	32	48	32
11	Woodfield – North of St. Clair Highway	650	42	17	42	17
12	King – South of Fred Moore Highway	740	42	22	42	22

The average flow during the testing day (June 16, 2020) was compared to the average day flow used for the model and the demands at each node were adjusted uniformly to coincide with the flows during the test date. Each individual flow recorded during the flow tests was imposed on the model, then various system parameters were varied until the static and residual pressures in the model resembled the corresponding pressures recorded during the field tests. The adjusted flow conditions were simulated, and typically the model was calibrated to obtain results within a generally accepted criterion of ten percent of the field measurements. Although, flow testing occurred during the COVID-19 pandemic which has resulted in government restrictions on regular activities, including those which require increased water usage. This has resulted in decreased flows than would be expected for this time of year. As such and due to limited growth in the community, flows were not adjusted beyond that of the previous study. This has resulted in some hydrants outside of the typical ten percent limit for the pressure difference.

The computer analyses of the water network are based on the Hazen-Williams Pipe Flow Formula, which requires pipe roughness coefficients (C-factors) to be assigned to each pipe. The roughness of a pipe represents the condition of the inside of a pipe (i.e., the friction factor) and is the largest unknown in preparing the model. The friction factor of a pipe, coupled with the pipe's size, has a large influence on the amount of flow passing through a pipe, which ultimately affects the resulting pressures and flows within the system. The hydrant flow tests generally impact the C-factors in the model more than any other parameter. It is common practice to alter the characteristics of all similar pipes throughout a system since it is impractical to perform a flow test on every segment of pipe in the system.

The C-factors for this analysis range between 60 and 150 based on pipe material, size, and age. The C-factors assigned to various pipe classifications are shown in Table 4.

Table 4. C-Factors Determined Through Calibration		
Material	Diameter	Hazen-Williams C-Factor
Asbestos Cement	4" – 12"	130
Cast Iron	4" – 8"	60
Cast Iron	16"	90
Ductile Iron	6" – 16"	130
HDPE	10"	140
PVC	8" – 12"	150

The HDPE and PVC pipes are represented in the water model with roughness coefficients (Hazen-Williams C-factors) of 140 and 150, respectively. The ductile iron and asbestos cement pipes have C-factors of 130. The 16-inch diameter cast iron pipe along Recor Road has a C-factor of 90, while the 4-inch to 8-inch cast iron pipes have C-factors of 60. The majority of pipes in the system are ductile iron and asbestos cement pipes with C-factors of 130; however, the water main along River Road and Chamberlain Street (between Bree Road and Recor Road) was given a C-factor of 60. Essentially, lower C-factors represent an actual reduction in pipe diameter due to tuberculation and corrosion or the presence of a partially closed valve(s) in the area. Pipes with lower C-factors are typically older pipes that are more susceptible to breaks, decreased flows, and lower water quality due to residual build-up within the pipes over time.

Another adjustment for calibrating the model included setting the water level at both East China elevated storage tanks to 690 feet and the Marine City water tower to 700. This resulted in a water depth of 15 feet at the north tank, 23.5 feet at the south tank and 20.5 feet in the Marine City tank. No valves were closed in this water distribution system. The results of the model calibration are shown in Table 6.

The hydraulic grade line (HGL) at the source of the water supply generally forms a boundary condition for the model. The HGL at this location can be determined through known elevations and pressures. While elevations remain constant, the pressures may fluctuate over time. Table 5 displays the pressure and HGL at the WTP that was used to calibrate and model the water distribution system.

Table 5. Existing Boundary Condition Modeled			
Supply	Ground Elevation	Pressure	HGL
Source	(ft)	(psi)	(ft)
ECH-WTP	586.00	45.0	690.0
MRN-WTP	582.55	50.8	700.0

Table 6. Calibration Results

No.	Location	Water Main Size (in)	Flow Hydrant (gpm)	Hydrant A							Hydrant B						
				Model Hydrant	Field Observed		Modeled		Difference		Model Hydrant	Field Observed		Modeled		Difference	
					Static Pressure (psi)	Residual Pressure (psi)	Static Pressure (psi)	Residual Pressure (psi)	Static Pressure (psi)	Residual Pressure (psi)		Static Pressure (psi)	Residual Pressure (psi)	Static Pressure (psi)	Residual Pressure (psi)	Static Pressure (psi)	Residual Pressure (psi)
1	River - South of Mattison	8	890	Hyd-36	48	32	45.5	38.6	2.5	-6.6	Hyd-34	48	32	46.3	39.4	1.7	-7.4
2	Urban - North of Mattison	10	890	Hyd-51	48	32	45.4	36.5	2.6	-4.5	Hyd-53	48	32	45.4	36	2.6	-4
3	Vista Belle - South of Meisner	6	845	Hyd-78	46	29	45.5	35.4	0.5	-6.4	Hyd-138	46	29	45.4	35.6	0.6	-6.6
4	Recor - West of River Road	16	800	Hyd-335	48	26	45.3	24.6	2.7	1.4	Hyd-333	48	26	44.2	24.6	3.8	1.4
5	King - South of Puttygut	16	800	Hyd-231	44	26	42.1	34	1.9	-8	Hyd-229	44	26	42.8	39.7	1.2	-13.7
6	Bree - West of Riverside	8	905	Hyd-318	44	33	41.8	37.9	2.2	-4.9	Hyd-316	44	33	42.3	38.3	1.7	-5.3
7	Puttygut - East of Range	12	670	Hyd-286	44	18	43.2	16.9	0.8	1.1	Hyd-252	44	18	43.2	11.9	0.8	6.1
8	River - South of hospital at Puttygut	12	785	Hyd-205	44	25	41.1	26.2	2.9	-1.2	Hyd-120	44	25	39.6	24.4	4.4	0.6
9	Chamberlain - South of Remer	10	670	Hyd-228	46	18	42	28	4	-10	Hyd-250	46	18	43.2	31.4	2.8	-13.4
10	Belle River - North of Springborn	16	890	Hyd-89	48	32	45.4	31.2	2.6	0.8	Hyd-88	48	32	45.4	29.9	2.6	2.1
11	Woodfield – North of St. Clair Highway	8	650	Hyd-266	42	17	37.2	20.4	4.8	-3.4	Hyd-267	42	17	37.2	18.2	4.8	-1.2
12	King – South of Fred Moore Highway	16	740	Hyd-206	42	22	37.2	32.1	4.8	-10.1	Hyd-207	42	22	37.2	20.2	4.8	1.8

Calibration Description: Uniformly decreased average day demands by 8.3% to match flows on test date

WTP/pump HGL = 690’ (pressure = 45 psi)

North EST water elevation = 690’ (depth = 15’)

South EST water elevation = 690’ (depth = 23.5’)

River/Chamberlain ext. 10” AC (Bree-Recor): C = 60

Hyd-231 and adjacent nodes lowered 1.4’

6.0 HYDRAULIC COMPUTER ANALYSIS

6.1 INTRODUCTION

The calibrated model was used to evaluate existing conditions for the combined water systems. Analyses consisted of four different scenarios: average day water use conditions, maximum day water use conditions, peak hour water use conditions, and maximum day water use plus fire flow conditions. Maximum day and peak hour conditions are achieved by applying the peaking factor for each condition to each node demand. Fire flow modeling is completed by setting fire demand criteria and adding that to the maximum day scenario. The computer model is capable of simulating fire flow conditions at each node throughout the system. Each computer simulation tested, verified, or analyzed some component of the system to evaluate the distribution system's ability to meet the water demands of today.

6.2 CRITERIA FOR SYSTEM EVALUATION

System criteria were established to evaluate the distribution system's ability to meet existing and future water demands, as well as the recommended standards of EGLE. According to EGLE's generally accepted "Recommended Standards for Water Works" (more commonly known as "Ten States Standards for Water Systems"), the normal working pressure in the distribution system should be approximately 60 to 80 psi and not less than 35 psi. However, the document suggests that individual water systems should be evaluated on their own unique basis and circumstances.

For the purposes of this Water Plant Consolidation Feasibility Study, we adopted EGLE's recommended minimum pressure constraint of 35 psi. The normal working pressures in the distribution system can range between 35 psi and 55 psi, which are above the minimum pressure criteria, but below the normal working pressures indicated by EGLE. However, the existing pressures in the system are suitable for the physical characteristics of China's, East China's, and Marine City's water distribution system.

