CITY OF REPUBLIC
Water & Wastewater Master Plan

Executive Summary

Abstract

The following Executive summary provides a high-level overview of the master planning efforts for the water and wastewater utility. Including the needed capital improvements to facilitate growth and maintain compliance.

Andrew Nelson, P.E.
Community Development Director

Greetings,

I am pleased to present this executive summary for your consideration. The following document represents 1 ½ years of data collection and planning efforts by City Staff and our consulting engineer Burns & McDonnell. This planning effort provides the staff and the citizens of Republic a clear and precise approach to building and maintaining utilities that are compliant and facilitate the growth of the City.

The Republic Water system is overall in good condition. While we do have areas that suffer from restricted fire flows and aging infrastructure, the service itself is still compliant and acceptable. We are positioned well to take a proactive rather than reactive approach and make the necessary investments to replace these pieces of the system before they disrupt service to our customers. From a perspective the City's projected growth shows that additional wells will be necessary in the 20-year planning period, however this does not adversely affect our aquifer and the underground supply shows to be adequate to facilitate our growth. There are also some options to participate in a regional effort to obtain water supply from Stockton lake if it proves to be economical.

The Republic Wastewater system is in a little bit tougher position. Although we have expired large debt services from the original plant expansion 20 years ago, aging infrastructure and deferred maintenance have created a backlog of capital projects. Along with that, the City entered into a voluntary compliance agreement with Missouri Department of Natural resources that expires in 2021. This agreement was a voluntary effort to achieve system compliance, due to overflow discharges at the wastewater treatment plant from excess stormwater. With no major progress made to eliminate the bypass of the treatment process, the City will now be entering into and Administrative Order with MDNR that will dictate a strict timeline to regain compliance. This Order will require major capital investment to achieve compliance and will have strict penalties associated if this goal is not met. The good news is that our completed master plans are the first major step in this process and position the City well to meet the requirements of the Administrative order within the deadline.

The effort and investment into these master plans create a well-defined path for the City to provide the most efficient, compliant and cost-effective network of utilities for the citizens of Republic. Execution and implementation of these planning efforts will also prepare the City exciting new growth and development opportunities. The best is yet to come!

Sincerely,

Andrew D. Nelson, PE
Community Development Director
City of Republic

Table of Contents

Republic Master Plan Executive Summaries

Water Master Plan

1.1 Water Distribution System

The City's water distribution system consists of four wells, three elevated storage tanks, one ground storage tank and associated pump station that supply water to the water main network. The four supply wells (Well 3, Well 4, Well 5, and Well 6) pump water from the Ozark Aquifer into the distribution system. Well 5 pumps to a ground storage tank and is pumped into the distribution system with a separate pump station. There are three elevated storage tanks and one ground storage tank with a total volume of 2.1 MG. The water distribution, as modelled, totals approximately 120 miles of pipe ranging in diameter from 4-inches to 12-inches.

1.2 Population and Water Demand Projections

City staff provided population projections for years 2020, 2030, and 2040. The 5-year and 20-year population projections are interpolated for year 2023 and year 2038 and apply a water usage of 91 gpcd and 96 gpcd respectively for the demand projections. The escalation in water usage from 2023 to 2038 is a conservative approach to account for an aggressive population growth which is expected to double in the next 20 years. Customer classes include residential, commercial, city use, and industrial (representative of manufacturing and warehouse facilities). From 2015 to 2018 the residential and commercial classes represented approximately 70 percent and 20 percent, respectively, of the total customer sales, therefore a population-based water demand projection is applied in the master plan. The mix of customers during this period is also representative of the previous 15 years and water usage, in terms of gallons per-capita-day (gpcd), has been consistent ranging between 88 gpcd and 94 gpcd since 2007. The City also anticipates the addition of a large water user in the amount of 1.0 MGD occurring after 2023. A summary of the population and water demand projections (maximum day demand) is listed below:

- Year 2019: 14,958 people at 3.02 MGD.
- Year 2023: 22,110 people at 3.62 MGD; and
- Year 2038: 35,358 people at 7.11 MGD.

1.3 Water Supply Planning

Source water planning to meet short and long-term water demand projections using the firm capacity design concept is recommended and calculates the City's water supply assuming the highest producing well is out of service. This approach provides additional supply resiliency for the City and help deliver water during periods of high demand, even if one well is out of service for cleaning or repairs. MDNR design guidelines for source water planning with groundwater systems requires the following for water supply capacity planning:

- Criteria 1: the total developed groundwater source capacity shall equal or exceed the design maximum day demand; and
- Criteria 2: all public water systems shall be capable of meeting design average day demand with the largest producing well out of service.

1.4 Short-Term Supply Planning

Based on the water demand projections through 2023, the capacity of the City's existing water supply sources complies with the firm capacity concept and MDNR guidelines. As indicated previously, the City is planning for a new large water user needing approximately 1.0 MGD occurring in or after 2024, which will fall out of compliance with the firm capacity concept. Therefore, a new well should be implemented as average and maximum day demands approach 3.1 MGD and 4.9 MGD, respectively. Similarly, as average and maximum day demands approach 4.4 MGD and 7.1 MGD respectively another well should be added. The short-term supply planning using the firm capacity concept is summarized in Table 1-1 below:

Table 1-1: 20-Year Water Supply Planning

Year	Demands (MGD)			Supply (MGD)		Recommended Action
	Large User	Average Day	Maximum Day	Firm Capacity	Total Capacity	
2019	0.0	1.7	3.0	2.8	4.3	none
2020	0.0	1.8	3.2	2.8	4.3	none
2023	0.0	2.0	3.6	2.8	4.3	none
2024	**1.0**	**3.1**	**4.9**	**4.2**	**5.8**	**add 1 new well**
2030	1.0	3.6	5.8	4.2	5.8	none
2038	**1.0**	**4.4**	**7.1**	**5.7**	**7.2**	**add 1 new well**

1.5 Long-Term Supply Planning

A total of six new supply wells are required to meet the long-term water demand projections for the 50- year planning horizon. This equates to adding a well every 8-9 years. Wells should be added in areas where growth is occurring to support the hydraulic gradients in the distribution system and elevated storage. Location and quantity should also consider connectivity to portions of the distribution system that have limited highway or railroad crossings to increase water supply redundancy in these areas. Use of water from a project that ultimately results from the Tri-State Water planning effort is an alternative to address the City's long-term supply deficits; however, significant uncertainties remain about that exact nature of that project which could shift it from a viable alternative to not recommended. Those uncertainties impact the business case for evaluating how the City can best meet long-term water demands. Given the uncertainties in the Tri-State Water project and available information as of the date of this report, the 50-year water supply plan includes options to develop wells or introduce surface water from the Tri-State Water project as a new supply source.

