WATER SYSTEM MASTER PLAN

Prepared For:

CITY OF NIXA, MISSOURI

STATE OF MISSOURI
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WATER SYSTEM MASTER PLAN
NIXA, MISSOURI

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TITLE

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Exhibits 1 through 8 (.pdf file)

Hydraulic Water Model Junction Map (.pdf file)

Hydraulic Water Model Numerical Data Output (.pdf file)

I. SUMMARY

A. Findings

1. Population data from 1910 was collected and analyzed, as well as information from various sources for the City of Nixa to develop a trend for future growth projections. Continuing the trend that reflects the City's past growth throughout the planning period results in a population of approximately 34,551 in the year 2032.

2. There are three billing categories for water customers; residential/rural, commercial, and city owned. From 1994 to 2012, the average annual increase in the number of total active water meters has been approximately 5.1%. However, the average annual increase in total active meters from 2006 to 2012 has been approximately 2.1% which is a significant decrease due to the most recent economic recession conditions experienced by the area.

3. The City has experienced an average annual water loss percentage of approximately 15% from 1994 to 2012. However, over the last 5 years, the average annual water loss has been approximately 23%. This percentage of unaccounted water is considered excessive.

4. The most recent ISO Commercial Risks Services, Inc. report indicates that the ISO Public Protection Class rating for the City is three. However, there are several areas throughout the City where available hydrant flows are less than the Nixa Fire District's desired fire flow of 1,500 gallons per minute (gpm).

5. The current number of active residential, commercial, and city owned connections is 7,070, 575, and 23, respectively, for a total number of current customer connections of 7,668.

6. The current average day demand (required pumpage to meet usage) is approximately 2,607,800 gallons per day (gpd), or 2.61 MGD. The current maximum day demand is approximately 5.09 MGD, which is approximately 1.95 times the average day demand. The current peak hour demand, as determined from well

pump flow data and information collected from City water department staff, is calculated as 8.66 MGD.

7. The total number of residential, commercial, and city owned water customer connections projected for the year 2032 is 12,163, 989, and 40, respectively. This is based on an average annual increase of 2.75% for each category, which correlates to the projected population growth.

8. The future average daily water usage by residential, commercial, and city customers after consideration of water losses is estimated at 275, 1,100, and 1,350 gpd/customer, respectively.

9. A ratio of 1.95 times the average day demand is an appropriate estimate of maximum day demand based on recent water system data. Also, a ratio of 1.7 times the maximum day demand is an appropriate estimate of the peak hour demand based on recent water system data.

10. The projected 2032 average day, maximum day, and peak hour demands are approximately 4.49 MGD, 8.76 MGD, and 14.89 MGD, respectively. Accordingly, the peak hour demand for the year 2032 is projected as 10,341 gallons per minute (gpm) for the entire water system.

11. Eight active groundwater wells are currently utilized to provide source water for the distribution system.

12. The City does not currently provide disinfection of the water supply source prior to distribution throughout the system.

13. The Missouri Department of Natural Resources (MoDNR) identified 41 sources of potential groundwater contamination of the City's wells in its 2012 source water assessment summary. A listing of these sources can be found on-line at http://maproom.missouri.edu/swipmaps/pwssid.htm with the City's Public Water Supply System Identification number (PWSSID-5010576).

14. MoDNR recommends that each water supply well operate no more than 8 hours per day to allow recharge of the groundwater supply source. Typical design is based on the pumps operating at 18 hours per day. Although the 8 hour/day criterion seems to be overly conservative, it does have merit for allowing sufficient recharge. Therefore, projections for future groundwater supply needs were based on 10

hours/day for average demand and 18 hours/day for maximum day demand. With the existing wells in the entire water supply system operating 10 hours/day, the total developed supply capacity is 3.39 MGD and the firm capacity is 2.73 MGD, which is sufficient to meet the current average day demand.

15. There are seven elevated storage tanks within the existing water system. The existing volume of nominal storage capacity in the entire distribution system is 3,500,000 gallons which is currently sufficient to meet the current average day demand storage requirements and recommended fire flow capacities.

16. The water system is on a single pressure plane with a common hydraulic grade line at elevation 1,428.70.

17. There is currently approximately 681,000 feet of water distribution piping within the system. New water lines are typically constructed with PVC and/or ductile iron, which constitute a great majority of the pipe material in the existing distribution system.

18. The water department utilizes a computerized, radio-communication Supervisory Control and Data Acquisition (SCADA) system for control and monitoring of the major water system facilities.

B. Recommendations

1. Budget for and construct the major capital improvements proposed in this report and implement user rate increases as necessary. The proposed capital improvements have been prioritized throughout the planning period with the majority of improvements scheduled within the next five years.

2. Develop a detailed water system user rate analysis to determine status of current rate structure and the yearly increases required for the implementation of the proposed capital improvements.

3. Continue working with State and Federal agencies to meet public water regulations regarding the MoDNR Groundwater Rule (GWR) regulations. This includes preparations for compliance monitoring should a trigger sample event occur.

4. Actively pursue land acquisition and/or easements for new groundwater well and elevated storage tank sites and water main routes in the southern and northern areas of the service area. Refer to Section IX for recommended sites.

5. Budget for, design, and construct a new groundwater supply well (Well No. 10) in the southern portion of the water system service area, along with associated distribution system improvements.

6. Budget for, design, and construct a new elevated storage tank (Tank No. 8) in the southern portion of the water system service area, along with associated distribution system improvements.

7. Construct new piping for elevated water storage Tank No. 1, No. 2, No. 3 and No. 4 to provide separate inlet and outlet piping to promote effective mixing and sufficient contact time should disinfection be implemented.

8. Budget for the inspection, cleaning, and repainting of elevated water storage Tank No. 4 and No. 5. Also, include in the yearly budget for the inspection of each of the existing tanks on a rotating basis.

9. Budget for the upgrade of the existing SCADA monitoring and control system to widen the ability of the system to monitor and control all components of the water supply, storage, and distribution system.

10. Continue to plan and budget for the future design and construction of disinfection equipment at each of the existing well sites. Also, begin to plan and budget for the installation of additional monitoring equipment, such as chlorine, pH, and temperature probes at all well sites and modification of existing SCADA programming for potential monitoring of 4-log inactivation of viruses should future Compliance Monitoring be required.

11. Begin budgeting efforts for a future groundwater supply well (Well No. 11) in the northern portion of the water system service area with local, sufficient disinfection contact time storage.

12. Budget for, design, and construct a new elevated storage tank to replace the existing Tank No. 1 for added storage in the central portion of the water distribution system.

13. Continue to budget for and perform distribution system improvements on an annual basis. Priority distribution system improvements are outlined in this Master Plan.

14. Continue efforts to reduce water losses by replacing inadequate water lines, fire hydrants and meters, and identifying meters that are not being read or billed regularly.

15. Implement a valve locating, valve exercising, and routine preventive maintenance plan, which will also allow for the identification of areas where additional valves can be cut into the distribution system, as needed to effectively isolate the system.

16. Continue updating the City's water system map to improve its accuracy and sharing information and resources with the Nixa Fire District to promote adequate fire protection. Update the hydraulic model of the City's water system as the addition of new supply, storage, and distribution system improvements are installed.

17. Continue performing routine inspections and maintenance at water supply wells, water storage tanks, and distribution system components as summarized in this Master Plan.

18. It is recommended that the City continue to be an active contributor in any planning efforts for future regional water supply alternatives by participating in regional non-profit organizations and technical sessions so that the City has positioned itself as an active participant in such regional water supply programs should the future need arise.

II. INTRODUCTION

A. Purpose

The purpose of this Water System Master Plan is to serve as a planning guide for the City of Nixa, Missouri for water system improvements during the proposed planning period to accommodate both the existing customers currently served by the water system and the anticipated future customers that will utilize the City's water supply system. The main objectives for this Master Plan are to evaluate the status of the existing system and propose improvements that benefit the current water customers, study and recommend future improvements that will position the City to more easily accommodate future customer growth within the existing and proposed service area, and allow the City to provide a reasonable level of fire protection.

Specifically, this report summarizes existing water system facilities, infrastructure and operation, historical water customers and demands, projects customer growth and consumption throughout the planning period, and proposes system improvements associated with the City's water supply, treatment, storage, and distribution system to meet the projected water demands. The proposed system improvements are prioritized with a schedule and are accompanied by construction cost opinions based on the current bidding climate and a fixed annual rate of inflation, as applicable.

B. Scope

Several steps were involved in the development of a Water System Master Plan that the City of Nixa can implement for proposed system improvements. The scope of this report consisted of developing an understanding of historical growth and water usage patterns and translating those into projected values that can be used for planning future water system improvements. This report, in conjunction with coordinating with City staff, estimates a proposed service area that will be provided water service by the City, consisting of the existing City limits and potential future service areas during the planning period.

The evaluation of historical trends of water system information was performed in a number of methods. The report evaluated historical trends and/or patterns for the number of water service meters, including rural/residential and commercial/industrial. Also, water use trends were evaluated by analyzing the well pumping amount, in addition to the amount of water sold to customers over the last several years. This type of evaluation is important in establishing current average, total, and unit flow rates currently experienced by the City's water supply and distribution system.