In conjunction with criteria set by EGLE, the fire flow simulations for this study were completed using maximum day demands. This is a conservative approach for determining recommended system improvements; however, future trends and usage, individual pipe conditions, and unidentifiable isolated ground elevation discrepancies justify being conservative.

Fire flow simulations completed for the entire system were generalized for residential, commercial, and industrial flows. The criteria were set at values of 1,000 gpm for residential areas and 2,500 gpm for commercial/industrial areas. The flow values exceed the minimum value of 500 gpm recommended by EGLE and meet the minimum Needed Fire Flow (NFF) for residential areas set by the International Organization of Standardization (ISO). Also adopted for the fire flow scenarios was the criterion set by EGLE stating that no point within the system shall have a residual pressure drop to less than 20 psi at any point during a fire scenario.

6.3 COMBINED CONDITIONS MODEL EVALUATION

The existing conditions model for the combined water systems was created by inputting the average water use during 2019 into the calibrated system model. The model was used to develop four scenarios: average day, maximum day, peak hour, and maximum day plus fire flow. Due to the advanced age of the Marine City facility and the lower elevation of the Marine City WTP, it was decided that the SCRSWA Plant will remain in operation for the purposes of this study. Should the Marine City Plant have been designated to remain on, it may have resulted in additional maintenance issues and required the installation of pumps to provide the required HGL to China and East China Townships. A discussion of each scenario is presented as follows:

<u>Average Day Scenario</u>

The water use in the distribution system under the average day scenario is approximately 310 gallons per minute (gpm) for China and East China Townships. Water use in Marine City under the same scenario was approximately 225 gpm. This results in a combined demand of 535 gpm, or 0.77 mgd. The model results show that system pressures in the communities range from 37 psi to 52 psi.

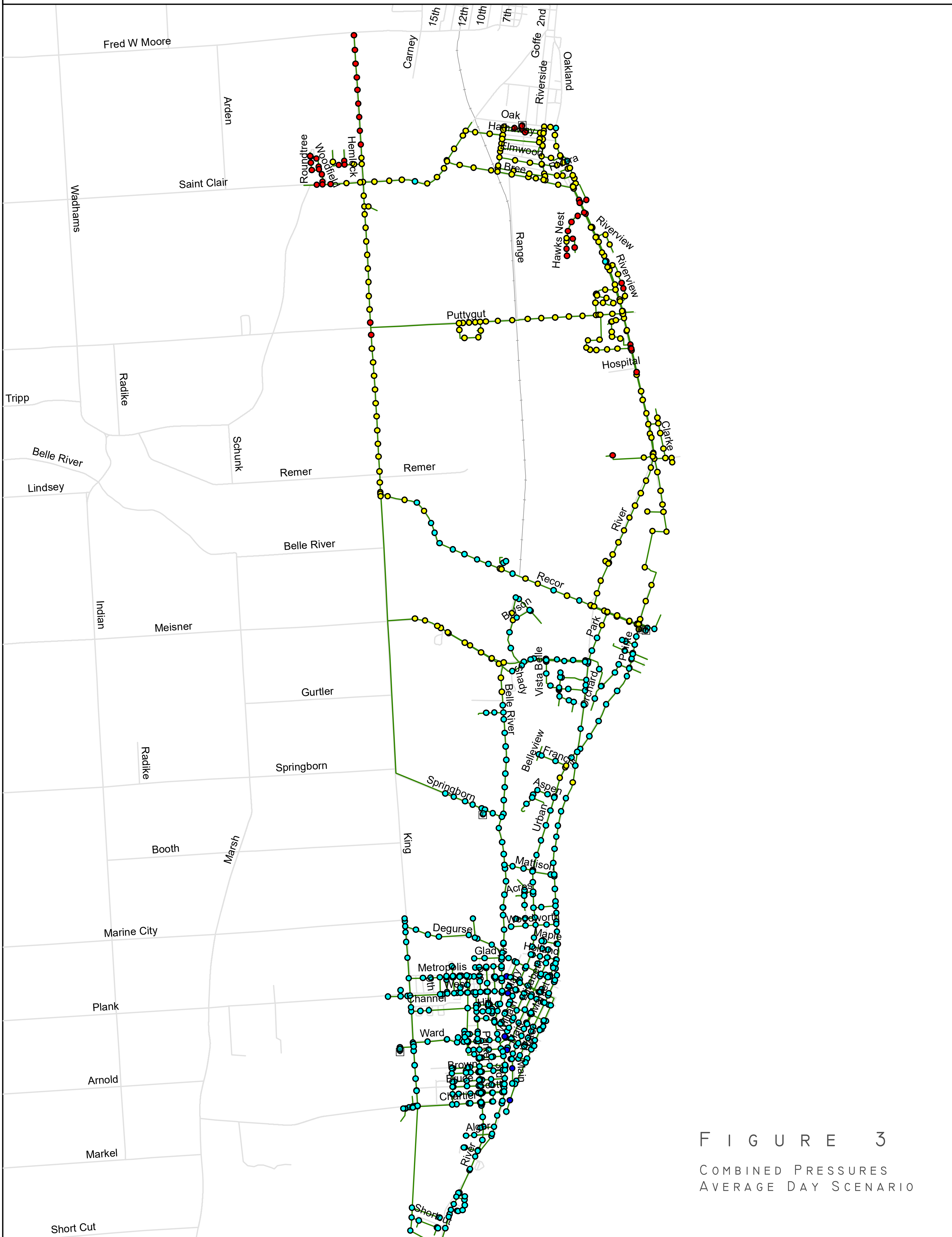
The analysis for China and East China Townships show approximately 11.2% of the active nodes in the model indicated pressures below 40 psi, with no active nodes in Marine City going below 40 psi. The nodes below 40 psi are nodes in the northern half of the system where elevations are generally higher. Areas with elevations of 597 feet or higher (such as those near the north elevated storage tank, as well as those along King and River Roads) experience the lowest pressures in the system. However, all pressures throughout the system are indicated to meet the criterion established for minimum pressures.

The integration of the water systems results in areas experiencing pressure changes ranging from a decrease of 3 psi to an increase of 7 psi. For Marine City, much of the City will experience a slight pressure decrease. This is caused by an equalization with the East China system, which currently experiences lower pressures than Marine City. The pressure decrease in Marine City does not cause any hydrants to be out of compliance for fire flow or to drop below the required 35psi. For China and East China Township, the pressure increase is likely due to the Marine City water tower which has a top of tank elevation at 710.5, where the south and north water towers in East China have elevations of 704 and 705 respectively, this results in a higher HGL in East China. East China will also experience more flow though their system as the existing WTP supplies Marine City. Figure 3 shows the change in the pressure caused by the merge of the two water systems under average day scenarios.

Figure 3 presents a color-coded water system map of the expected pressure ranges for the combined system scenario under average day demands.

SCRSWA and Marine City

St. Clair County, Michigan



F I G U R E 3

COMBINED PRESSURES
AVERAGE DAY SCENARIO

Legend

WTP

Tanks

Pressure

35 - 40

40 - 45

45 - 50

50 - 55

Water Main

Roads

Railroad

0.65 Miles

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January 2020

Maximum Day Scenario

A peaking factor of 1.83 was applied to the average day water usage to generate the demands for the maximum day scenario for Marine City and SCRSWA. The water use for this scenario is approximately 1,019 gpm, or 1.47 mgd. The model results show that the system pressures range from 37 psi to 51 psi with little change from the average day scenario results. Approximately 3.1% of the active nodes in the model indicated pressures below 40 psi. Similar to the average day results, those nodes were located in the northern half of the system where elevations are generally higher. All pressures throughout the system meet the minimum pressure criteria. Figure 4 presents a color-coded water system map of the expected pressure ranges for the existing conditions scenario under maximum day conditions.

Peak Hour Scenario

A peaking factor of 4 was applied to the average day water usage to generate the demands for the peak hour scenario for Marine City and SCRSWA. The water use for this scenario is approximately 2,226 gpm, or 3.21 mgd. The model results show that the system pressures range from 35 psi to 50 psi. Approximately 5.6% of the active nodes in the model indicated pressures below 40 psi. Similar to the previous scenarios, those nodes were located in the northern half of the system where elevations are generally higher. All pressures throughout the system meet the minimum pressure criteria. Figure 5 presents a color-coded water system map of the expected pressure ranges for the existing conditions scenario under peak hour conditions.