1.6 Water Master Planning

The City identified growth areas for the 5-year and 20-year planning periods and are illustrated in Figure 1-1. Distributions for the population projections are allocated by development area and planning period based on input from City staff. The projected water demands for these growth areas are based on anticipated customer and land use classifications and are evaluated with the model to identify capital improvements required to convey these demands to customers in the existing and future water service area.

1.7 Hydraulic Model Development

Field testing was conducted from June 27, 2018 through July 29, 2018 and included fire hydrant testing with pressure monitoring, via data loggers, in the distribution system. Data loggers are positioned on fire hydrants located at or near water mains ranging between 4-inch and 12-inches in diameter. Other data included in the model calibration effort includes SCADA historian information from the City's water system facilities and are listed below:

- Flow and discharge pressure at wells 3, 4, 5, and 6.
- Elevated storage level at Tanks 3, 4, and 6; and
- Flow, discharge pressure, and ground storage tank level at the Well 5/pump station facility.

A total of 28 fire hydrant tests were conducted throughout the distribution system on 4-inch, 6-inch and 8- inch water mains. Fire hydrant testing creates hydraulic stress in the distribution system and the results are used to calibrate the model to accurately simulate static conditions. Model calibration is performed by adjusting the Hazen-Williams coefficient, or C-value, assigned to pipes to simulate the test results, data logger pressure information, well performance, and tank levels. The calibrated model adequately represents the fire hydrant test results and pressure at each of the data logger locations.

Water Master Planning for City of Republic, Missouri

Growth Area	Population and Demand Allocation			
	5- year Population	5-Year Demand (MGD)	20-year Population	20-year Demand (MGD)
1	919	0.15	4,231	1.77
2	552	0.09	2,539	0.46
3	736	0.12	3,385	0.62
4	552	0.09	2,539	0.46
5	919	0.15	4,231	0.77
5-year Subtotal	3,678	0.6	--	--
5-year Total	22,110	3.62	--	--
20-year Subtotal	--	--	16,925	4.08
20-year Total	--	--	35,358	7.11

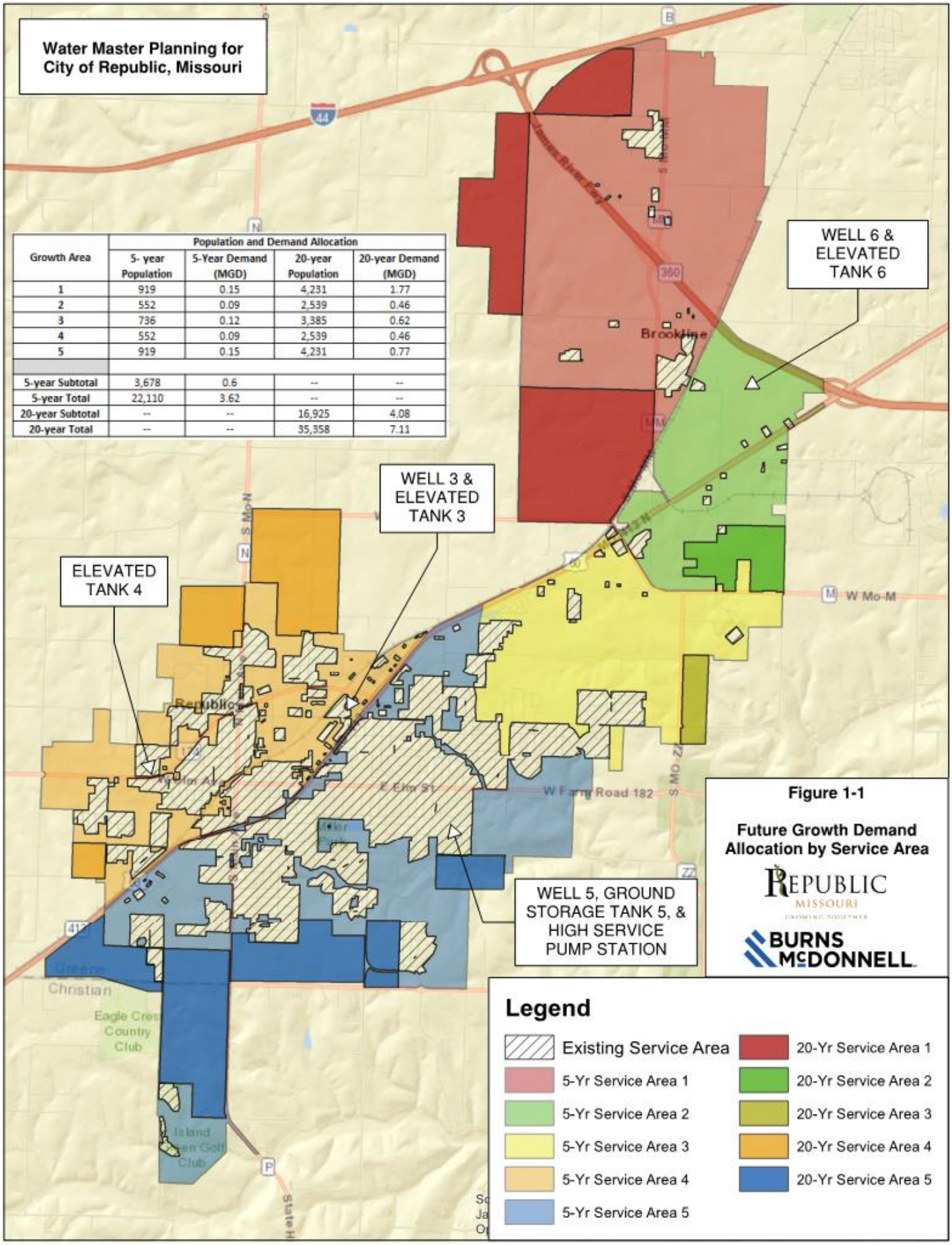


Figure 1-1

Future Growth Demand Allocation by Service Area

REPUBLIC MISSOURI

BURNS McDONNELL

1.8 Hydraulic Model Development

The hydraulic analysis for the existing system is based on a maximum day demand of 3.02 MGD, a peak hour demand of 5.78 MGD, a minimum hour demand of 1.66 MGD, and a fire service under maximum day demands. The average pressure in the system under maximum day demands is approximately 68 psi, with approximately 83 percent of the system ranging between 50 psi and 80 psi. The model results identified no high velocity and/or high head loss watermains under these demand conditions. Frisco square experience pressure between 35 psi and 40 psi under peak hour demands and is attributed to the elevation in this area, which is the highest in the distribution system.