Using historical data, projections of future population growth, water meters, and water usage have been calculated. This information allowed for the determination of future needs and/or demands of the water supply and distribution system so that proposed improvements were established and recommended. In addition to potential future improvements, this report also analyzed the existing water supply, treatment, pumping, storage, and distribution system, based on a description of the facilities and operation provided by the City as well as our own observations and system research. The purpose of this evaluation was to identify potential areas within the current system that could be modified to provide for more efficient system operation.

Upon the establishment of both historical and projected water usage and customers, and identification of proposed system improvements, a hydraulic model of the City's water supply and distribution system was developed utilizing computerized hydraulic modeling software. This tool allowed for the analysis of various system demands and the affects they would have on the City's current and proposed water supply, pumping, storage, and distribution system. Also, this model allowed for the evaluation of various fire fighting demands and how those demands would affect the water system.

Once future improvements were established, a schedule of the proposed improvements, prioritizing from most important and most beneficial, was developed. Along with the prioritization schedule, an opinion of probable project cost was developed for each of the proposed improvements. The schedule and cost estimates will aid the City in budgeting and planning the future implementation of the recommended improvements.

A summary of the project scope used in the preparation of this Water System Master Plan is as follows:

- Understand growth expectations and water service needs with City officials.
- Delineate the service area to be provided water service by the City during a planning period ending in 2032.
- Evaluate historical trends in the number of water meters in-service.
- Evaluate water use (demand) trends based on well pumping and metered water consumption.
- Project the number of water customers and anticipated water usage during a planning period ending in 2032.

- Analyze the existing water supply, treatment, storage, and distribution system based on a description of facilities and operation provided by the City.
- Develop and evaluate water supply, treatment, storage, and distribution system improvements capable of meeting the projected needs of the water system throughout the planning period. The evaluation includes utilizing a computerized hydraulic model of the City's water system.
- Establish a priority schedule and develop cost opinions for the proposed improvements.

III. PLANNING AREA

A. Location

The City of Nixa, Missouri is located in the northwestern portion of Christian County, Missouri. The major transportation routes through Nixa are U.S. Route 160/Missouri Route 13 and Missouri State Highway 14. The eastern boundary of Nixa is located approximately 3 miles from U.S. Highway 65. The City is located in close proximity to two airports that support commercial airlines. The Springfield Airport is located approximately 20 miles from the City and the Branson Airport is located approximately 40 miles from the City. The northern City limits are approximately 3 miles from the City of Springfield. Other surrounding communities include the City of Ozark, Clever, and Highlandville. Exhibit 1 indicates the current City of Nixa city limits.

The name and mailing address for the City of Nixa is:

City of Nixa, Missouri
715 W. Mt. Vernon
P.O. Box 395
Nixa, Missouri 65714

Mayor:	Sam Clifton
City Administrator:	Brian Bingle
Director of Public Works:	Doug Colvin

City Personnel can be contacted by calling City Hall at (417) 725-3785, or the Public Works Department at (417) 725-2353.

The Planning Area for this Master Plan includes all of the land currently within the City of Nixa's incorporated boundaries as well as adjacent surrounding and infill areas that could reasonably be served by the City's water distribution system within the planning period. Due to the proximity of the City of Springfield and City of Ozark city limits to the north and east, respectively, and the Finley River to the south, the growth area of the City of Nixa is becoming somewhat limited. Additionally, the City does not contain many areas of potential infill within the current City limits. Refer to Exhibit 1 for a current map of the City of Nixa's city limits.

B. General Description

The City of Nixa is the local entity concerned with water supply in the Planning Area. The area currently served by the City's water system includes a great majority of the area within the corporate limits of the City along with a few areas just outside of the City limits. Presently, only a small amount of water line exists outside of the City limits. The City's water customer base consists mainly of residential and rural homes along with commercial and light industrial establishments. Exhibits 3A (north) and 3B (south) show the extent of the City's water system and locates major water system facilities within the City limits and Planning Area boundaries.

The topography of the Planning Area exhibits the rolling terrain typical of the Ozarks with over 230 feet of relief between the highest and lowest elevations in the area. The highest point in the Planning Area (approximate USGS elevation 1330 feet above mean sea level) is located on the eastern edge of the city limits. The high point is northeast of the intersection of Cheyenne Road and North Road at the site of Well No. 9 and the High Pointe Elevated Storage Tank. The lowest points (approximate USGS elevation 1100 feet above mean sea level) are located in the south and southeastern portion of the Planning Area in the Finley River and Spout Spring Hollow Creek valleys. The Planning Area is drained by unnamed tributaries of Spout Spring Hollow, McCafferty Hollow, the Finley River, and the James River. All of these waterways are tributary to the James River which drains the entire Planning Area toward the south, eventually draining into an arm of Table Rock Lake in Stone County near Galena, Missouri. Exhibits 2A (north) and 2B (south) illustrate the topography throughout the planning area as indicated by the USGS mapping system.

Two main natural factors that affect development in Nixa are the karst topography and the surface drainage features. In general, the City is surrounded by sinkholes which are expected to impede widespread outward growth of the City's service boundaries. Sinkholes pose a natural barrier to most structural development, including transportation. Development is also influenced by Spout Spring Hollow and the Finley River, the two most notable natural drainage features in the Planning Area, and to a lesser extent the location of the James River also plays a role in restricting development on the northern and western areas of the planning area. Although there are some structures currently within the 100-yr flood boundary of these two waterways, the availability of readily developable land outside of the floodplain should discourage general building in flood-prone areas. Future waterworks construction should avoid known sinkholes and flood-prone areas to the maximum extent possible. Where waterworks must be constructed in the flood-prone areas, they should be constructed to protect against flooding.

Man-made features, such as highways and bridges, pose barriers to pipeline location and extension to the extent that open-cut construction may be prohibited where highway rights-of-way or elevated bridges must be crossed. More expensive construction techniques (such as boring) are commonly required at such locations. Authorization in the form of contractual agreements (permits) to cross such rights-of-way must also be obtained from the owning and operating agency. Where pipelines cross creeks and rivers, special construction techniques are often required to adequately protect the pipeline while maintaining full stormwater flow capacity within that particular drainage channel.

C. Planning Period

The planning period associated with this Water System Master Plan extends to the year 2032, with intermediate analysis provided for the years 2012, 2017, 2022, and 2027 to enable the City to compare actual trends with the projections stated herein. Based on past experience, a 20-year period is typically used for planning water system improvements. Due to recent economic trends throughout the nation, growth trends have slowed considerably for the region. Therefore, the intermediate analysis intervals are useful for periodic evaluation of the water system status and how the demands correspond to the proposed improvements recommended in the Master Plan. The increasing rate of demands on Nixa's water system has slowed in recent years due to less growth; however, economic recovery could lead to an increased rate of demand on the water supply system thus requiring earlier implementation of the proposed improvements.

Also, in the summer of 2012, the region experienced a widespread and extended drought period with very high temperatures and little to no rainfall. The drought condition put a huge burden on the City's water supply system. Typically, demands on the water system are based on usage associated with growth and development; however, water demand during drought conditions needs to be considered in future projection calculations.

D. Service Population

According to the U.S. Census Bureau, the City of Nixa had a population of 12,124 in the year 2000 and a 2009 population estimate of 19,458. The U.S. Census Bureau completed the latest nationwide census in 2010, resulting in a City of Nixa population of 19,022. Table III-1 shows the historic population trend based on census figures for Nixa as well as the U.S. Census Bureau's annual population estimates for 1910 through 2010. The U.S. Census data indicates that the City of Nixa experienced a large amount of growth from 1990 to 2000 and another significant jump from 2000 to 2010. However, the majority of that growth

occurred from 2000 to 2006. Based on estimates from the U.S. Census Bureau, the percentage increase per year in population growth began to decline after 2006. This could potentially be due to the slowing economic conditions that have been experienced on a nationwide basis. The annual population growth rate from the year 2000 to 2010 was approximately 3.6% with the largest annual growth occurring from 2004 to 2005 at approximately 14%.

The fluctuating population growth and current economic downturn make it difficult to anticipate a clear population projection over the proposed Planning Period. In order to determine a population projection that will best represent anticipated future conditions, data was collected from several sources and compared in Table III-1. The table shows the relationship between the census counts and the calculated geometric growth (also called exponential growth) projected out through the planning period. The geometric growth projections are based on the historic census data from 1910 to 2010.

The Missouri Department of Natural Resources (MoDNR) conducted a sanitary survey of the City's water system and completed the study in May 2010. Within this survey, MoDNR developed population projections to the year 2030. Their population projections were based on a 4.46% growth to 2015, 3.72% to 2020, 3.10% to 2025, and 2.5% to 2030. The results of the MoDNR projections are indicated in Table III-1 as well.