Maximum Day plus Fire Flow Scenario

The maximum day scenario was used as the basis for the evaluation of fire flow availability. The model results indicate that approximately 92% of the combined distribution system can provide over 1,000 gpm of water and 64% of the distribution system is capable of providing over 2,000 gpm of water. However, approximately 13.1% of the distribution system is currently not able to provide the recommended fire flow rates for residential areas (1,000 gpm) and commercial/industrial areas (2,500 gpm) while maintaining a residual pressure of 20 psi throughout the system. The areas that do not have sufficient fire flow are located throughout the entire water system. Only one hydrant changes status from a fail to a pass in the combined system.

Once the models were combined and the Marine City Water Plant deactivated, Marine City experienced the same number of hydrants failing and China/East China Township experienced one less hydrant failure. This hydrant was benefited by the connection to Marine City and the flow originating from the Marine City Water Tower.

Interconnection Evaluation

The above scenarios assume that all three interconnect locations will be utilized. For the average day scenario, the connection at Belle River provides 76 gpm to Marine City, the connection at Mary Street/Urban Road provides 74 gpm, and the connection at North Main Street/River road provides 42 gpm. We have repeated the analysis with only two interconnections open to determine if the system would function with fewer connections. The results of the hydraulics evaluation are listed below:

8" on Belle River Avenue – Shutting down this interconnect reduces pressure by 0.5-2.0 psi, but has a drastic effect on fire flow, reducing many hydrants west of Belle River near or below the established 500 gpm minimum fire flow rate.

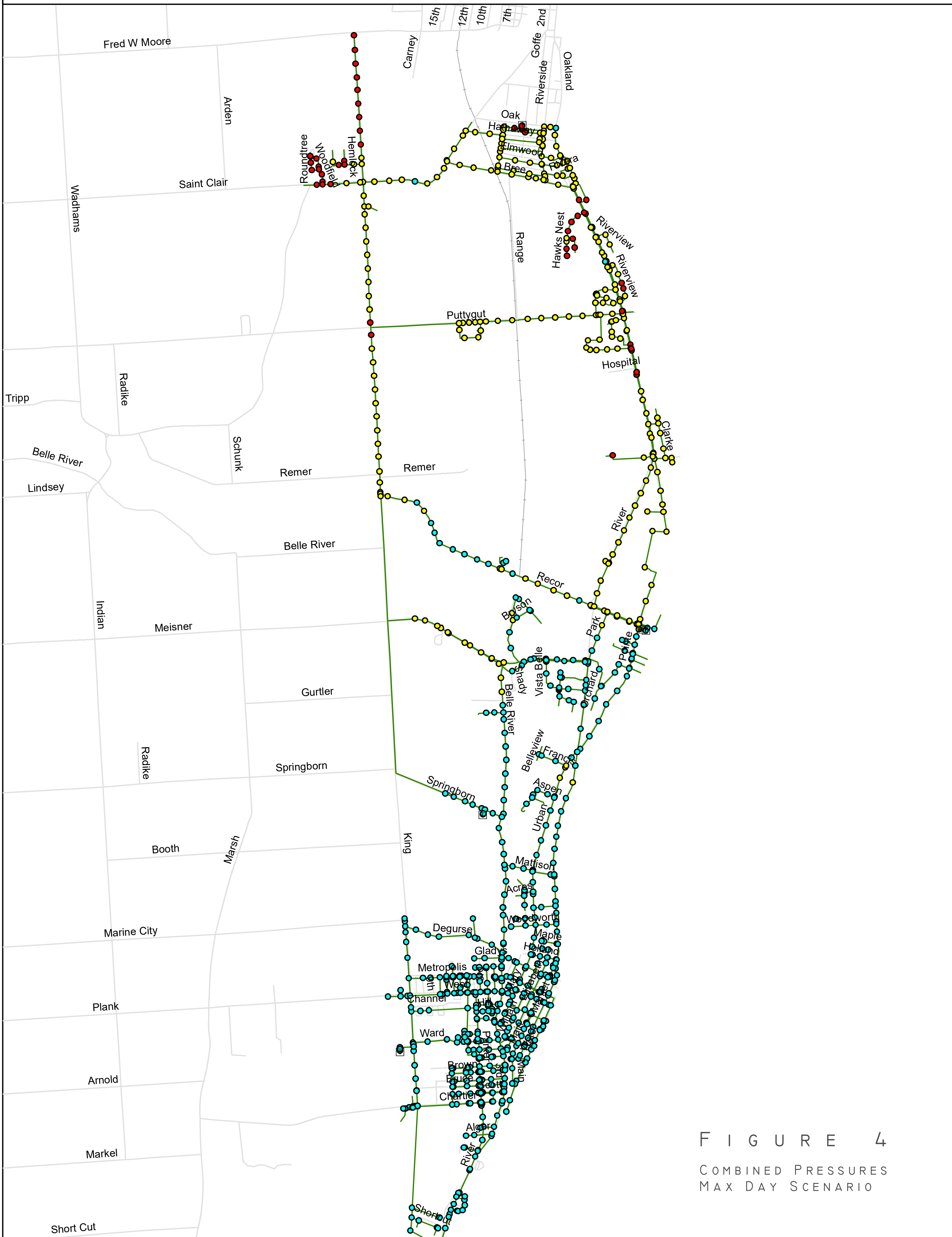
10" on North Mary Street/Urban Road – This is the largest diameter pipe and would have the most capability to increase flow if necessary. If this interconnect remains closed, pressure reduces by 0-3 psi and fire flow is reduced drastically in multiple locations, with some areas falling below the 500 gpm minimum.

8" on North Main Street/River Road – Shutting down this interconnect reduces pressure by 0-1.0 psi and reduces fire flows by around 500-700 gpm in several locations. This connection provides the lowest flow to Marine City and would appear to be the best candidate to remain closed, however, closing this connection reduces fire flow capabilities significantly.

The analysis showed that closing one of the three interconnections would reduce pressures minimally, however, closing any one of the three has a dramatic impact on available fire flow. Having the third interconnection open helps to provide the volume of water needed to adequately fight fires. It is recommended that all three interconnects be utilized to provide the greatest pressure and fire flow to residents. Having all three interconnects remain operational also allows for a level of redundancy should a connection need to be taken out of service temporarily for any reason in the future.