The model results indicate all wells and the pump station at the Well 5/ground storage tank facility are adequately sized to convey maximum day demands and fill elevated storage during low demand periods. The desktop, or quantitative, storage analysis indicates a storage surplus of approximately 0.93 MG; therefore, no storage improvements are recommended. Elevated storage is adequately located, with respect to water main capacity, to deliver peaking demands and maintain adequate pressure throughout the distribution system, which is greater than 40 psi, with exception to a couple of dead ends in the Frisco Square area.

The hydraulic model evaluates available fire flow under the maximum day demand condition. The City's fire flow requirement for sizing distribution system water mains is 1,500 gpm at a 20-psi residual. Most of the low fire flow areas, less than 1,500 gpm, are dead-end 4-inch and 6-inch diameter pipes with available fire flow between 800 gpm and 1,500 gpm that may not warrant a fire flow improvement, at least initially, if there are no active service connections. Remaining areas with low available fire flow are evaluated in the Year 2023 model simulation for the projected demand and include fire-flow driven improvements.

The average water age in the distribution system under average day and maximum day demands are 54 hours and 35 hours, respectively. The water age of the existing distribution system is considered good, or low, for this type of groundwater supply-distribution system, customer makeup, water demands, and water main sizing. Tank 6 operating levels exhibit minimal turnover. This is primarily due to the Well 6 pump controls that operate based on tank level and low water demands within the tank's area of influence. The pump cycling can be lengthened with modifications to the control system at Well 6 to promulgate more turnover within the tank; this will also lessen the mechanical taxing on the pump. SCADA historian tank level trending during field testing indicated between 3 and 4 well pump starts per day based on a turnover of approximately 3 ft in the tank bowl with a head range of 37.5 ft. Model results indicate a tank turnover between 7 ft and 9 ft can still provide adequate pressure service within its area of influence. From a water quality perspective, a general guideline is to turnover between 25 percent and 33 percent of the tanks volume daily.

1.9 Year 2023 System Analysis

The hydraulic analysis for the year 2023 planning period is based on a maximum day demand of 3.62 MGD, a peak hour demand of 6.90 MGD, a minimum hour demand of 1.99 MGD, and fire service under maximum day demands. The average pressure in the distribution system under maximum day demands is approximately 69 psi, with approximately 75 percent of the system ranging between 50 psi and 80 psi.
The storage analysis indicates a storage surplus of approximately 0.93 MG; therefore, no storage improvements are recommended.

Capital improvements for fire flow service total approximately 17 miles of water main and development driven improvements total approximately 42 miles of water main to support anticipated growth within the existing distribution system and peripheral growth that will expand the water service area. Development driven improvements that provide looping on the periphery of the existing distribution system also help meet the fire flow requirement, without them, available fire flow will decrease depending on the location and demand conditions and may not comply with the City's fire service requirement of 1,500 gpm at a
20-psi residual.

1.10 Year 2038 System Analysis

The hydraulic analysis for the year 2038 planning period is based on a maximum day dem4and of 7.11 MGD, a peak hour demand of 12.7 MGD, a minimum hour demand of 4.4 MGD, and fire service under maximum day demands. The average pressure in the distribution system under maximum day demands is approximately 67 psi, with approximately 77 percent of the system ranging between 50 psi and 80 psi.
The storage analysis indicates a storage surplus of approximately 0.4 MG; therefore, no storage improvements are recommended.

The water main improvements for fire flow service identified in the year 2023 planning period are adequately sized for the 2038 planning period, therefore, no additional capital improvements are required for compliance with the City's fire flow requirement. There are approximately 17 miles of water main improvements needed for future development to expand the service area.

1.11 Capital Improvements Plan

Opinions of probable cost in todays' dollars for capital improvements based on the water demands evaluated in the model are listed below. The small mains replacement cost opinion is a catch-all for any remaining water mains less than or equal to 4-inches not associated with a fire service trigger. Please note that cost opinions can increase for individual linear improvements, or portions thereof in terms of length, if rock excavation is required which can be highly variable based on the sporadic nature of karst formations within the water service area. The opinion of probable cost for each CIP is summarized below:

- Year 2023 Planning Period subtotal at $31.9 million:
    - New water mains for fire service at $1.0 million.
    - New water mains for fire service to replace existing small mains at $4.8 million.
    - Development driven improvements at $22.5 million; and
    - Development driven improvements that also increase distribution system redundancy/connectivity at $3.5 million.
- Year 2038 Planning Period subtotal at $9.7 million:
    - Development driven improvements at $7.6 million; and
    - Water supply improvements at $2.2 million.
        - This includes two production wells and associated pump, motor, well house, electrical, mechanical needs for well house, SCADA/controls, and permitting, engineering, and construction.
        - The first production well is contingent based on the demand projections and a new large user(s) requiring 1.0 MGD of water service beginning in or after year 2024.
        - The second production well should be implemented as maximum day demands approach 7.11 MGD and includes the large user(s) water demand indicated above.
- Small mains replacement at $11.0 million.
- Total opinion of probable cost at $52.5 million.