The population projections illustrated below were also compared to the latest version of the City's Comprehensive Land Use Plan (Comp Plan), which was developed in 2003. To determine future population projections, the Comp Plan assumed a population projection for 2010 of 18,885 with an increase to 21,080 in the year 2015, an increase to 23,017 in the year 2020 and an increase to 24,663 in the year 2025. This method used a conservative approach to estimating the population. This information was developed before the economic boom within the area from 2004 to 2006.

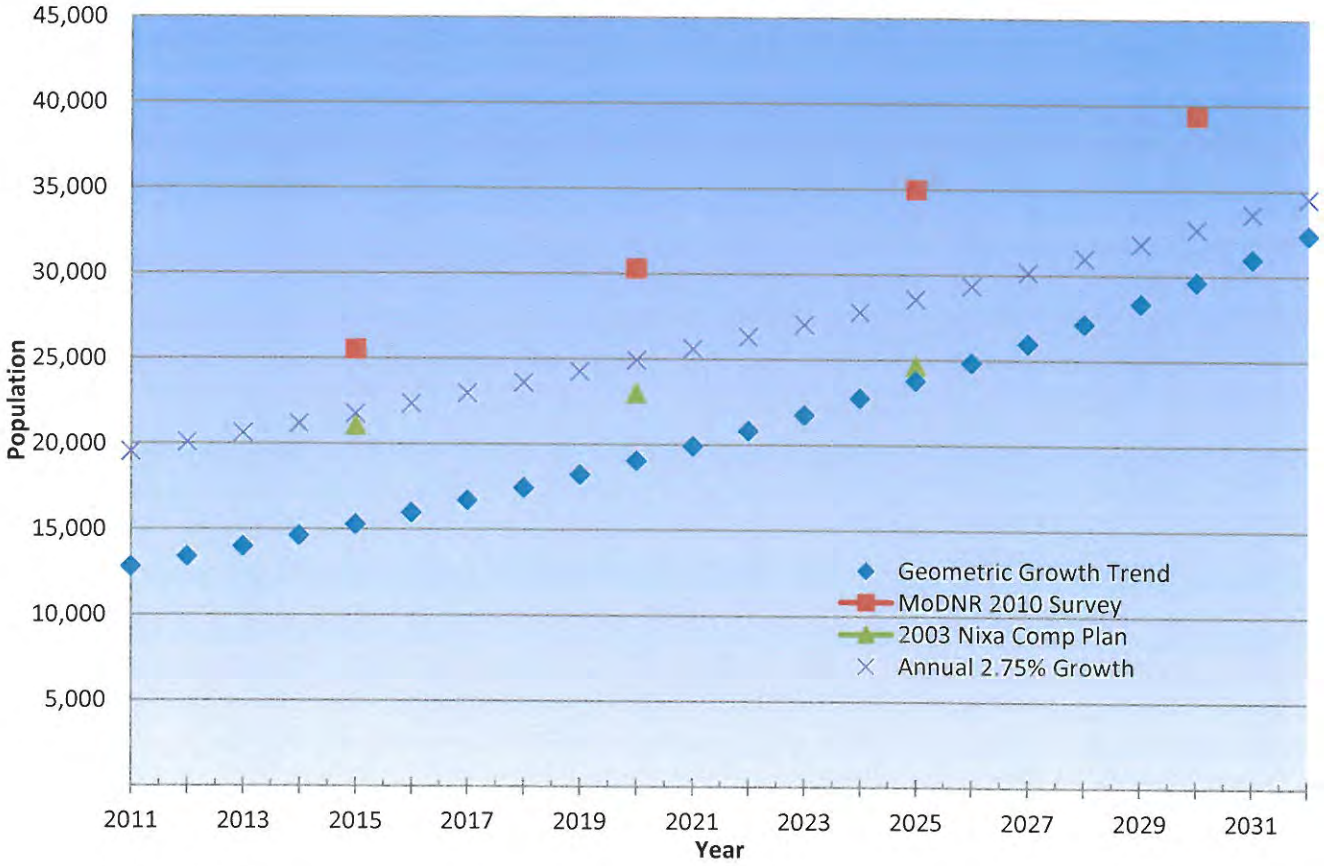
Upon comparing the various population projections and the historical population data, it was determined that an average 2.75% yearly population increase would be most suitable to calculate future population projections. This average accounts for the anticipated slow growth over the next several years due to sluggish local economic conditions and the potential for a higher population growth as the economy improves toward the latter part of the Planning Period. Accordingly, the projected population for the City of Nixa at the end of the Planning Period considered in this report is approximately 35,000 persons. Additional information is presented in the remainder of this report regarding the projected customer base and subsequent water usage associated with the planned service area. The data

points used for the population comparisons and trends is also shown graphically in Figure III-1.

TABLE III-1
POPULATION SUMMARY AND PROJECTIONS

		Population Projection			
Year	Historical US Census Population Data	Geometric Growth Trend	MoDNR 2010 Sanitary Survey	City of Nixa 2003 Comp Plan	Annual Growth Percentage (2.75%)
1910	276	--	--	--	--
1920	370	--	--	--	--
1930	307	--	--	--	--
1940	370	--	--	--	--
1950	509	--	--	--	--
1960	944	--	--	--	--
1970	1,636	--	--	--	--
1980	2,662	--	--	--	--
1990	4,893	--	--	--	--
2000	12,124	--	--	--	--
2010	19,022	--	--	18,885	--
2012	--	13,406	--	--	20,083
2015	--	15,303	25,547	21,080	21,785
2017	--	16,715	--	--	23,000
2020	--	19,082	30,300	23,017	24,950
2022	--	20,842	--	--	26,341
2025	--	23,793	34,996	24,663	28,575
2030	--	29,667	39,370	--	32,726
2031	--	31,005	--	--	33,626
2032	--	32,404	--	--	34,551

FIGURE III-1
PROJECTED POPULATION TRENDS



E. Land Use

The type and amount of growth within the City directly correlates to the type of infrastructure that must be provided to service this growing demand. The Comprehensive Land Use Plan conducted for the City of Nixa occurred in 2003. There has been a large fluctuation in the rate at which growth has occurred since the development of the 2003 Comp Plan. From 2004 to 2006, the City of Nixa experienced a great deal of growth; however, from 2007 to present day, growth within the City has slowed considerably. The City would benefit from an updated comprehensive land use plan that reflects the anticipated growth in consideration of the events that have hindered growth over the last several years.

The 2003 Comp Plan contains a projected land use planning area that encompasses a total land area of approximately 42 square miles. This projected area is bound by the Greene County line to the north, the James River to the west, the Finley River to the south, and approximately ½ mile east of Cheyenne Road to the east. This is an extremely large

planning area considering the current City limits comprise approximately 7± square miles. This also indicates that the City has a large amount of space in which to grow. The growth within the City has occurred in an inward-out type pattern, meaning there has not been a lot of strip annexation which leads to gaps of un-annexed land within the City Limits. This type of City growth is much better for expansion of water services and prevents long runs of smaller water lines servicing small developments.

The City has identified several categories of major land use types that are expected to occur within the City. The land use map contained in the 2003 Comp Plan included the following categories of development:

- Low Density Single Family
- Medium Density Single Family
- High Density Single Family
- Two-Family (duplex)
- Multi-Family (apartments)
- Center City Commercial
- Neighborhood Commercial
- General Commercial
- Transitional Office
- Light & Heavy Manufacturing
- Mobile Home Park
- Agricultural

The type of development projected in the land use plan is equivalent to the type of development that has occurred over the last several years within the City of Nixa. Therefore, it is anticipated that the type and amount of water usage demand for the future water system will be similar to past demand types. In the event a commercial or industrial type development occurs within the City limits that requires a large water supply, a detailed analysis will be required for that specific development to ensure the unique water demands can be met.

The City of Nixa has continued to experience growth in the number of new homes being constructed as well as commercial developments along major transportation routes since the development of the 2003 Comp Plan; however, the rate at which growth has occurred has slowed significantly. Table III-2 indicates the number of building permits issued by the City of Nixa for each building category between 2001 and 2012 from data provided by the

City of Nixa. The data would suggest that the development within Nixa has continued during the recent economic recession, but growth has slowed a great deal from the peak experienced from 2004-2006.

TABLE III-2
BUILDING PERMITS ISSUED – CITY OF NIXA

	Category				
Year	Residential	Duplex	Multi-Family	New Commercial	In-fill
2001	237	10	32	8	59
2002	216	12	72	7	56
2003	231	6	16	16	49
2004	522	0	24	13	62
2005	498	12	184	7	71
2006	261	0	21	6	67
2007	157	2	11	25	305
2008	34	0	2	6	62
2009	43	0	0	7	53
2010	90	0	0	4	58
2011	42	25	0	2	58
2012	14	0	0	1	15

The majority of growth over the last twelve years has occurred in the northeast, southeast, and southern areas of the City of Nixa. Development has been slower in the northwest and west portions of the area. A couple of factors that limit growth in these areas are the abundance of sinkholes and the location of the City's existing wastewater treatment plant (WWTP). The WWTP is located in the southeastern portion of the City; therefore any development that occurs to the northwest and west would require large pumping facilities to transport sanitary sewer flows to the WWTP. However, the City's water system does have storage and supply facilities in these portions of the City which will promote growth in these areas.