SCRSWA and Marine City

St. Clair County, Michigan



0.65 Miles

Legend

- WTP
- Tanks

Pressure

- 35 - 40
- 40 - 45
- 45 - 50
- 50 - 55

- Water Main
- Roads
- Railroad

FIGURE 4

COMBINED PRESSURES
MAX DAY SCENARIO

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SCRSWA and Marine City

St. Clair County, Michigan

F I G U R E 5

Combined Pressures
Peak Hour Scenario

Legend

WTP
Tanks

Pressure

- 35 - 40
- 40 - 45
- 45 - 50
- 50 - 55

Water Main
Roads
Railroad

0.65 Miles

WADE TRIM

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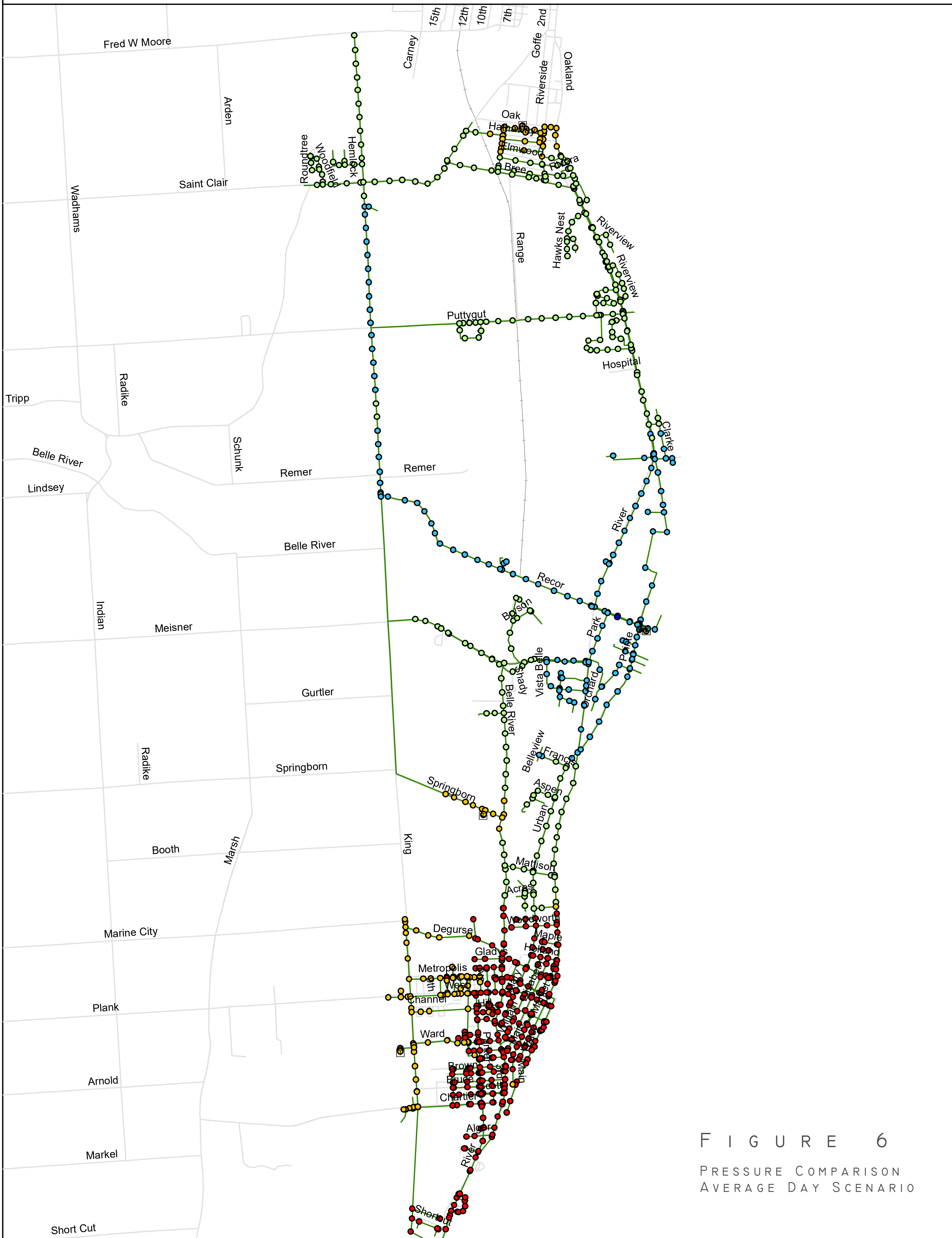
January 2020

SCRSWA and Marine City

St. Clair County, Michigan



F I G U R E 6

PRESSURE COMPARISON
AVERAGE DAY SCENARIO

0.6 Miles

Legend

- WTP
- Tanks

Pressure Change (PSI)

- -3 to -1
- -1 to 1
- 1 to 3
- 3 to 5
- 5 to 7

- Water Main
- Roads
- Railroad

WADE TRIM

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July 2020

6.4 FUTURE CONDITIONS EVALUATION

Water system hydraulic analyses typically extrapolate historical population growth as a method of estimating future water demands. The SEMCOG population forecasts for China, East China, and Marine City (which are further detailed in Section 4.2, Future Water Use) results in a total population increase of approximately 244 people by 2045 and an estimated average day demand increase of 18 gpm. A 10-year scenario was applied to the model, although an increase of 18 gpm had a minor impact on the system and is within the East China WTP's firm capacity of 2.0 mgd.

7.0 CONCLUSIONS

7.1 WATER SYSTEM MANAGEMENT

The model of the existing water system shows that the decommissioning of the existing Marine City WTP is possible with the existing distribution system. The pressures throughout the system were maintained above the minimum requirement of 35 psi during each scenario simulated; however, the existing WTP in East China may need to be operated for additional hours for the water tanks to be completely filled as is the current practice.

During the first few days of the Marine City WTP decommissioning, extensive monitoring of the system could be conducted, including the recording of any customer complaints regarding a significant drop in pressure or water quality. This transition will likely cause flow in different directions and could cause water to become temporarily cloudy due to changing flow direction in some pipe sections.

The highest elevations within the water network are in the northern half of the system. These areas require water to be pumped upward to receive service and result in lower pressures. For SCRSWA, approximately 11.2% of the active nodes in the existing conditions model indicated pressures below 40 psi while none of the nodes in the Marine City model were below 40 psi. In the combined model, Marine City maintained all pressures above 40 psi while SCRSWA had only 2.3% below 40 psi. Areas with elevations of 597 feet or higher (such as those near the north elevated storage tank in East China, as well as areas along King and River Roads) typically experience these lower pressures. However, all pressures throughout the system meet the criterion established for minimum pressures.

7.2 OPERATIONAL ISSUES

The joining of the Marine City and SCRSWA distribution system will result multiple operational issues including staffing, materials, redundancy, and maintenance. Due to the increased demand that would be placed on SCRSWA WTP, the plant will need to operate for additional hours of the day. This will result in an increased staffing cost and need for chemicals at the facility, although there will be a savings attributed to the decommissioning of the Marine City WTP.

Currently, both communities have the option to temporarily shut down one plant without losing service for their customers by opening the interconnects with the other community. This currently provides an opportunity to complete maintenance activities and address any emergencies that may arise. The current redundancy would be lost should the decommissioning of the Marine City WTP move forward.

Although, the SCRSWA system has redundancy by providing interconnects with the City of St. Clair WTP, the City of St. Clair water system cannot provide water for Marine City, SCRSWA communities, and the City of St. Clair.

7.3 MARINE CITY INTEGRATION INTO SCRSWA

Multiple options exist for Marine City to join SCRSWA. The first option allows Marine City to become a customer of the Authority. This would not provide Marine City any voting rights within the Authority and would likely result in higher rates as they would not be covering capital costs for the WTP or distribution system. Should the Authority and Marine City wish to pursue this option, a discussion as to how upgrades for the SCRSWA WTP, required for the addition of Marine City, would be paid for.

The second option involves Marine City joining the Authority as a member. Becoming a member of the Authority would provide the City with voting rights based on their population as a portion of the entire population served by the Authority. As a member of the Authority, Marine City would have water rates similar to those of the existing Authority member communities. Both China and East China Townships have bought into the SCRSWA providing each of them with a percentage ownership of the WTP. Marine City would need to do the same if they were to join as a member. This may result in the need to purchase capacity from either or both China and East China Townships.

7.4 COST ESTIMATES

The combined model shows that the existing SCRSWA WTP can supply the existing Authority communities and the City of Marine City without any capital improvements to the plant. The firm capacity of the plant is 24.2% higher than the modeled water demand for all three communities.

Recently, the Authority has been discussing installing master meters for water being delivered to China Township. Currently, China is invoiced for water based on the summation of the individual water meters for their customers. Using a master meter is a much more accurate means of measuring water being delivered to China Township. We anticipate that if Marine City were to obtain their water from SCRSWA that master meters would be required at each connection point. Cost for these master meter pits could range from $75,000 to $150,000 each depending on availability of right-of-way, availability of power, and other factors.

7.5 IMPROVEMENTS

The goal of this study is to determine if the decommissioning of the Marine City WTP and permanent connection to the SCRSWA system was feasible. Overall, it appears that the integration would result in minor hydraulic changes for both existing systems without the need for any improvements to the distribution system or improvements to the SCRSWA WTP. Should the systems be combined, it is recommended that the Marine City and SCRSWA water systems be connected by opening all three interconnections to provide adequate pressure and fire flow.

Per the Ten States Standards for Water Supply Systems, Part 2.1, “The system including the water source and treatment facilities shall be designed for maximum day demand at the design year.” The SCRSWA WTP will be able to provide maximum day demands as the firm capacity is 1.94 mgd, and the combined demand will be 1.47 mgd. It should be noted that the plant will not be able to handle peak day flows, although due to the storage and high service pump capacity, service should be able to be maintained in a peak hour scenario.

It is also likely that the East China WTP will need to be operated for additional hours daily to account for the additional demand. In an average day scenario, it is estimated that all of the tanks should be full in less than ten hours of operation, but this will vary.

Should the integration occur, it is recommended that the interconnects be opened prior to the shutdown of the Marine City WTP as to limit any pressure issues caused by the shutdown. Residents should also be notified prior to the integration that sediment may be present in the water lines during the first few hours of the transition due to a change in flow direction throughout the system.