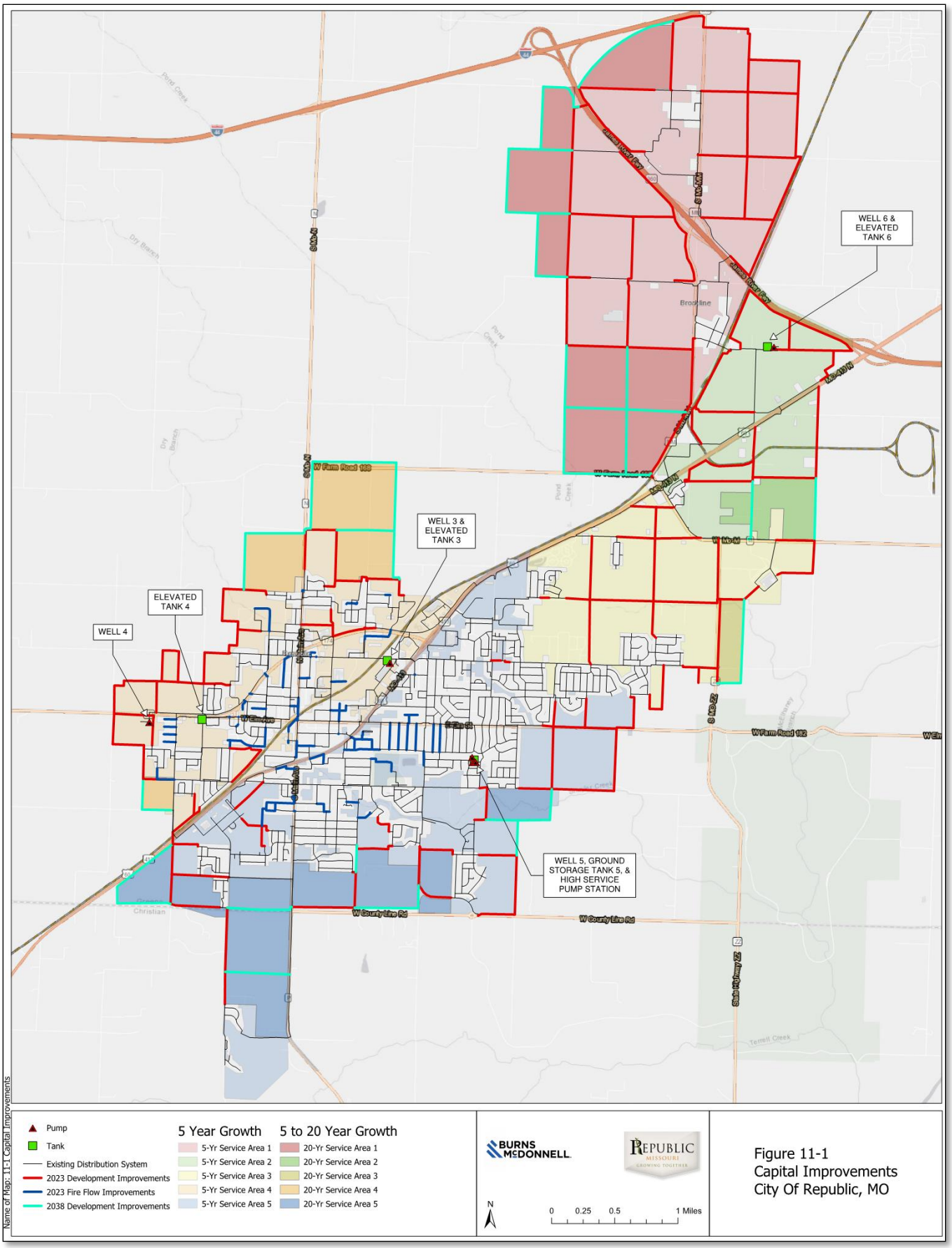


Figure 11-1
Capital Improvements
City Of Republic, MO

1.12 Water Master Plan Conclusion

In conclusion, the existing water system is robust in terms of storage, distribution connectivity, and is appropriately sized for current and projected water demands through the end of the 2038 planning period; hence there are no high-priority hydraulic improvements required in the short-term other than the addition of a new well which is recommended to maintain a level of water supply redundancy. Additional water supply capacity is also conditional based on the addition of a new large user occurring in or after 2024, but the impetus for implementing the first new well should be triggered by water demand, not necessarily the improvement period which can accelerate or delay its implementation schedule. This places the City in a repair/replacement mode of operation for known problematic areas (i.e. aging infrastructure, frequent water main break areas, etc.), fire service improvements as funding is available, and development-driven improvements when needed.

Nonrevenue water, by definition in this report (difference between meter production and billed consumption) is moderately high for a system of this size and customer base which is primarily residential and commercial and any efforts to lower this amount can potentially impact the scheduling of water supply improvements and even impact fire flow improvement needs and sizing. Nonrevenue water varied widely since 2013, ranging from 13 percent to 23 percent during a period of marginal variance in average and maximum day demands. An AWWA M36 top-down water audit is recommended as a starting point to better manage, quantify, and identify nonrevenue water and potential sources of real losses and apparent losses.

Real losses are physical water losses (i.e. water main breaks, background leakage, flushing activity, etc.) in the distribution system that are pumped and treated, but never reach customer service taps, and are valued at the variable production cost (electricity and disinfectant). Apparent losses represent “paper losses” attributed to unauthorized consumption, meter inaccuracies, systematic data handling errors in the billing system transcription of customer meter readings, etc. and are valued at the customer retail unit cost. All distribution systems have varying degrees of real and apparent losses; with respect to Republic and the presence of karst in the region, real water losses have more potential to influence the overall water loss standing of the utility because water main breaks and/or leakage may never surface, hence it never gets reported or estimated because this type of topography is known for its sinkholes and caves. Water auditing with the M36 reporting sheets should be conducted annually and integrated as a business practice; the reporting worksheets are made available to all water industry providers at no cost from AWWA and can be downloaded from their website.

Wastewater Collections

2.1 Introduction

The City of Republic, Missouri (City) retained Burns & McDonnell (BMcD) to develop a sanitary sewer system model to complete an existing conditions evaluation and to create a Capital Improvement Plan (CIP) for the 5-year (2023) and 20-year (2038) planning periods. This report provides the City with a comprehensive document pertaining to an evaluation of the existing system and future conditions assessment. Specifically, this report summarizes the following components of the modeling project:

- Existing Conditions
- Inflow & Infiltration (I&I) Reduction Strategy
- Population Growth
- CIP Projects
- Opinion of Probable Costs

2.2 Existing Conditions Analysis

Evaluation of existing conditions included identifying projected sanitary sewer pipes and manholes with a reduced level of service during the 5-year, 24-hour design event. The evaluation was performed using the existing conditions model. Details related to model development can be found in the *Hydraulic Model Calibration & Verification* technical memorandum dated May 2019. The model showed flow constrictions at several locations throughout the model and indicated a restricted level of service in several conduits and manholes. Most of these restrictions were located in the FM- 109 meter catchment and along the Shuyler Creek interceptor.