IV. DESCRIPTION OF EXISTING WATER FACILITIES

A. Existing Water System

The City of Nixa owns and operates its own water supply, storage, and distribution system under the Public Water Supply System Identification (PWSSID) Number MO-5010576. Operation of the existing water system is conducted by the Director of Public Works and the Public Works staff. In order to operate the City's water system, the minimum certification required for the distribution system is DS-III and the minimum certification required for treatment operations of the water system is D. The City currently has six certified operators of the water system. All six have a DS-III level certification for operation of the distribution system. The City has one Class A, one Class C, and one Class D staff member for the operation of treatment for the water system.

The existing water system operates on only one pressure plane throughout the entire system. Due to the varying topography throughout the City, pressure in low lying areas tend to be higher, with the higher elevations throughout the City experiencing lower system pressures. Exhibits 3A and 3B indicate the layout of the existing water supply, storage, and distribution system.

1. Supply

The City of Nixa's water supply is obtained from a groundwater source via eight (8) active, State approved wells. The Source Water Assessment Plan (SWAP), as developed by MoDNR, for the City's water supply wells, has been included in Appendix B. The SWAP indicates the location of each well, buffer zones, and potential contaminant sources.

The following Table IV-1 lists specific details for each of the active water supply wells:

TABLE IV-1
EXISTING WATER SUPPLY WELL INFORMATION

Well Name	Well Address	Well No.	Capacity (gpm)	Certification Number	Year Drilled	Casing Depth (feet)	Casing Size (inches)	Total Depth (feet)	SWL (feet)
Old Shop	203 East St. Louis	1	350	Pre-law	1948	372	8	1251	340
Kyle Street	702 Hill Street	3	340	Pre-law	1975	450	8	1675	260
Rotary Park	308 Tower Street	4	425	A021980	1990	450	10	1660	280
Lutheran Church	911 West Mt. Vernon	5	635	A030981	1993	603	10	1675	302
Spring Valley	727 Mt. Vernon	6	710	A176503	1998	509	12	1700	233
High School	514 South Nicholas	7	835	A090861	2000	465	12	1700	320
Tracker	1240 West Tracker Rd.	8	830	A137357	2006	590	12	1600	318
High Pointe	1355 North Street	9	1060	A159434	2008	585	12	1600	295

Well No. 2, which is no longer active, currently serves as a MoDNR monitoring site for evaluation and data collection of groundwater levels in the area. This well is located southwest of the intersection of West Mt. Vernon Street and Main Street. Per the MoDNR well monitoring website, the coordinates for this observation well are latitude 37°02'35.2" and longitude 93°17'42.3".

Each of the existing well sites contains all of the standard items that are required of a groundwater well installation. Those items include, but are not limited to, a screened vent casing, a draw down tube/gage, butterfly or gate valve, check valve, and flow meter. Each of the well casings have been installed a minimum of 18-inches off of the well house floor, with some of the well casings up to 30-inches high. However, at Well No. 1, the well head is only approximately 10-inches off of the well house floor. An ideal installation would be to have the well head greater than 18-inches off of the well house floor; however, it appears the well head for Well No. 1 is sealed via the cover plate being welded to the casing pipe with some additional caulk sealant for well head protection.

The flow meter at each of the well sites consist of a propeller style flow meter. Flow meters require a run of straight pipe both before and after the meter so that turbulence in the flow from bends, fittings, and/or valves can be reduced, allowing the meter to provide more accurate readings. There are varying opinions as to the amount of straight run pipe that should be provided. A typical standard for straight pipe runs is ten (10) pipe diameters upstream, and five (5) pipe diameters downstream of the flow meter. At well sites No. 1 and 3, the flow meter has been installed either directly to or within close proximity to a bend or valve, thus not providing any straight run of pipe. This type of installation can greatly reduce the accuracy of the flow meter readings. At well sites No. 4 through 9, the flow meter installation has been provided with some straight run of piping both on the upstream and downstream sides of the flow meter. However, some of these lengths do not adhere to the general rule of 10/5 pipe diameters. Due to this installation configuration, the accuracy of flow readings may be reduced.

The well house for Well No. 1 consists of a wood frame building with composite shingle roof. The well house currently contains an old steel storage tank that was once used as a hydropneumatic type pressure system. The connection to the steel tank has been removed; however, the tank remains within the well house. All of the remaining well houses consist of a masonry block and brick type structure with a composite shingled roof. Each roof is equipped with a skylight in the event the well pump needs to be removed for maintenance. All of the existing structures appear to be good shape, with only the well house at Well No. 1 needing immediate miscellaneous maintenance due to deterioration of the wood framing and general clean-up of the interior of the well house.

Site security is an important issue concerning a public water supply system. Installing the well pumps and associated equipment within a well house structure provides a certain level of security. Additional site security measures have been implemented at some of the well house locations. The site for Well No. 5 has been surrounded by a 6-foot high, treated wood fence with a padlocked gate. The site for Well No. 3, No. 4, No. 7, No. 8, and No. 9 has been surrounded by a 6-foot high, chain link fence with a padlocked gate. The chain link fencing at Well No. 8 and No. 9 are also topped with barbed wire. The well sites for Well No. 1 and No. 6 do not have a perimeter fence. The only site security at these locations is the lockable door to the well house.

The discharge piping at all of the well sites contains some type of blow-off or pump-to-waste connection. This consists of an in-line tee with a branch line already connected or

a blind flange on the branch line for a future connection of a waste line. The discharge piping within the well house at Well No. 3 is the only location that does not contain a specific blow-off or waste line connection point. A fire hydrant located just outside of the well house is utilized as the blow-off or waste line for the well pump. The waste line is needed in the event water being pump by the groundwater well needs to be wasted prior to entering the distribution system due to a maintenance or contamination issue.

The power supply to each of the well sites is supplied via a commercial power line provided from one direction only. Emergency, back-up power is provided at each of the well sites via a permanently installed stand-by generator. The well houses contain an automatic transfer switch so that the power supply will automatically change over to the generator in the event of a power failure. The existing generators range in size from 125 to 175 kilowatts (kW). It appears that all of the generators have been sized accurately for the corresponding pump motor size, except for Well No. 9. The pump for Well No. 9 contains a 150 horsepower (hp) motor and the generator is sized at 150 kW. It is important for the generator to be sized properly so that it will have ample power to start-up and run the corresponding well pump.

The most recent annual inspection on all of the water supply wells was performed by Flynn Drilling Company, Inc. on March 21, 2012. Based on this inspection the total capacity of the eight active wells was approximately 5,770 gallons per minute (gpm) at the drawdown amounts indicated in Table IV-2. The United States Department of Agriculture declared a large area of southwest Missouri as experiencing a D4 drought condition in late July and all of August 2012. Due to these drought conditions, the groundwater elevation fell approximately 50 to 60 feet. This required the City to lower both Well No. 3 and Well No. 5 approximately 105 feet each. The additional head on these two pumps lowered their pumping capacity, which resulted in a total pumping capacity of the system of 5,650 gpm, based on the most recent surveys performed by City personnel. The firm capacity (capacity with the largest well out of service – Well No. 9) of the water supply system is 4,550 gpm. All of the well pumps utilize a submersible pump and motor combination with a pump motor size ranging from 60 hp to 150 hp. Commercial power provided to each of the well sites is 3-phase, 480 volt, 60 Hertz. All of the motor starters operate across the line, with no variable frequency drives (VFDs). Table IV-2 summarizes additional pump information for each of the active groundwater wells from the most recent well inspection report:

TABLE IV-2
ACTIVE WELL PUMP SUMMARY

Active Well	Well No.	Capacity (gpm)*	Pump Head (feet)	Pump Setting (feet)	Motor Hp	Year Installed	Drawdown (ft) at Flow (gpm)
Old Shop	1	310	720	567	75	1948	76 @ 340
Kyle Street	3	370	500	420	60	1975	25 @ 425
Rotary Park	4	450	730	598	100	1990	20 @ 635
Lutheran Church	5	660	500	441	100	1993	37 @ 715
Spring Valley	6	800	485	441	125	1998	35 @ 850
High School	7	800	510	462	125	2000	23 @ 825
Tracker	8	800	510	441	125	2006	40 @ 880
High Pointe	9	1100	440	546	150	2008	--

*Data was taken from annual well pump inspection performed on March 21, 2012. A copy of the well inspection reports has been included in Appendix D.