Extensive monitoring of the system post-integration should also occur, and any new complaints should be recorded to provide a detailed log of any issues for the first few days. This will indicate if there are any critical issues within the system.

The minimum pressure requirement of 35 psi continues to be achieved throughout the distribution system for each scenario (i.e., average day, maximum day, and peak hour) incorporating the recommended improvements. Also, nearly 98% of the hydrants in the model were able to achieve the minimum fire flow requirements for residential and commercial/industrial areas (1,000 gpm and 2,500 gpm, respectively).

A copy of this report should be submitted to SEMCOG, as well as EGLE should the communities decide to move forward with consolidation. EGLE will evaluate the plan for compliance with the "Safe Water Drinking Act," Public Act 399 of the State of Michigan.

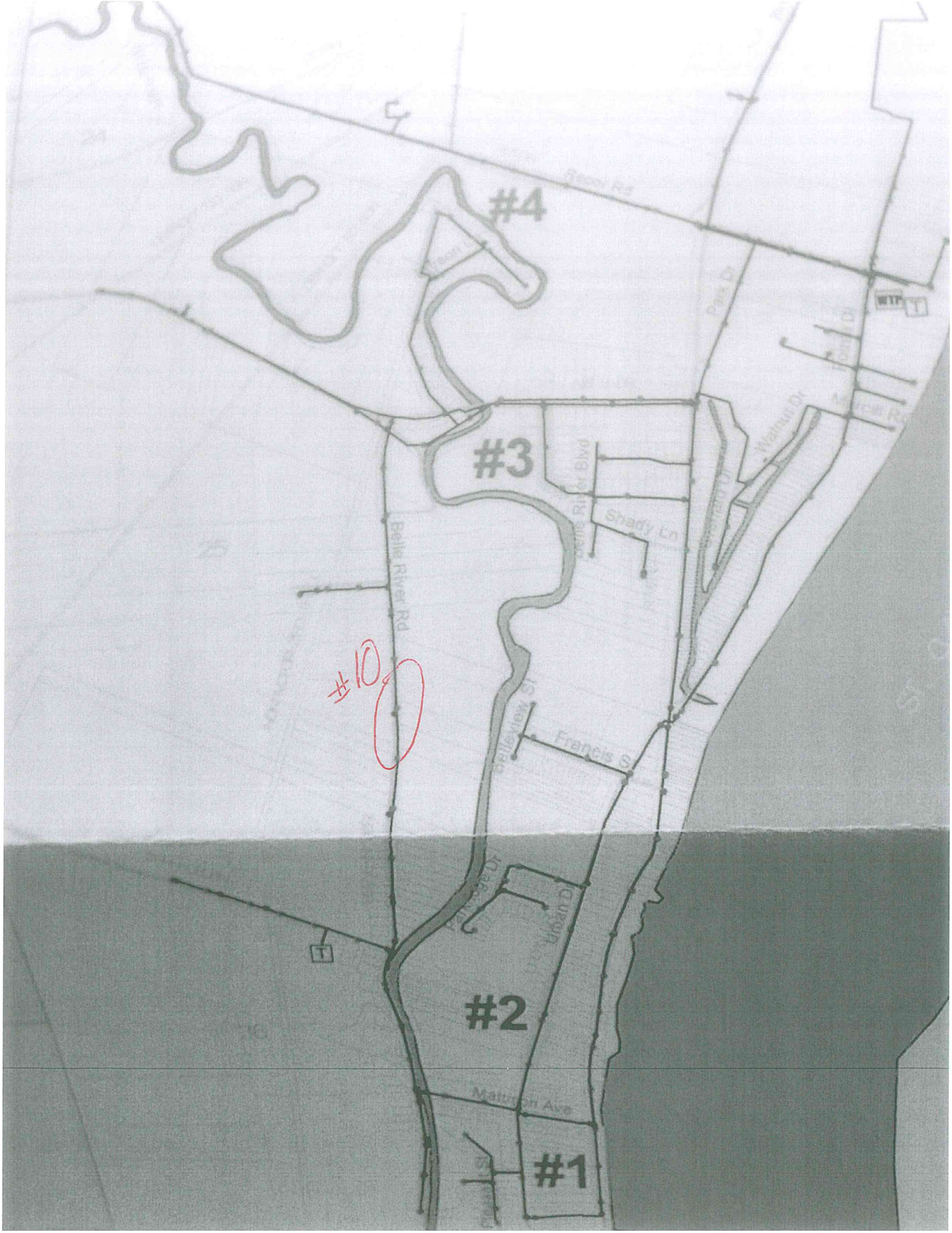
APPENDIX

2002.19

BMJ ENGINEERS & SURVEYORS, INC.
Civil Engineers & Land Surveyors
519 Huron Avenue
PORT HURON, MICHIGAN 48060
Phone: (810) 984-5596
Fax: (810) 984-8760

JOB SCRSWA WATER SYSTEM RELIABILITY STUDY
SHEET NO. 1 OF 1
CALCULATED BY TMK DATE 6-16-2020
CHECKED BY — DATE —
SCALE NONE

LOCATION	STATIC TEST			FLOW TEST			
#	HYD. #	BEFORE PSI	DURING PSI	HYD. #	READING PSI	FLOW GPM	START TIME
1	029	48	48	028	32	890	9:05
2	012	48	48	009	32	890	9:20
3	116	46	46	115	29	845	9:40
4	142	48	48	141	26	800	10:10
5	327	44	44	328	26	800	12:09
6	262	44	44	264	33	905	11:20
7	211	44	44	212	18	670	11:03
8	174	44	44	175	25	785	10:45
9	164	46	46	163	18	670	10:28
10	086	48	48	085	32	890	9:52
11	288	42	42	289	17	650	11:36
12	306	42	42	305	22	740	11:52



#4
Park Dr
#3
Belle River Blvd
Shady Ln
Walnut Dr
Belle River Rd
#10
Belleview St
Francis St
Urban Dr
#2
Mattison Ave
#1

Tim Kelch

From: Brent Moore
Sent: Tuesday, June 02, 2020 8:45 AM
To: Patrick Phelan
Cc: Tim Kelch
Subject: 2002.19 - SCRSWA Water System Reliability Study
Attachments: image.jpeg; image.jpeg

Pat,

Here are the locations that we should probably get hydrant tests:

1. M-29 – Between Mattison Avenue and Woodworth Street
2. Urban Drive – Between Mattison Avenue and Aspen Way (3 hydrants closest to Mattison Avenue)
3. Vista Belle – S. of Meisner Road
4. Recor Road – Between King and River Road (hydrants 4 through 7 west of River Road, adjacent to park)
5. King Road – Between Remer Road and Puttygut Road (hydrants 4 through 7 North of Remer Road)
6. Bree Road – Between St. Clair Hwy and Riverside Avenue
7. Puttgut Road – Between King Road and River Road (hydrants 6 through 8 west of River Road)
8. River Road – Beteen South Hospital Drive and Remer Road (Hydrants closest to hospital)
9. Chamberlain Street – S. of Remer Road