2.3 I&I Reduction Strategy

To assist in alleviating the restricted levels of service in the existing system, a Goal-Based I&I Reduction strategy is proposed. A Goal-Based I&I Reduction strategy will be used to target specific percent reductions at defined points within the sanitary sewer system. This type of plan identifies the current level of I&I at a point in the system and defines a percent reduction along with a time frame for achievement. Goal-Based I&I Reduction is usually coupled with additional CIP projects to look at the sewer system as part of a comprehensive master plan to achieving a certain level of sanitary service. This type of I&I reduction program provides measurable goals, which are important if I&I reduction is considered in place of or as part of a future capital improvement program. These levels are typically defined utilizing hydraulic models, which identify the most efficient means of achieving the desired level of service. A Goal-Based I&I Reduction strategy will allow the City to utilize their capital budget on cost efficient I&I removal on the basins with the highest priorities.

2.4 Population Growth

In addition to an existing conditions analysis, a future conditions model was developed for use in determining CIP projects. A large portion of these projects are related to projected population growth in the City. The City provided BMcD with growth areas for the 5-year and 20-year planning period, which were allocated throughout the model. The updated population projections, along with increased sanitary flows, were used to identify proposed linear, lift station, and force main improvements as part of the overall Wastewater Master Plan.

2.5 Capital Improvement Plan

Proposed planning level sewer improvements were developed as part of the CIP. These improvements addressed manholes and conduits that indicated a reduced level of service during the existing conditions analysis. The proposed CIP Projects focused on the following measures:

2.5.1 I&I reduction

2.5.2 Increased pipe diameters

2.5.3 Increased pipe slopes

2.5.4 Lift station improvements

The proposed improvements were organized into 20 projects for the CIP. These projects were then phased using both a 5-year (2023) and 20-year (2038) planning periods. A summary of the projects, phasing, and opinion of probable cost can be found in, and an overview of the projects can be found in Figure 0-1.

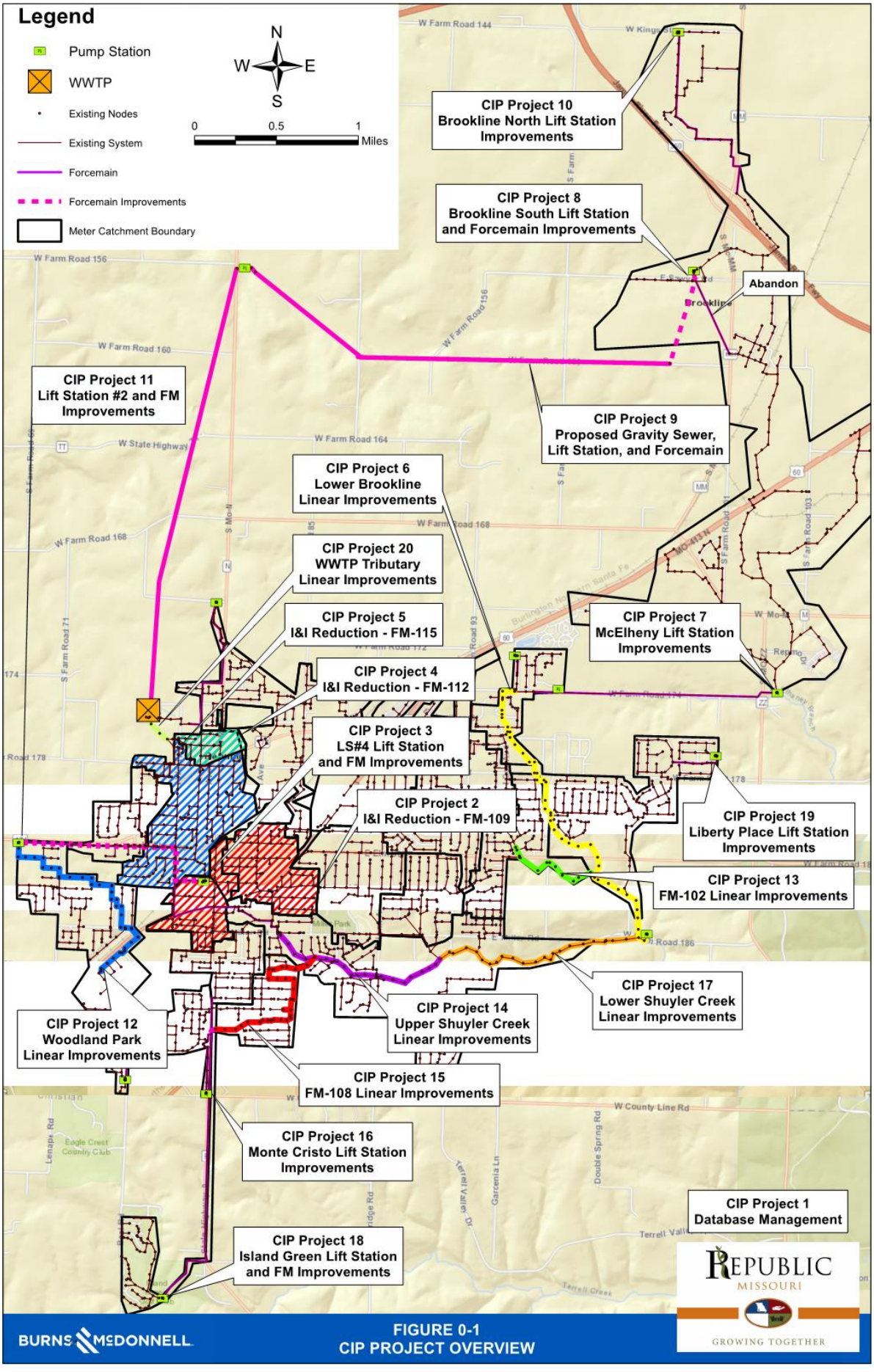

Legend
Pump Station
WWTP
Existing Nodes
Existing System
Forcemain
Forcemain Improvements
Meter Catchment Boundary
N
W
E
S
0
0.5
1
Miles
CIP Project 10
Brookline North Lift Station
Improvements
CIP Project 8
Brookline South Lift Station
and Forcemain Improvements
Abandon
CIP Project 11
Lift Station #2 and FM
Improvements
CIP Project 9
Proposed Gravity Sewer,
Lift Station, and Forcemain
CIP Project 6
Lower Brookline
Linear Improvements
CIP Project 20
WWTP Tributary
Linear Improvements
CIP Project 5
I&I Reduction - FM-115
CIP Project 7
McElheny Lift Station
Improvements
CIP Project 4
I&I Reduction - FM-112
CIP Project 3
LS#4 Lift Station
and FM Improvements
CIP Project 2
I&I Reduction - FM-109
CIP Project 19
Liberty Place Lift Station
Improvements
CIP Project 13
FM-102 Linear Improvements
CIP Project 17
Lower Shuyler Creek
Linear Improvements
CIP Project 14
Upper Shuyler Creek
Linear Improvements
CIP Project 12
Woodland Park
Linear Improvements
CIP Project 15
FM-108 Linear Improvements
CIP Project 16
Monte Cristo Lift Station
Improvements
CIP Project 1
Database Management
CIP Project 18
Island Green Lift Station
and FM Improvements
W Farm Road 144
W Farm Road 156
W Farm Road 160
W Farm Road 164
W Farm Road 168
W State Highway
W County Line Rd
Terrell Creek
BURNS McDONNELL
FIGURE 0-1
CIP PROJECT OVERVIEW
REPUBLIC
MISSOURI
GROWING TOGETHER