The amount of flow each well contributes to the system has changed over the years as new wells have come on line. Prior to Well No. 9 coming online, the older Wells No. 1 and 3 were required to contribute a much more significant amount of flow to the system. Well No. 9 has alleviated stress on these two wells, along with Well No. 5. From a volume standpoint, the highest contributing well to the water supply system is Well No. 7. The following Table IV-3 illustrates the percent contribution to the distribution system from each groundwater well for the time period when all current wells were active (2009):

TABLE IV-3
WELL CONTRIBUTION PERCENTAGE SUMMARY

	Well No.							
Year	1	3	4	5	6	7	8	9
2009	7%	9%	15%	7%	1%	30%	8%	22%
2010	8%	9%	11%	5%	5%	29%	11%	23%
2011	7%	3%	10%	13%	15%	30%	8%	14%
2012	7%	7%	14%	9%	15%	29%	5%	13%
Average	7%	7%	12%	8%	9%	29%	8%	18%

2. Treatment

The City of Nixa does not provide any form of disinfection of the water supply source prior to being pumped into the water distribution system. Disinfection is provided prior to new infrastructure components being placed into service, but it is not practiced on a continual basis. The only treatment provided to the groundwater supply is the injection of fluoride at each of the well sites. The fluoride supply and storage systems consist of similar equipment at each of the well sites. The hydroflurosilic acid/fluoride solution is stored in containers that are positioned on scales for determination of remaining chemical. There is not a containment curb around each of the scales or chemical storage locations to contain a potential chemical spill. Also, each of the well sites does not have safety equipment for chemical handling permanently located at the site or an emergency eye wash station.

The fluoride solution is injected into the well pump discharge line by an LMI chemical metering pump. The solenoid-driven metering pump has the ability to inject up to 10 gallons per day of the fluoride solution at a maximum pressure of 140 psi. Control of the chemical dosing equipment is performed by a flow switch that is installed on the discharge line of the well pump. Once tripped, the flow switch activates the power to the wall receptacle to which the metering pump is plugged into. This control scheme allows for the dosing of fluoride only when the well pump is running and water is flowing into the system. This prevents overdosing of the system when the well is not running.

3. Storage

The City of Nixa storage component of the water system currently consists of seven (7) elevated storage tanks. All of the elevated tanks are a spheroid, single pedestal type design, except for the High Pointe tank which is a composite type design. Each of the elevated tanks is located at one of the water supply well sites. Typically , the water level in the elevated tanks is the controlling factor for the well pump on/off operation. Storage tank No. 1 is located at Well No. 1; Tank No. 2 is at Well No. 4; Tank No. 3 is at Well No. 5; Tank No. 4 is at Well No. 6; Tank No. 5 is at Well No. 7; Tank No. 6 is at Well No. 8; and Tank No. 7 is at Well No. 9. Only Well No. 3 is not associated with an adjacent elevated storage tank. The single pressure plan established by the overflow elevations of the City's elevated storage tanks, in conjunction with the service areas elevation range, result in maximum water pressures ranging from 42 psi to 140 psi. Table IV-4 summarizes information pertaining to the existing elevated storage tanks:

TABLE IV-4
WATER STORAGE SUMMARY

Tank Address	Tank No.	Type	Year In Service	Total Capacity (gallons)	Base Elevation (feet)	Overflow Elevation (feet)	Height to Overflow (feet)
203 East St. Louis	1	Elevated - Single Pedestal	1964	100,000	1300.7	1428.7	128.0
308 Tower Street	2	Elevated - Single Pedestal	1986	300,000	1285.7	1428.7	143.0
911 West Mt. Vernon	3	Elevated - Single Pedestal	1993	300,000	1294.6	1428.2	133.6
727 East Mt. Vernon	4	Elevated - Single Pedestal	1998	300,000	1257.0	1428.7	171.7
514 South Nicholas	5	Elevated - Single Pedestal	2000	750,000	1315.0	1434.7	119.7
1240 West Tracker Rd.	6	Elevated - Single Pedestal	2008	750,000	1266.0	1428.7	162.7
1355 North Street	7	Elevated - Composite	2011	1,000,000	1330.7	1428.7	98.0

Per Chapter 7 of the Missouri Department of Natural Resources Design Guide for Community Water Systems, the City must provide a nominal storage capacity equal to the average day demand, as well as a minimum design needed fire flow for the length of fire duration. The nominal storage capacity is based on maintaining a minimum of 20 psi at the base of the storage tank. This typically only comes into play when there is a standpipe involved. All of the City's tanks are elevated. Based on this criterion, the nominal storage capacity of the City's water system is 3,500,000 gallons.

All of the existing elevated storage tanks have been inspected within the past six years. Tank No. 1 was inspected in October 2007 and was found to be in generally good condition with no major deficiencies. The exterior of the tank was power washed and overcoated and the interior coating was touched up in various places. Tank No. 2 was inspected in September 2009 at which time the interior was clean blasted and coated with a primer, intermediate, and final coat. The exterior coating system appeared to be in good condition at the time of the inspection; however, the exterior was repainted in 2012. Tank No. 3 was inspected in August 2006 at which time the exterior was power washed and overcoated and the interior coating system was touched up in various locations. The exterior of the tank was repainted again in 2012. Tank No. 4 was

inspected in September 2009 and the exterior was power washed and overcoated. Tank No. 5 was inspected in June of 2008 and no major deficiencies were found. The exterior of this tank was power washed and overcoated. The last inspection on Tank No. 6 was performed in September of 2009. The tank was installed in 2008; therefore, as expected, the coating system and tank components were in good condition. Tank No. 7 was placed into service in 2011 and is the newest of all tanks. An annual inspection was performed in October 2012 which indicated the tank's coating system and components were in good condition. A copy of the tank inspection reports for Tank No. 1 through No. 6 has been included in Appendix E of this report.

4. Distribution System and Operation

The City of Nixa's water distribution system consists mostly of 6-inch and 8-inch polyvinyl chloride (PVC) water lines. There are approximately 682,000 feet (129 miles) in the City's distribution system. Table IV-5 summarizes the distribution system's inventory. The length of pipe for each size and material is based on the mapping of the existing distribution system and percentage per material provided by the City of Nixa.

TABLE IV-5
WATER DISTRIBUTION SYSTEM SUMMARY

Pipe Size (Inches)	Length (feet)				
	PVC	CI	DIP	AC	Total
≤ 3	2,086	1,298			3,384
4	19,760	5,123		2,195	27,078
6	179,319	13,947	5,977		199,243
8	381,411		20,074		401,485
10	21,284		2,365		23,649
12	24,163		2,685		26,848
Total	628,023	20,368	31,101	2,195	681,687

PVC – Polyvinyl Chloride CI – Cast Iron
DIP – Ductile Iron Pipe AC – Asbestos Cement

The majority of the City's distribution system is arranged in a grid type pattern with frequent looping of water lines to provide more than one direction of water feed into an area. New developments that connect to the existing water system are typically required to install a minimum line size of 8 inches. Also, the new water lines must be looped wherever practical. The City does have some locations where a line 'dead ends'

at the end of a long run. These areas typically require periodic flushing to prevent stagnant water.

The City also has a policy that when smaller (6-inch or less) existing lines require replacement, that those lines are replaced with a minimum line size of 8 inches. These standards are practiced to promote better flow distribution to existing areas and to provide ample flow capacity in the event the City continues to grow and expand into areas further away from the City's core distribution system. The City has typically required PVC material for new and upgraded water lines; however, ductile iron pipe, although typically more expensive, is a good alternative should a more structural application be required.

New lines are to be sized so they provide a minimum operating pressure of 35 psi under all demand conditions. As previously stated, the City operates on one pressure plane throughout the entire system. Even though the topography throughout the City varies, the existing distribution system does not contain any pressure reducing valves (PRVs) or booster pump stations on the main distribution lines. The only pressure control within the distribution system consists of a valve on the water line leading to the wastewater treatment plant (WWTP) that is throttled (partially closed) to reduce pressure at the plant.

One of the main factors with providing an adequate water distribution system to all parts of the service area is traversing natural and man-made obstacles. One of the main natural obstacles that present a problem to distribution piping are sinkholes within the service area. In the event of a sinkhole collapse or settlement, water lines could be ruptured causing a large amount of water loss and disruption of service. The City has had past issues of sinkholes effecting water distribution lines; however, these problems have been minimal. Man-made items that affect the distribution system within the Nixa service area consists of major highways. It is important that a sufficient number of crossings are available so proper water distribution can be achieved on both sides of major roadways. Typically, crossings at major roadways require the piping to be installed in a casing pipe in the event the piping would need to be serviced in the future. Nixa has the benefit of a diverse location of water supply wells and elevated storage tanks throughout the system, which aids in serving both sides of major roadways throughout the City Limits.

There appears to be ample valving installed throughout the distribution system. Existing valves are typically gate valves and located at junctions between mains and branch lines.

City regulations require that inline valves be installed at a minimum interval of 500 feet in commercial districts and 800 feet in residential areas. It is important that a sufficient number of valves are installed in strategic locations in the event a section has to be isolated for maintenance. This will allow for a minimal amount of customers to have their water service interrupted during periods of maintenance on the existing distribution system. Fire hydrants are installed on main water lines that are sized appropriately to provide fire flow. Fire hydrants are required to be installed at 350 to 600 foot intervals depending on the type of surrounding development to be served.