Brent S. Moore, P.E.
Engineer
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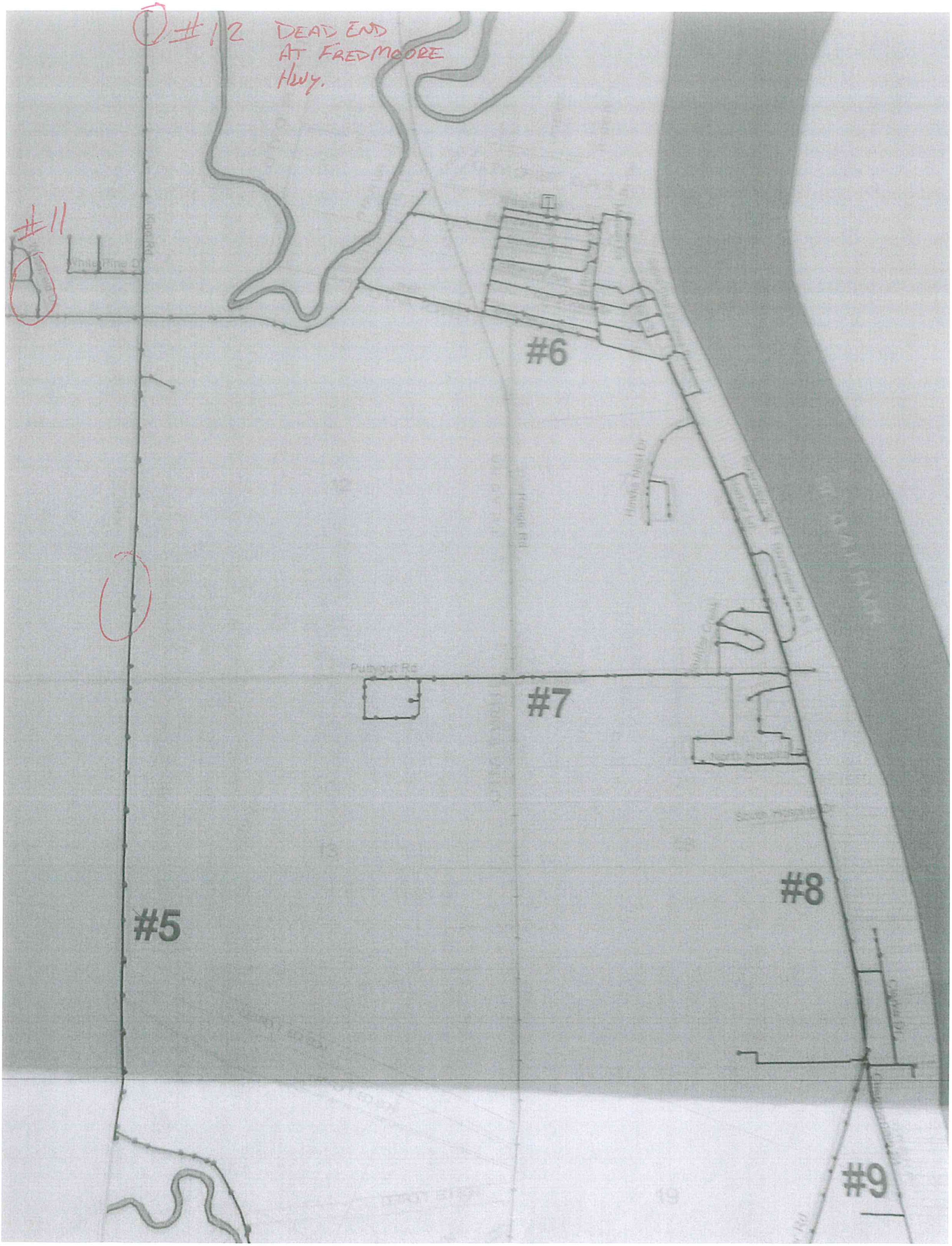

#12 DEAD END AT FREDMOORE HWY.
#11
White Pine Dr
#6
12
Putty Gut Rd
#7
13
#8
#5
#9
19

INSURANCE SERVICES OFFICE, INC.

HYDRANT FLOW DATA SUMMARY

City Marine City

County Michigan(St Clair), State MICHIGAN (21) Witnessed by: Insurance Services Office Date: Sep 12, 2014

TEST NO.	TYPE DIST.*	TEST LOCATION	SERVICE	FLOW - GPM				PRESSURE PSI		FLOW -AT 20 PSI		REMARKS***	MODEL TYPE
				INDIVIDUAL HYDRANTS			TOTAL	STATIC	RESID.	NEEDED **	AVAIL.		
2 sup		E/S Parker St., 1st hyd. S. of Chartier	Marine City Water Department, Main	950	1050	0	2000	51	45	4500	4900	(D)-(4486 gpm)	
2a		E/S Parker St., 1st hyd. S. of Chartier	Marine City Water Department, Main	950	1050	0	2000	51	45	6500	4900	(A)-(6000.0 gpm)(D)-(4486 gpm)	
2b		E/S Parker St., 1st hyd. S. of Chartier	Marine City Water Department, Main	950	1050	0	2000	51	45	3500	4900		
3		S/S Chartier, 1st hyd. E. of Elizabeth St.	Marine City Water Department, Main	1060	1030	0	2090	50	44	3000	5000		
4		Chartier & King Rd., N/W corner hyd.	Marine City Water Department, Main	1100	0	0	1100	48	47	3000	6700		
5a		W/S King Rd., 1st hyd. S. of Ward St.	Marine City Water Department, Main	950	950	0	1900	50	48	5000	8200	(D)-(4486 gpm)	
5b		W/S King Rd., 1st hyd. S. of Ward St.	Marine City Water Department, Main	950	950	0	1900	50	48	3000	8200		
6		Ward St. & Parker St., N/W corner hyd.	Marine City Water Department, Main	530	0	0	530	49	48	3500	3300		
7		E/S King Rd., 1st hyd. N. of West Blvd.	Marine City Water Department, Main	950	950	0	1900	49	44	3000	4900		
8		DeGurse Ave., 1st hyd. W. of River Valley Dr.	Marine City Water Department, Main	930	0	0	930	50	47	3000	3200		
9a		Main St. & Broadway St., S/W corner hyd.	Marine City Water Department, Main	1130	0	0	1130	50	44	2000	2700		
9b		Main St. & Broadway St., S/W corner hyd.	Marine City Water Department, Main	1130	0	0	1130	50	44	1000	2700		

THE ABOVE LISTED NEEDED FIRE FLOWS ARE FOR PROPERTY INSURANCE PREMIUM CALCULATIONS ONLY AND ARE *NOT* INTENDED TO PREDICT THE MAXIMUM AMOUNT OF WATER REQUIRED FOR A LARGE SCALE FIRE CONDITION.

THE AVAILABLE FLOWS ONLY INDICATE THE CONDITIONS THAT EXISTED AT THE TIME AND AT THE LOCATION WHERE TESTS WERE WITNESSED.

*Comm = Commercial; Res = Residential.

**Needed is the rate of flow for a specific duration for a full credit condition. Needed Fire Flows greater than 3,500 gpm are not considered in determining the classification of the city when using the Fire Suppression Rating Schedule.

*** (A)-Limited by available hydrants to gpm shown. Available facilities limit flow to gpm shown plus consumption for the needed duration of (B)-2 hours, (C)-3 hours or (D)-4 hours.

INSURANCE SERVICES OFFICE, INC.

HYDRANT FLOW DATA SUMMARY

City Marine City

County Michigan(St Clair), State MICHIGAN (21) Witnessed by: Insurance Services Office Date: Sep 12, 2014

TEST NO.	TYPE DIST.*	TEST LOCATION	SERVICE	FLOW - GPM $Q=(29.83(C(d^2)p^{0.5}))$				PRESSURE PSI		FLOW -AT 20 PSI		REMARKS***	MODEL TYPE
				INDIVIDUAL HYDRANTS			TOTAL	STATIC	RESID.	NEEDED **	AVAIL.		
1		6730-6764 S. River Rd., rear hyd. S/W side	Marine City Water Department, Main	1060	0	0	1060	52	46	1750	2600		
10		S. Water St. & Jefferson St., S/W corner hyd.	Marine City Water Department, Main	1030	0	0	1030	52	48	3000	3200		
11		N. Main St. & Holland St.	Marine City Water Department, Main	1010	0	0	1010	50	47	2500	3500		
12		E/S River Rd., 1st hyd. N. of Broadbridge Rd.	Cottrellville TS Water Department, Main	1030	0	0	1030	49	41	1750	2100		
13a		W/S River Rd., 1st hyd. S. of Roberts Rd.	Cottrellville TS Water Department, Main	980	0	0	980	50	37	1500	1500		
13b		W/S River Rd., 1st hyd. S. of Roberts Rd.	Cottrellville TS Water Department, Main	980	0	0	980	50	37	1000	1500		
14		S/S Shea Rd., 3rd hyd. E. of McKinley Rd.	Ira TS Water Department, Main	900	0	0	900	56	30	500	1100		
15a		Arnold Rd., 2nd W. of McKinley Rd.	Ira TS Water Department, Main	920	0	0	920	49	33	3000	1300		
15b		Arnold Rd., 2nd W. of McKinley Rd.	Ira TS Water Department, Main	920	0	0	920	49	33	500	1300		
16		Urban Dr., 1st hyd. S. of Rosemary	East China TS Water Department, Main	990	0	0	990	45	42	1000	3100		
17 sup		Park Dr., 1st hyd. S. of Recor Rd.	East China TS Water Department, Main	1750	0	0	1750	45	20	4000	1800	(A)-(3000.0 gpm)	
17a		Park Dr., 1st hyd. S. of Recor Rd.	East China TS Water Department, Main	1750	0	0	1750	45	20	4000	1800		
17b		Park Dr., 1st hyd. S. of Recor Rd.	East China TS Water Department, Main	1750	0	0	1750	45	20	3000	1800		
18		Pointe Dr., 2nd hyd. S. of Recor Rd.	East China TS Water Department, Main	1560	0	0	1560	53	42	2250	2800		
19a		Meisner Rd., 3rd hyd. W. of Belle River Rd.	East China TS Water Department, Main	990	0	0	990	45	40	5500	2400	(A)-(1500.0 gpm)	
19b		Meisner Rd., 3rd hyd. W. of Belle River Rd.	East China TS Water Department, Main	990	0	0	990	45	40	3500	2400		

THE ABOVE LISTED NEEDED FIRE FLOWS ARE FOR PROPERTY INSURANCE PREMIUM CALCULATIONS ONLY AND ARE *NOT* INTENDED TO PREDICT THE MAXIMUM AMOUNT OF WATER REQUIRED FOR A LARGE SCALE FIRE CONDITION.