Table 0-1: CIP Project Summary

CIP Project	Description	Phasing Priority	Opinion of Probable Cost
1	Database Management	1	$52,000
2	I&I Reduction - FM-109	1	$1,323,000
3	LS#4 Lift Station and FM Improvements	1	$1,190,500
4	I&I Reduction - FM-112	1	$280,500
5	I&I Reduction - FM-115	1	$1,440,500
6	Lower Brookline Linear Improvements	1	$2,849,500
7	McElhany Lift Station Improvements	1	$851,500
8	Brookline South Lift Station Improvements	1/2	$1,100,000
9	Proposed Gravity Sewer, Lift Station, and Forcemain	2	$9,317,500
10	Brookline North Lift Station Improvements	3	$530,000
11	LS#2 Lift Station and FM Improvements	1/2	$1,853,000
12	Woodland Park Linear Improvements	2	$1,543,000
13	FM-102 Linear Improvements	2	$812,500
14	Upper Shuyler Creek Linear Improvements	2	$1,479,000
15	FM-108 Linear Improvements	2	$1,523,500
16	Monte Cristo Lift Station Improvements	3	$426,000
17	Lower Shuyler Creek Linear Improvements	2	$1,965,000
18	Island Green Lift Station Improvements	3	$402,000
19	Liberty Place Lift Station Improvements	3	$237,000
20	WWTP Tributary Linear Improvements	3	$824,000
Contingency	Contingency Projects	X	$2,387,500
Total Opinion of Probable Cost (Including Contingency Projects)			**$32,387,500**

Note: The costs presented above reflect cost estimates as of December 2019 and are not projected to predicted construction year.

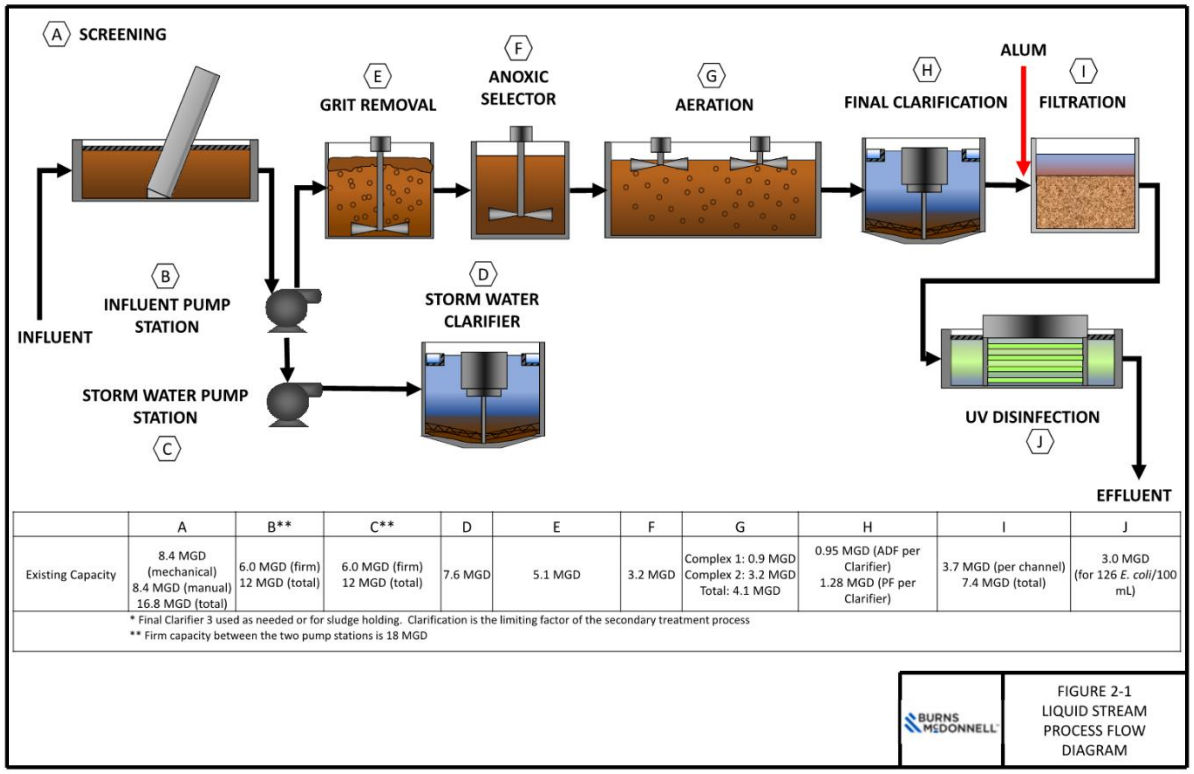
Wastewater Treatment Plant

3.1 Scope of Assessment

The City of Republic (the City) retained Burns & McDonnell (BMcD) to conduct an assessment of the existing wastewater treatment plant (WWTP) as part of the Wastewater Master Plan, setting forth evaluations and a plan of improvements for the facility through the planning year of 2038. Systems evaluated include influent screening, influent pumping, stormwater treatment, secondary treatment, clarification, chemical feed, tertiary filtration, disinfection, solids handling, and ancillary facilities. The existing WWTP was constructed in 1986 as an extended aeration activated sludge process and expanded in 2001. Currently, the WWTP is rated for an average day flow of 3.2 MGD and a peak flow of 5.1 MGD (at full expansion). Implementation of future processes or process modifications to accommodate National Pollution Discharge Elimination System (NPDES) permit changes, including biological nutrient removal (BNR), were also considered. The drivers for the improvements identified in this memorandum are based on anticipated regulations, growth projections, and capacity and performance-related issues.