5. Supervisory Control and Data Acquisition (SCADA) System

The City currently utilizes a Supervisory Control and Data Acquisition (SCADA) System for the control and monitoring of the existing groundwater well pumps and existing elevated storage tanks. At a minimum, each site included in the SCADA system has a module, radio, and antenna to complete its functionality. The operation of the existing well pumps is controlled by the status of the water elevation in the adjacent elevated storage tank via a local pressure transducer. Well No. 3 does not have an adjacent elevated storage tank; therefore, the on/off operation for this pump is controlled based on the system pressure via a local pressure transducer. The on/off control of the individual well pumps is not connected to the other system well pumps. Each are independently controlled and operated.

The SCADA system consists of a combination of controller modules and remote input/output modules. The system controller modules are Zetron, Model 1700. The controller manages the transfer of data between the Remote Terminal Unit (RTU) and the centralized control program. The RTU modules are Zetron, Model 1708. The RTU unit provides basic monitoring of parameters, such as, pump on/off status, system pressure, tank water level, and well house security. All information monitored at each of the well sites is sent to a centralized control program located at the Public Works Office via a radio connection.

6. Historical Regulatory Violations & Inspection Reports

The Missouri Department of Natural Resources (MoDNR) Southwest Regional Office conducted a Sanitary Survey on the City of Nixa water supply, storage, and distribution system for the purposes of inspecting and reviewing the public water system's "adequacy, reliability, and safety for producing and distributing safe, high quality

drinking water". The Sanitary Survey was developed May 19, 2010, and a copy can be found in Appendix A.

The Sanitary Survey indicated that the City of Nixa has received no Notice of Violations (NOV) regarding standalone regulatory issues at least since the year 1996. In August of 1996, a boil order was implemented for the City water system due to total coliform being present in samples taken from the water system. The boil order was in effect for two days until subsequent samples showed there was no total coliform present. There have been a few complaints filed by City residents alleging taste and odor issues and/or contamination of the water system; however, testing of the water supply in response to the complaints revealed no contamination issues associated with the water supply system.

The following is a summary of the recommendations provided by the MoDNR Sanitary Survey, dated May 19, 2010:

- Monitor fluoride dosing at the point of entry into the water system on a daily basis.
- City staff should be prepared to perform triggered source water monitoring in the event samples from the water distribution system indicate total coliform present.
- Provide chlorine disinfection for the entire distribution system.
- Develop a program to identify elements that contribute to water loss and a program to correct those areas.
- Develop an updated Water System Master Plan.
- Develop a written stand-alone emergency operation plan.
- Conduct updated inspections of all elevated storage tanks.

The evaluations and recommendations provided in this Master Plan address MoDNR's concerns as expressed in the inspection report. This Master Plan, along with the computerized hydraulic model of the City's water system should satisfy MoDNR's recommendation for a distribution system study.

A MoDNR Source Water Assessment Plan (SWAP) published on July 30, 2012, noted 41 potential contaminant sources amongst the City of Nixa's water supply wells. A copy of the Source Water Assessment Plan for each of the groundwater supply wells is included in Appendix B.

7. City of Nixa's Observed Deficiencies and Needs

The City of Nixa staff and Public Works Department personnel were consulted to determine what deficiencies or known needs the water system appeared to have based on their everyday operation of the system. As with any water system the size of Nixa's, there are always miscellaneous, everyday maintenance items that must be attended to. The following discussion centers on specific maintenance or upgrade items the City has plans to address in the near future.

Currently, the existing groundwater wells, overall, appear to be in good shape. All that is needed is some periodic maintenance and everyday monitoring. One issue with the wells has been during times when there is a large demand on the water system due to several irrigation systems running at the same time. This was readily evident during the drought conditions in the summer of 2012. The groundwater well pumps were not able to keep up with the maximum day and peak hour demands during this period. Another issue identified by the City that effects the operation of the groundwater supply wells was the lowering of the water table at each of the well sites. As a result, the City was forced to lower two of their groundwater wells due to the lower groundwater level. A lower groundwater level directly results in a lower pumping rate for a well pump under the same horsepower conditions.

The condition of the coating system for the existing elevated storage tanks was discussed in a previous section; however, there are several miscellaneous maintenance items associated with each of the tanks that must be addressed for safety reasons, as well as maintaining compliance with governing regulations for elevated storage tanks. The following Table IV-6 lists the various maintenance items associated with each elevated storage tank as provided by the City of Nixa staff:

TABLE IV-6
ELEVATED TANK MAINTENANCE SUMMARY

Tank	Interior Painted	Exterior Painted	Maintenance Items
1	2007*	2007	• Install New Safety Climb System • Replace Aircraft Warning Light Wiring • Replace Vent Screen • Repaint Interior Dry Areas
2	2009	2012	• Replace Overflow Screen • Add Curb on Condensate Platform • Fill Pipe Modifications for Improved Mixing • Cover Plates at Roof Penetrations • Repaint Interior Dry Areas
3	2006*	2012	• Replace Overflow Screen • Replace Roof Vent • Repaint Interior Wet Areas • Repaint Interior Dry Areas
4	1998	2009	• Inspect Interior Wet & Dry Areas
5	2000	2008	• Repaint Interior Wet & Dry Areas • Replace Roof Vent • Perform an Overall Inspection
6	2008	2008	• Replace Chain on Roof Access Manhole • Perform an Overall Inspection
7	2011	2011	• None

*Coating system of the interior areas were inspected, cleaned, and touched-up.

In addition to the maintenance items listed above, the City has expressed an interest in potentially removing Elevated Tank No. 1 from service. This tank is the oldest of all of the elevated storage tanks. Also, the 100,000 gallon storage capacity does not provide a major benefit to the water system. The City has observed this tank quickly being drained during high demand periods, such as those experienced in the summer of 2012.

Overall, the water distribution system appears to be in good shape concerning the condition of waterline pipes and current pipe size. Per the City staff, there are a few areas that are supplied by 2-inch water lines that are of concern when it comes to providing the necessary fire flow to these areas. Also, an item that the City is continually looking to implement to improve the distribution system is the installation of water lines that will create a loop in the distribution system. Looping of water lines promotes better circulation of flow, as well as a higher flow rate to areas due to flow coming from more than one direction.

The water system needs and deficiencies observed by City and water department personnel were examined and are addressed by the improvements proposed in this Master Plan.

8. Insurance Services Office Guidelines and Existing Fire Flow Service

The Insurance Services Office (ISO) is an advisory fire insurance rating organization that evaluates municipal fire protection to produce a numerical classification. These classifications are utilized by insurance companies to establish local fire insurance premiums. The City of Nixa is served by the Nixa Fire Protection District. The Nixa Fire Protection District's ISO Public Protection Class rating is 3 inside the City of Nixa's city limits and a Class 5 throughout the rest of the fire district, based on information provided by the Nixa Fire Protection District website. The District has developed a hydrant flushing program and routinely performs hydrant flow tests throughout the District's service area. The Nixa Fire Protection District has four stations throughout Nixa and consists of 33 full-time staff; including one fire chief, two assistant chiefs, three battalion chiefs, six company officers, one fire marshal, one Chaplain, eighteen firefighters, and one administrative assistant. The following is a summary of the major firefighting equipment used by the Nixa Fire Protection District:

- 4 Engines
- 2 Brush Units
- 2 Tankers
- 1 Water Rescue
- 1 Aerial
- 1 Heavy Rescue
- 1 Command Trailer
- 1 Service Truck
- 6 Staff Vehicles

Fire District personnel recognize that areas of low pressure and available flow throughout the City pose a serious threat to their ability to provide adequate fire protection. Ideally, the Fire District would prefer at least 1,500 gpm in residential areas and 3,500 gpm in commercial areas to be available throughout the water distribution system to allow them to effectively fight a fire. The Fire District's fire-fighting engine equipment consists of pumps that are rated at 1,500 gpm and their aerial has a pump rating of 2,000 gpm; however, the on-board storage volume is minimal and thus the water distribution system is directly depended upon when fighting fires. The Fire

District would also ideally prefer a minimum pressure of 50 psi throughout the water distribution system; however, it is impossible for the system to maintain this pressure at all points due to the hydraulic grade line elevation established for the system. In the higher elevations throughout the system, the maximum pressure is approximately 45 psi. Using a computerized hydraulic model of the City's water system, Exhibit 4 uses color-coded nodes to illustrate the range of available flows throughout the existing distribution system during the maximum day demand event. The parameters of the computerized hydraulic model as well as the evaluation of the model's results are discussed in subsequent paragraphs of this section.

As indicated in Exhibit 4, the majority of the City's distribution system maintains a minimum available flow of 1,500 gpm; however, there are several locations that fall short of this goal. The general areas of the distribution system that exhibit available flows less than 1,500 gpm include:

- Bentwater Subdivision on the northern end of the distribution system.
- Bluebird Hills and eastern Wicklow Subdivisions on the northeastern end of the distribution system.
- Wellington Park and Cedar Heights Subdivisions on the western end of the distribution system.
- Central area located on both the east and west side of Main Street from North Road to Highway 14.