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*** (A)-Limited by available hydrants to gpm shown. Available facilities limit flow to gpm shown plus consumption for the needed duration of (B)-2 hours, (C)-3 hours or (D)-4 hours.

CITY OF MARINE CITY

DEPARTMENT OF PUBLIC WORKS

303 S. Water Street
MARINE CITY, MICHIGAN 48039
(810) 765-9711 • Fax (810) 765-1796

December 10, 2015

Dear Board Members,

This is information to let you know what we have for water mains and the specifications of the system. As you all know, we have a very old system. Please see the attached sheets for a breakdown of water mains, which provides street names, pipe material utilized, size, and length. The information provided is an approximation and please note that we did our best to research all of our maps, but some of the maps are missing or were never updated.

WATER PLANT

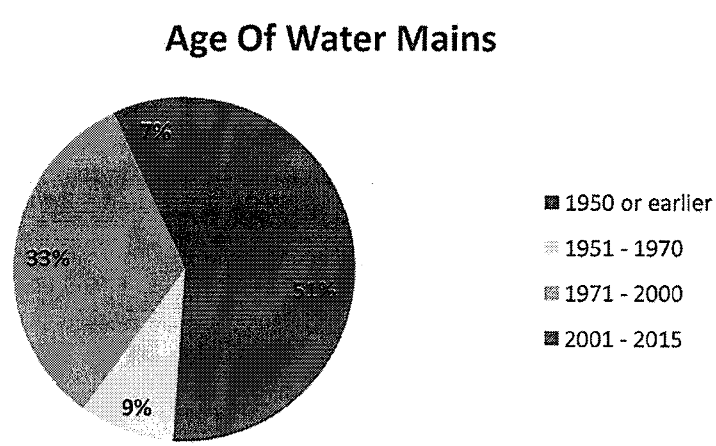
To begin with, the Water Plant has had many updates over the years, but the original pumps and piping from 1937 are still being used to pump water into the system. At this point, we can still have the pumps rebuilt, but we do not know how long they would last. Both 10 inch lines that leave the plant were put in during 1937 and then again in 1948.

WATER MAINS

As for the water mains, the amounts shown below include piping only; the valves were not included in the figures. We have approximately 130,671 feet of water mains in town. Below is a breakdown of the age of mains as well as the approximate size and length.

AGE:
1950 or lower = 67,422 feet
1951 thru 1970 = 11,282 feet
1971 thru 2000 = 43,408 feet
2001 thru 2015 = 8,559 feet

SIZE:
2 inch water mains = 3,617 feet
4 inch water mains = 36,067 feet
6 inch water mains = 36,039 feet
8 inch water mains = 4,754 feet
10 inch water mains = 10,432 feet
12 inch water mains = 37,499 feet
16 inch water mains = 2,263 feet



CITY OF MARINE CITY

WATER

STREET NAME	*MAJOR/LOCAL RD.*	*PIPE MATERIAL*	*SIZE*	*LENGTH*	*APPROX. INSTALL YEAR*
Alger	Local Road	Ductile Iron	4"	939 ft	Prior to 1949
Bell (West of S. Parker)	Local Road	Copper	2"	350 ft	1987
Bell (East of S. Parker)	Local Road	Ductile Iron	6"	910 ft	1998
Bell (S. Third to S. Belle River	Local Road	Ductile Iron	4"	475 ft	1949
N. Belle River (Degurse to NCL)	Local Road	Ductile Iron	10"	1,463 ft	1998
N. Belle River (Degurse to West Blvd)	Major Road	Ductile Iron	6"	1,393 ft	1949
S. Belle River (Fairbanks to Chartier)	Local Road	Ductile Iron	6"	6,455 ft	1949
S. Belle River (Chartier to Alger)	Local Road	Ductile Iron	4"	1,299 ft	1949
Bowery	Local Road	Ductile Iron	6"	482 ft	1960s
Bridge St. (S. Main to S. Water)	Major Road	Ductile Iron	4"	554 ft	1949
Bridge St. (S. Market to S. Water)	Major Road	Ductile Iron	10"	294 ft	1999
Broadway (S. water to Belle River)	Major Road	Ductile Iron	6"	1,738 ft	1955
Brown (Parker to WCL)	Local Road	Ductile Iron	6"	1,094 ft	1978
Brown (Parker to Belle River)	Major Road	Ductile Iron	6"	946 ft	1978
Bruce	Local Road	Ductile Iron	4"	1,967 ft	1949
Butler	Local Road	Ductile Iron	4"	626 ft	1949
Butler (Metropolis to West Blvd)	Local Road	Ductile Iron	12"	626 ft	1973
Carroll	Local Road	Ductile Iron	4"	1,987 ft	1949
Catherine	Local Road	No Main	N/A	494 ft of Road	N/A
Charles	Local Road	Ductile Iron	12"	371 ft	1949
Chartier (M-29 to King)	Major Road	Ductile Iron	12"	1,910 ft	1995
Chartier @ King Rd going South to K-Mart Plaza	Major Road	Ductile Iron	12"	3,500 ft	1980

CITY OF MARINE CITY

WATER

STREET NAME	*MAJOR/LOCAL RD.*	*PIPE MATERIAL*	*SIZE*	*LENGTH*	*APPROX. INSTALL YEAR*
Chartier (M-29 to Third)	Major Road	Ductile Iron	6"	431 ft	1994
Cottrell	Local Road	Ductile Iron	10"	838 ft	1938
Degurse	Major Road	Ductile Iron	12"	3,700 ft	1997
Delina	Local Road	Ductile Iron	6"	847 ft	1978
N. Elizabeth (Broadway Street to Westminister)	Local Road	Ductile Iron	6"	909 ft	Prior to 1949
N. Elizabeth (Westminister to Holland)	Local Road	Ductile Iron	4"	614 ft	Prior to 1949
S. Elizabeth	Local Road	Ductile Iron	6"	2,208 ft	Prior to 1949
Fifth	Local Road	Galvanized Steel	2"	616 ft	Prior to 1949
Fourth	Local Road	Ductile Iron	6"	616 ft	1987
Frederick	Local Road	No Main	N/A	469 ft of Road	N/A
Gladys	Local Road	Ductile Iron	6"	851 ft	1987
Hanover	Local Road	Galvanized Steel	2"	275 ft	N/A
Harold	Local Road	Ductile Iron	4"	582 ft	N/A
High	Local Road	Ductile Iron	8"	499 ft	Prior to 1949
Hill	Local Road	Ductile Iron	6"	887 ft	1978
Holland (M-29 to N. Elizabeth)	Local Road	Ductile Iron	8"	307 ft	1947
Holland (M-29 to N. Elizabeth)	Local Road	Ductile Iron	12"	307 ft	1947
Holland (N. Elizabeth to N. Mary Street)	Local Road	Ductile Iron	6"	633 ft	Prior to 1949
Industrial Way	Local Road	Ductile Iron	12"	800 ft	2003
Jefferson (Main to S. Water)	Major Road	Ductile Iron	12"	810 ft	1948
Jefferson (Main to Belle River)	Local Road	Ductile Iron	6"	1,002 ft	1947
Katherine	Local Road	No Main	N/A	619 ft of Road	N/A
King (Chartier to MC Highway	Major Road	Ductile Iron	12"	7,000 ft	1973
King	Major Road	Ductile Iron	12"	700 ft	1982
Louis Miller	Local Road	No Main	N/A	360 ft of Road	N/A
Lowell	Local Road	Galvanized Steel	2"	242 ft	N/A
Mabel	Local Road	Ductile Iron	6"	1,104 ft	1949