3.2 Service Area Description

The Republic WWTP treats wastewater generated by residential, commercial, and some industrial customers. Growth projections through the 2038 planning period show the City's service areas expanding both in terms of physical area and population density. The WWTP is currently able to treat up to 2.2 million gallons per day (MGD), but it will require additional capacity to accommodate the anticipated growth. Refer to the Existing and Future Conditions Assessment Memorandum for additional detail on the WWTP service area.



	A	B**	C**	D	E	F	G	H	I	J
Existing Capacity	8.4 MGD (mechanical) 8.4 MGD (manual) 16.8 MGD (total)	6.0 MGD (firm) 12 MGD (total)	6.0 MGD (firm) 12 MGD (total)	7.6 MGD	5.1 MGD	3.2 MGD	Complex 1: 0.9 MGD Complex 2: 3.2 MGD Total: 4.1 MGD	0.95 MGD (ADF per Clarifier) 1.28 MGD (PF per Clarifier)	3.7 MGD (per channel) 7.4 MGD (total)	3.0 MGD (for 126 *E. coli*/100 mL)

* Final Clarifier 3 used as needed or for sludge holding. Clarification is the limiting factor of the secondary treatment process
** Firm capacity between the two pump stations is 18 MGD

BURNS MCDONNELL

FIGURE 2-1
LIQUID STREAM PROCESS FLOW DIAGRAM

3.3 Capital Improvements

The drivers for the improvements identified for the WWTP are based on regulations (both existing and anticipated), growth potential, and performance-related issues of supporting processes. The WWTP has historically been in compliance with effluent ammonia limits. However, improvements to increase treatment capacity, provide sufficient aeration, and reduce sludge age are necessary to ensure future compliance. Further, regulations for biological nutrient removal are being planned for future implementation state-wide by MDNR; thus, provisions for future total nitrogen and total phosphorus removal should be considered. The City should contemplate improvements to position the Plant for commercial and industrial growth in the service area. Improvements should aim to easily accommodate potential suitors by offering flexibility in loading scenarios.

Supporting processes, including the headworks, tertiary filtration, disinfection, and solids handling system, necessitate improvements to better control the liquid stream process and operations. A well-operating headworks protects downstream mechanical equipment, such as pumps and mixers, and a well-operating solids handling system with sufficient capacity is critical for nitrification and maintaining biological stability in the secondary process. Further, the hydraulic bottleneck created by the filters and UV disinfection needs to be alleviated to realize 4.1 MGD treatment capacity.

3.3.1 Headworks

The existing WWTP has experienced performance-related issues in downstream processes due to inadequate influent screening, which threatens pipe clogging, wearing pumps, and binding mixers. A grinder is currently installed upstream of the influent screen to reduce the size of larger influent solids. However, the grinder is performing poorly and is producing stringy material rather than more homogenously ground material. Also, the screening area floods during peak wet weather events due to the insufficient hydraulic capacity of the existing screen.

Installation of new influent screening and grit removal is recommended. Interceptor capacity to convey flow to the WWTP is approximately 16 MGD. The WWTP, with the improvements recommended by BMcD, has a capacity to treat a peak flow of 8.2 MGD through the secondary treatment process. Flow in excess of this would be conveyed to the stormwater treatment system. Direct discharges from the stormwater clarifier are no longer permitted and must be reported. MDNR has accommodated blending at other municipalities as an alternative for wet weather management. Peak flows in a blending scenario typically pass through primary treatment prior to being blended with fully treated effluent. Construction of a wet weather transfer pump station is recommended to pump peak flows from the stormwater clarifier to filtration for particulate BOD and TSS removal prior to discharge. Blending would eliminate future discharges from the stormwater system.

3.3.2 Secondary Treatment

The performance of the liquid stream process is threatened by insufficient solids handling capacity. Elevated MLSS concentrations yield SRTs that threaten the biological health in the aeration basins. The historic operational SRT of the aeration process (approximately 25 days) has been in the range where endogenous respiration occurs. During endogenous respiration, the microorganisms oxidize their own cellular mass in lieu of an organic source and release ammonia in the process. Further, elevated solids concentrations in the secondary process impacts the capacity of the system and hinders its ability to react during periods of higher loading. Thus, operating at a long SRT and high MLSS concentration threatens permit compliance without improvements to the solids handling and liquid stream processes.

A two-phase approach is recommended to improve the liquid stream process: (1) expansion of the selector basin, rehabilitation of Aeration Complex No. 2, and construction of a fourth clarifier (2) rehabilitation of Aeration Complex No. 1. The phased approach allows the City to gradually implement changes and add additional capacity when needed. Improvements made in each phase serve to incrementally improve treatment performance and capacity and preclude the need to construct a new treatment plant.

3.3.3 Tertiary Treatment (Filtration)

The existing traveling bridge sand filters are inefficient and lack the performance of cloth media filtration. Replacement of the traveling bridge sand filters with disc filters is recommended to maintain TSS and total phosphorus removal.

The existing traveling bridge filters are hydraulically located such that the disc filters could be installed within the existing filter channels. Two disc-filters, each rated for 8 MGD, would be installed in the filter channels and would receive clarifier effluent and stormwater flow from the proposed transfer pump station. One disc-filter would be used during normal operation, and both would be operated during peak conditions.

3.3.4 Disinfection

The existing UV disinfection system was installed in 2000 and has exceeded its useful design life. Further, the process creates a hydraulic bottleneck during wet weather events, as it was designed for a peak flow of 3.7 MGD. The original system was designed to achieve an effluent *fecal coliform* limit of 400 CFU/100 mL at 3.7 MGD, but the process has since been de-rated twice due to the more stringent *E. coli* limits in the facility's NPDES permit (126 colonies/100 mL). Operations staff indicated the maximum flow the UV equipment can treat is 3.0 MGD.

The UV system should be sized to accommodate flows equal to the influent pumping capacity – 16 MGD. The UV system would disinfect the 4.1 MGD treated by the plant and the 12 MGD peak wet weather flow pumped via the proposed transfer pump station. In order to reduce capital cost and make use of existing infrastructure, the new

equipment could be installed in the center channels of the abandoned chlorine contact basin.

Inclined UV systems are relatively new to the market and were created to alleviate issues with the large footprints associated with horizontal and vertical configurations for systems exceeding 5 MGD. They were designed to fit within the channels of chlorine contact basins, as numerous utilities replaced their chlorine disinfection systems with UV technologies. The inclined configuration improves on the potency of UV lamps without sacrificing efficiency or lamp size. The inclined configuration eliminates dead space within the channel and provides constant contact between the wastewater and UV light, which reduces the overall number of components (lamps, ballasts, cabinets, etc.).