The common theme for the first three locations listed above is that they are all located on the edges of the distribution system and are generally fed from one direction by one main line. Due to the location and lack of surrounding development, water distribution lines are not looped from and to these locations. The flow issues associated with the central areas can be attributed to smaller diameter (2" and 4") water mains that inhibit the ability of the system to distribute high flows in these areas. Pressures in these lower fire flow areas are generally maintained above 35 psi. This falls short of the desired 50 psi by the Fire District; however, it more than meets the minimum requirement of 20 psi.

The formulas and classifications summarized in the 2008 Guide for Determination of Needed Fire Flow published by ISO Properties, Inc. were used to estimate the needed fire flow at 25 specific sites throughout the City. The calculated fire flows are compared to the hydraulic model available fire flows in Table IV-7. The 2008 ISO Guide is included in Appendix C. The sites were selected to generally conform to the Occupancy Types

described in the 2008 ISO Guide. Since a thorough inspection of each building's materials of construction, effective area, exposure and communication factors, and other considerations such as existing sprinkler systems was not performed, some assumptions were made. The assumptions include all buildings consisting of either Class 3 or 4 Construction, considering only the largest single floor of the schools and assuming no sprinklers, and approximating the building areas from high-resolution aerial photos. Any building included in Table IV-7 that is equipped with a sprinkler system would require a lesser fire flow. As a general calculation, the 2008 ISO Guide results in a needed fire flow of 750 gpm for a 2,500 square foot (SF) facility/residence having an average C-3 occupancy factor.

TABLE IV-7
NEEDED AND CALCULATED FIRE FLOWS FOR SELECTED SITES

Site Name	Address	Approx. Area (SF)	Occupancy Type	Needed Fire Flow (gpm)	Available Fire Flow (gpm)
Residence	---	2,500	C-3	750	---
Nixa High School	514 S. Nicholas Rd	136,000	C-2	4,500	2,900
Nixa Junior High School	205 North St.	120,000	C-2	4,200	2,500
Summit Intermediate School	800 N. Cheyenne Rd	85,000	C-2	3,600	4,000
Mathews Elementary	605 S. Gregg Rd	56,000	C-2	2,900	2,900
Thomas Elementary	312 N. Market St.	50,000	C-2	2,700	2,700
Century Elementary	732 North St.	65,000	C-2	3,100	3,400
ESPY Elementary	220 S. Gregg Rd	53,000	C-2	2,800	1,600
Aldersgate United Methodist	460 Aldersgate Drive	28,000	C-2	2,000	3,300
Victory Baptist Church	252 N. Nicholas Rd	29,000	C-2	2,100	1,900
First Baptist Church	601 Wasson	18,000	C-2	1,600	2,500
Nixa Community Center	701 N. Taylor Way	30,000	C-2	2,100	3,500
Nixa City Hall	715 W. Mt. Vernon Rd	23,000	C-2	1,900	3,600
Nixa City Recycle Center	1093 Eaglecrest St.	1,000	C-5	600	2,600
Happy Days Children Center	402 S. Main St.	2,500	C-2	600	2,000
Gentle Care Animal Hospital	125 Aldersgate Drive	5,000	C-2	900	3,100
Diversified Plastics	108 W. Mt. Vernon Rd	110,000	C-5	6,000	4,000
Nixa Hardware & Seed	510 W. Mt Vernon Rd	50,000	C-3	3,200	1,900
Knight Heating & Cooling	468 W. Tracker Rd	14,000	C-2	1,400	3,300
Anytime Fitness	916 N. Main St.	3,500	C-2	700	3,200
Great Southern Bank	1341 N. Main St.	3,500	C-2	700	3,100
Casey's General Store	1306 W. Mt Vernon Rd	6,000	C-2	900	3,000
Buckingham's B-B-Q	606 W. Mt. Vernon Rd	5,500	C-3	1,100	2,900
Cruisin USA Frozen Custard	105 Ridgecrest Ave.	2,500	C-3	700	3,000
Price Cutter Plus	400 N. Massey Blvd.	78,000	C-3	4,000	2,100

Upon examination of the available fire flow determined by the hydraulic model for the sites listed in Table IV-7, it appears that most areas throughout the City have a significant amount of available fire flow. However, upon comparison of the available fire flow versus the calculated needed fire flow (ISO) for the indicated sites, there are a few locations that fall short of the preferred fire flow supply. The majority of the sites that indicate a lower available fire flow than the needed fire flow are located in the central portion of the City and of the water distribution system. Existing water mains in the central portion of the City largely consist of 4" to 6" diameter mains. There is a

great deal of looping of the water mains in this area; however, the smaller diameter mains inhibit the ability to provide sufficient fire-fighting flow to these areas. Upgrading the existing line sizes in these areas and ensuring that future mains are adequately sized, will increase the available fire flow capacity.

The Nixa Fire Protection District's fire codes are based on NFPA standard codes, but not all of the NFPA recommendations are enforced or available throughout the City. While increasing the water pressure in high-elevation areas will be difficult and/or expensive with the current water tank overflow elevations, strategic water line improvements throughout the City can increase the available flow to under-served areas. In general, the City only installs 8-inch or greater diameter water lines in order to sustain fire-flow hydraulic capabilities. The distribution system improvements proposed in this Master Plan are motivated by the need to increase the available fire flow to areas that are currently under-protected.

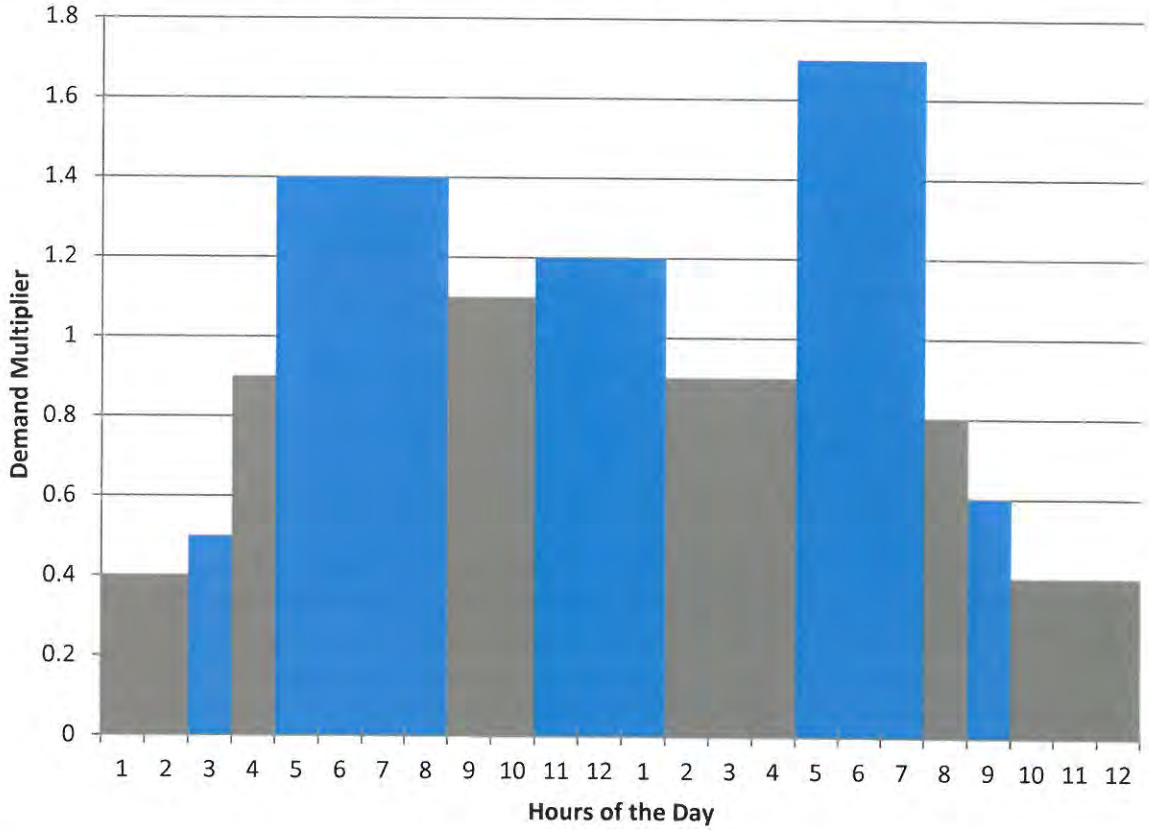
B. Computerized Hydraulic Model – Existing System

One of the tools used to analyze the hydraulic operation of the existing system is a computerized water system modeling program called WaterCAD, which integrates with AutoCAD. An electronic AutoCAD map served as the base map for the water system and the WaterCAD model was developed from the CAD drawing. Exhibits 3A and 3B display a map of the existing water supply, storage, and distribution system. City staff were consulted to ensure the water distribution system mapping was as accurate as possible. The model consists of the pipes, junctions, well pumps, and tanks associated with the City's water system. Actual elevations, pump data, tank dimensions and operating points have been coordinated with City water department personnel and have been assigned to the various model elements along with the appropriate water demands based on historical water usage, as summarized in Section VII. A USGS topographic map was used to determine the ground elevations to be assigned to each model element. The WaterCAD software allowed simulation of the supply, storage, pumping, distribution, and usage associated with the water system for the purposes of analyzing the existing system and evaluating the impact of potential improvements to the system.