Created: 8-7-2015

CITY OF MARINE CITY

WATER

STREET NAME	*MAJOR/LOCAL RD.*	*PIPE MATERIAL*	*SIZE*	*LENGTH*	*APPROX. INSTALL YEAR*
N. Main	Local Road	Ductile Iron	12"	3,109 ft	2003
S. Main (Broadway to Jefferson)	Major Road	Ductile Iron	12"	617 ft	1948
S. Main (Jefferson to Union Street)	Major Road	Ductile Iron	6"	1,155 ft	Prior to 1949
S. Main (Jefferson to Union Street)	Major Road	Ductile Iron	4"	1,155 ft	1949
S. Main (Union Street to Bridge Street)	Major Road	Ductile Iron	4"	658 ft	1949
Maple	Major Road	Ductile Iron	6"	874 ft	1949
Marine	Local Road	Ductile Iron	4"	551 ft	1949
Mariner's Landing (King Rd to MC Fire Hall - S. Parker)	N/A	Ductile Iron	12"	2000 ft	1996
N. Market (Broadway to Westminister)	Local Road	Ductile Iron	8"	907 ft	Prior to 1949
N. Market (Westminister to N. Main Street)	Local Road	Galvanized Steel	2"	488 ft	1949
S. Market (Broadway to Washington Street)	Major Road	Ductile Iron	6"	1,006 ft	1978
S. Market (Washington Street to Union)	Major Road	Ductile Iron	10"	764 ft	1937
S. Market (Union to Bridge St.)	Major Road	Ductile Iron	10"	438 ft	2000
N. Mary (Charles to NCL)	Local Road	Ductile Iron	10"	1,355 ft	1948
N. Mary (Broadway to Holland Street)	Major Road	Ductile Iron	4"	1,370 tf	1948
S. Mary	Local Road	Ductile Iron	4"	1,522 ft	Prior to 1949
Metropolis (Belle River to King Rd.)	Local Road	Cement	12"	3,400 ft	1973
Murray Court	Local Road	Cement	6"	902 ft	1976
N. Parker	Local Road	Ductile Iron	4"	920 ft	Prior to 1949
S. Parker (West Blvd. to Ward Street)	Major Road	Ductile Iron	6"	1,838 ft	1949

Created: 8-7-2015

CITY OF MARINE CITY

WATER

STREET NAME	*MAJOR/LOCAL RD.*	*PIPE MATERIAL*	*SIZE*	*LENGTH*	*APPROX. INSTALL YEAR*
S. Parker (Ward Street to Chartier Street)	Major Road	Ductile Iron	16"	2,263 ft	1978
S. Parker (Chartier Street to SCL)	Major Road	Ductile Iron	12"	4,650 ft	2003
Pearl St. (N. Water to N. Main Street)	Local Road	Ductile Iron	4"	535 ft	1955
Pearl St. (N. Main Street to Belle River) **N side of Pearl St.	Local Road	Ductile Iron	4"	1,449 ft	1955
Pearl St. (N. Main Street to Belle River)**S side of Pearl St.	Local Road	Ductile Iron	12"	1,449 ft	1973
Pittsburgh	Local Road	Ductile Iron	4"	998 ft	1949
Plank (West Blvd to City Limits)	Local Road	Ductile Iron	10"	600 ft	1992
Pleasant	Local Road	Ductile Iron	4"	898 ft	1949
Pleasant (Mabel to NCL)	Local Road	Plastic	2"	268 ft	N/A
River	Local Road	Galvanized Steel	2"	214 ft	N/A
River Valley	Local Road	Ductile Iron	8"	804 ft	1995
Riverview	Local Road	No Main	N/A	192 ft of Road	N/A
Robertson	Local Road	Ductile Iron	4"	2,027 ft	1949
Scott	Local Road	Ductile Iron	10"	835 ~~1,927~~ ft	Prior to 1949
Scott (M-29 to WCL)	Local Road	Cast Iron	4"	1,092 ft	1970
Second	Local Road	Ductile Iron	4"	1,185 ft	Prior to 1949
Short Cut	Local Road	Ductile Iron	~~12~~" 6"	1,039 ft	1981
Sixth	Local Road	Ductile Iron	4"	612 ft	Prior to 1949
East St. Clair (Main to Belle River)	Local Road	Ductile Iron	4"	879 ft	Prior to 1949
East St. Clair (Main to S. Water)	Major Road	No Main	N/A	531 ft of Road	N/A
West St. Clair	Local Road	Galvanized Steel	2"	697 ft	Prior to 1949
N. Third	Local Road	Ductile Iron	4"	1,196 ft	Prior to 1949
S. Third	Local Road	Ductile Iron	4"	2,957 ft	Prior to 1949
Thompson Drive	Local Road	Cement	6"	268 ft	1962
Union (S. Market to S. William St.)	Local Road	Ductile Iron	10"	811 ft	1937

Created: 8-7-2015

CITY OF MARINE CITY

WATER

STREET NAME	*MAJOR/LOCAL RD.*	*PIPE MATERIAL*	*SIZE*	*LENGTH*	*APPROX. INSTALL YEAR*
Ward (Parker to Belle River)	Local Road	Ductile Iron	4"	716 ft	Prior to 1949
Ward (Tracks to King Rd)	Major Road	Ductile Iron	6"	2,055 ft	1950
Ward (M-29 to former tracks)	Major Road	Ductile Iron	8"	379 ft	1998
Washingon (S. William to Mary)	Local Road	Plastic	2"	274 ft	2012
Washingon (S. Market to S. Water)	Local Road	Ductile Iron	10"	262 ft	1937
N. Water	Local Road	Ductile Iron	4"	281 ft	Prior to 1949
S. Water (Bridge St. to S. Main)	Local Road	Ductile Iron	10"	1,080 ft	1999
S. Water (S. Main to SCL)	Local Road	Ductile Iron	4"	1,191 ft	Prior to 1955
S. Water (Broadway to Bridge St.)	Major Road	Ductile Iron	6"	2,143 ft	Prior to 1955
West Boulevard (M-29 to Belle River)	Major Road	Ductile Iron	~~6"~~ 4	948 ft	Prior to 1949
West Boulevard (M-29 to Sixth St.)	Major Road	Ductile Iron	4"	1,016 ft	Prior to 1949
West Boulevard (Sixth Street to King Road)	Major Road	Cement	6"	1,400 ft	N/A
West Boulevard (West Blvd to DPW *Under Bike Path)	Local Road	Ductile Iron	12"	2,250 ft	1973
Westminister	Local Road	Ductile Iron	8"	2,062 ft	Prior to 1949
N. William (Maple to NCL)	Local Road	Plastic	2"	467 ft	N/A
N. William (Broadway to Maple)	Major Road	Ductile Iron	4"	2,011 ft	Prior to 1949
S. William	Major Road	Ductile Iron	4"	1,922 ft	Prior to 1949
Woodworth (M-29 to Mary)	Local Road	Ductile Iron	4"	750 ft	Prior to 1948
Woodworth (Mary to Belle River)	Local Road	Ductile Iron	6"	948 ft	1987

Created: 8-7-2015

We also have three river crossings under Belle River:

1. Union at S. William to S Belle River Rd just south of Ward St. = 10 inch installed in 1937
2. Pearl St to N Belle River Rd just north of Fairbanks = 12 inch installed in 1973
3. Westminster to N Belle River just north of Gladys = 8 inch installed prior to 1949

FIRE HYDRANTS

We have 212 fire hydrants in town

VALVES

We have approximately 1,000 valves in our system; we should have at least 3 times the valves that we have now.

As mentioned, this is all information only, but as you can see we need to address this in the years to come as there is no quick fix. At today's prices we have approximately *$3.7 million* worth of mains, fire hydrants, valves, and service lines; this is materials only.

On the last page of the attachment, you will see a monthly and yearly report on water production from our water plant. I hope this information is helpful to you. These are all things to consider as we look towards the future to keep Marine City a safe and vibrant place to live.

Respectfully,

Michael Itrich
Superintendent
Department of Public Works