3.3.5 Solids Handling

Sludge hauling frequency is dictated by land availability. When land application is not a viable option, the City occasionally hauls sludge to the City of Springfield's WWTP for further processing and disposal. Digestion capacity is insufficient, which often causes operations staff to store solids in the liquid stream process, yielding a long sludge age and threatening settleability and nitrification ability. Burns & McDonnell recommends constructing an additional aerobic digester and adding solids dewatering to produce a cake prior to land application.

The sludge quantities developed for this evaluation were based on influent BOD, TSS and temperature data provided by operations staff. The design wasting rate to maintain an eight to ten-day SRT in the secondary treatment process is 140,000 gpd at 0.5% to 1.0% solids, which equates to approximately 10,000 lbs./day. This solids loading will be used as the design basis for the solids processing system.

3.3.6 Administrative Building

The existing Administration Building (Admin Building) lacks adequate space for the operations staff, so the City has added a trailer behind the building to supplement the administrative space. Further, the shop within the Admin Building is too small to allow operations staff to work on most equipment The City indicated they have plans to construct a new shop within the next year; however, additional office space is still needed. A new multi-purpose building is proposed to supplement the existing administrative space. The proposed addition would be a metal building that includes both administration and dewatering spaces

The dewatering space will include a room to house the screw press or centrifuge and associated chemical feed equipment. The room would have an adjacent exterior area with overhead cover for cake storage and loadout. The building would also include an electrical room with CMU walls. The administration area would include an office, control room, and breakroom. It will also have new restroom, locker, shower and laundry facilities, and storage spaces.

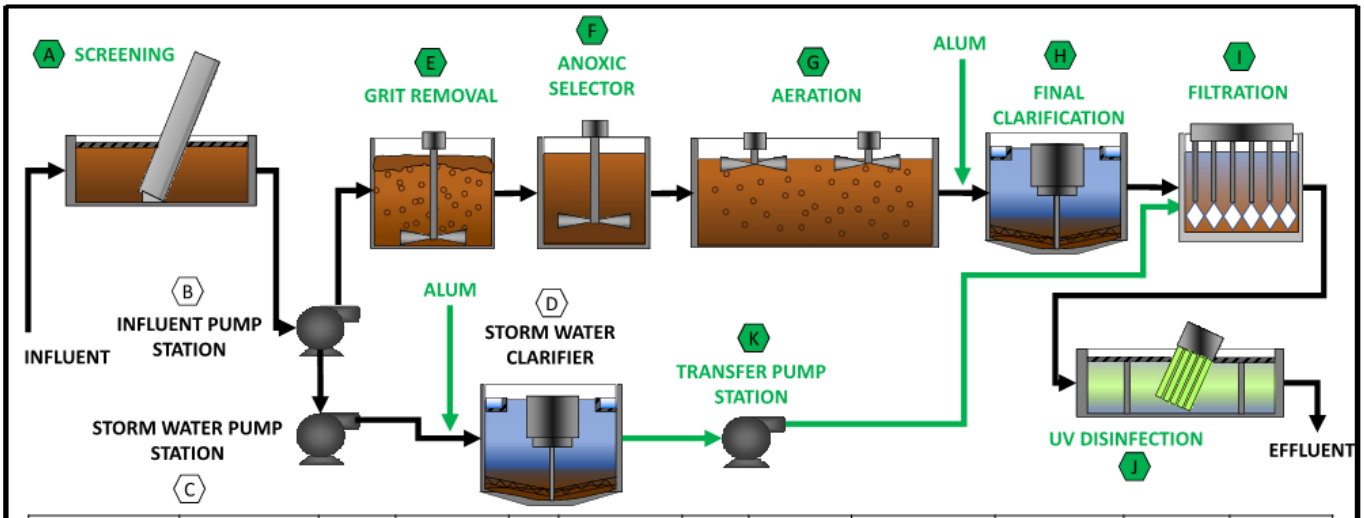
3.3.7 Probable Cost

Based on these improvements, BMcD developed opinions of probable construction costs. The cost opinions show the capital required for each project and the opportunity for phasing. Cost opinions are based on preliminary manufacturer data and raw water quality. These order-of-magnitude cost opinions are based primarily on our experience and judgment as a professional consultant combined with information from past experience, vendors, and published sources. Since BMcD has no control over weather, cost, availability of labor, availability of material and equipment, labor productivity, construction contractor's procedures and methods, unavoidable delays, construction contractor's methods of determining prices, economic conditions, government regulations and laws (including the interpretation thereof), competitive bidding or market conditions, and other factors affecting such opinions or projections, BMcD does not guarantee the actual rates, costs, etc. will not vary from the opinions and projections developed herein.

Table 5-11: WWTP Opinions of Probable Cost

Project	Capital Cost
Headworks	$3,900,000
Secondary Treatment: Phase I	$5,800,000
Secondary Treatment: Phase II	$1,500,000
Filtration	$2,500,000
Disinfection	$2,000,000
Solids Handling	$4,000,000
Total	**$19,700,000**

A 30-percent contingency allowance is included to cover all types of unaccounted-for project costs resulting from conditions, details, or components which are not normally known or determined until final detailed design. Costs specifically do not include geotechnical evaluations, deep foundations, surveys, permitting preparation and fees, utility services to site, and taxes.



	A	B*	C*	D	E	F	G	H	I	J	K
Recommended Improvement	Add additional mechanical screen	N/A	N/A	N/A	Rehabilitate equipment	Add capacity	Replace rotors	Add fourth clarifier	Retrofit filters with cloth media filters	Install inclined UV system in former chlorine contact basin	Install pump station to send treated storm water to filtration
Future Capacity	8.4 MGD (per mech. screen) 8.4 MGD (manual) 16.8 MGD (total mechanical)	6.0 MGD (firm) 12 MGD (total)	6.0 MGD (firm) 12 MGD (total)	8 MGD	3.2 MGD (per channel) 6.4 MGD (total)**	4.1 MGD	Complex 1: 0.9 MGD Complex 2: 3.2 MGD Total: 4.1 MGD	0.95 MGD (ADF per Clarifier) 1.28 MGD (PF per Clarifier)	8 MGD (per channel) 16 MGD (total)	16 MGD	12 MGD (firm) 16 MGD (total)
	• Firm capacity between two pump stations is 18 MGD ** Allowable to run at 8 MGD										

BURNS MCDONNELL

FIGURE 5-13
LIQUID STREAM IMPROVEMENTS SUMMARY