Several demand scenarios or 'runs' were evaluated for the existing water system. The demand scenarios were viewed in two basic modes, a snap-shot view and an extended period simulation. The snap-shot view consists of viewing and analyzing the available flow at each node at a point in time when the entire system is under a specific demand event, whether it be average day or maximum day demand. The parameters for this scenario were

set such that all wells were off and the water levels in the elevated storage tanks were at their lowest level prior to the adjacent well pump turning 'on' to replenish the storage volume. This scenario assists in viewing particular distribution system improvements that may be needed in areas with less than desired available flow and pressure. The extended period simulation (EPS) utilizes a diurnal curve that represents a typical pattern of water demand changes over the course of a day. Figure IV-1 indicates the demand multipliers that were used in the hydraulic model simulation, which represents the diurnal demands throughout a typical day.

FIGURE IV-1
EXTENDED PERIOD SIMULATION – DIURNAL CURVE



An EPS analysis can simulate any number of consecutive day demands. The results of a three-day simulation are shown in this Master Plan. The EPS scenarios allow the operation of the wells and tanks to be viewed under changing conditions over several hours or days so potential improvements can be analyzed and evaluated. The various aspects of the existing system that were analyzed during the runs was the on/off operation of the existing wells, the fluctuating water levels in the existing water storage tanks, and the pressure and the

available flow at various nodes throughout the system. The following is a listing of the various demand scenarios that were run for analysis of the system:

- 2012 Average Day Demand (snap-shot for available flow and pressure at each node)
- 2012 Maximum Day Demand (snap-shot for available flow and pressure at each node)
- 2012 Average Day Demand – 3 Day Extended Period Simulation with Diurnal Demands
- 2012 Maximum Day Demand – 3 Day Extended Period Simulation with Diurnal Demands

The results of the maximum day demand snap-shot hydraulic analysis revealed that residual pressures throughout the system ranged from 35 psi to 110 psi and that the majority of the City's service area had an available flow greater than 1,000 gpm, with the majority of areas greater than 1,500 gpm. However, there were a few locations that indicated an available flow less than 500 gpm. These areas were typically located in the older, central portion of the service area and associated with smaller (2" to 4") diameter water mains. The available flows determined by the hydraulic model for this scenario are based on sustaining a minimum system pressure of 20 psi.

Also, this demand scenario was analyzed to evaluate the available pressures at the various assigned nodes throughout the City's service area. The evaluation indicated that residual pressures throughout the system were greater than 35 psi at all locations during the maximum day demand event. The residual pressure is the available pressure at a particular location even when water is flowing from the system at other demand points. Public water systems are required to maintain a minimum residual pressure of 20 psi for fire-fighting capabilities. As indicated by the hydraulic model analysis, the City currently more than meets this requirement. Exhibit 4 and Exhibit 5 indicate the available flow and system residual pressure analysis, respectively, during the maximum day demand event via color-coded nodes for the various flow rates and pressures.

The EPS was conducted using the diurnal, maximum day demand over a 3-day timeframe. The results of the diurnal analysis indicated that all of the wells cycled on/off as one would typically expect from this type of daily operation; however, some of the wells required longer run times (14+ hours per day) to replenish the storage tank volume while meeting the demands of the system. The smaller volume of Tank No. 1, coupled with the relatively lower pumping rate of Well No. 1 and centralized demands at this location, resulted in the tank volume not being able to be completely filled throughout the day and required an 18+

hour per day runtime for the well to meet system demands. Well No. 4 appeared to have the capabilities to fill the adjacent Tank No. 2, even during higher demand times throughout the day, but it also required 16+ hours per day of runtime for the well. Tank and well combinations of Tank No. 3 and Well No. 5, and Tank No. 5 and Well No. 7 operated in a similar manner as Tank No. 2 and Well No. 4 with the ability to meet system demands and replenish the tank volume, but requiring longer pump runtimes.

The tank and well combinations of Tank No. 4 and Well No. 6; Tank No. 6 and Well No. 8; and Tank No. 7 and Well No. 9 operated in a more consistent on/off type of operation with shorter runtimes. The shorter runtimes allow for the groundwater source to recover in between each pump operation. The common theme of these particular tanks and wells is that they are located closer to the outer edges of the City limits and not near the central, higher demand areas of the water distribution system. The bulk of the water system demand is being placed on the tank and well sites that are more centrally located. As the City continues to grow toward the outer areas surrounding Tanks No. 4, No. 6, and No. 7, then they will become more prevalent in their contribution to the water system. In the meantime, it is important that properly sized distribution lines are provided from these locations back into the central portion of the City where the higher demand areas are currently located.

The City has expressed concern for the operation of Tank No. 1 due to its small size. As previously discussed, during the maximum day demand event, the tank volume is not replenished throughout the day. Well No. 3 is the next closest well to the Well No. 1 and Tank No. 1 site, and does not have its own adjacent elevated tank. The hydraulic model indicated that the flow from Well No. 3 is required to run constantly in order to meet maximum day demands and assist Well No. 1 in replenishing the volume within Tank No. 1. Another scenario was evaluated to determine the effects of Well No. 3 on the operation and water level in Tank No. 1. For this model run, Well No. 3 was turned off. This scenario indicated that the water level in Tank No. 1 was directly dependent on the operation of Well No. 3, as illustrated by the low water levels in the tank throughout the day, as well as the tank being completely drained during the high demand period. This appears to be a direct result of the small volume of Tank No. 1. A factor that compounds this issue is the fact that Tank No. 1 is centrally located in the higher demand areas of the water distribution system.

The following Figure IV-2 indicates the diurnal operation of Tank No. 1, Well No. 1, and Well No. 3 during the maximum day demand over a 3-day period. Figure IV-3 indicates the diurnal operation of Tank No. 1 and Well No. 1 during the maximum day demand over a 3-day period with Well No. 3 turned off. These two figures indicate that Tank No. 1 is reliant

on Well No. 3 to keep from completely depleting its entire volume, but also, regardless of the operation of Well No. 1 and No. 3, the tank has trouble maintaining a sufficient volume due to its small size. The diurnal graphs for the remainder of the tank and well combinations are located in Appendix F of this Master Plan.

FIGURE IV-2
3-DAY DIURNAL OPERATION, MAXIMUM DAY DEMAND
TANK 1, WELL 1, & WELL 3

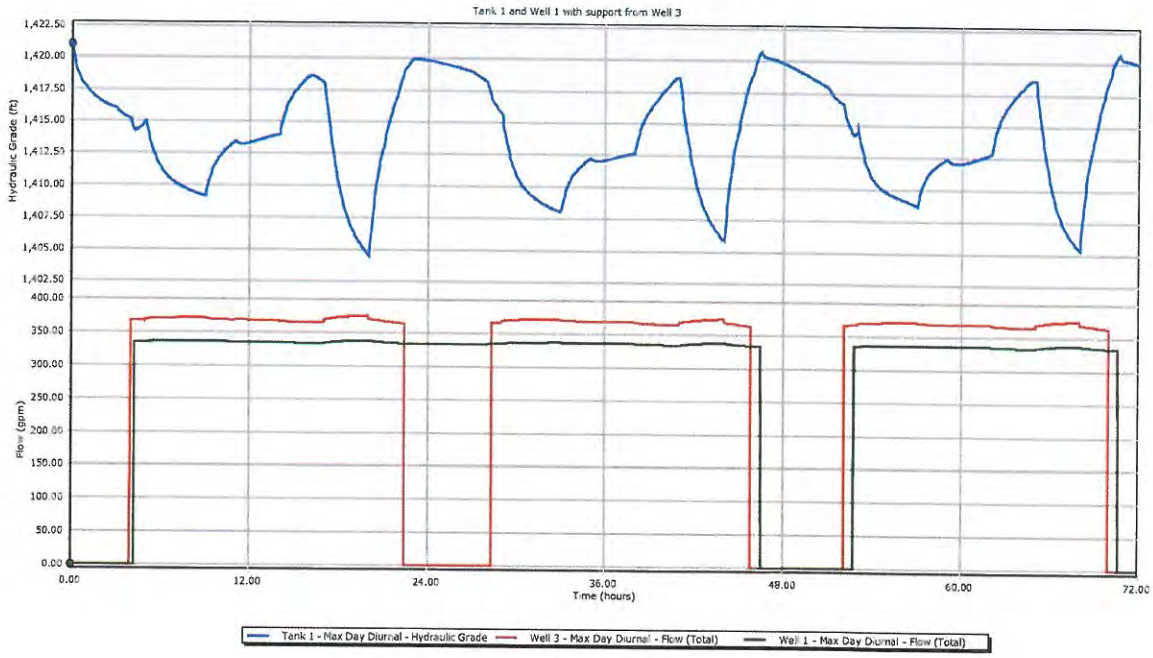
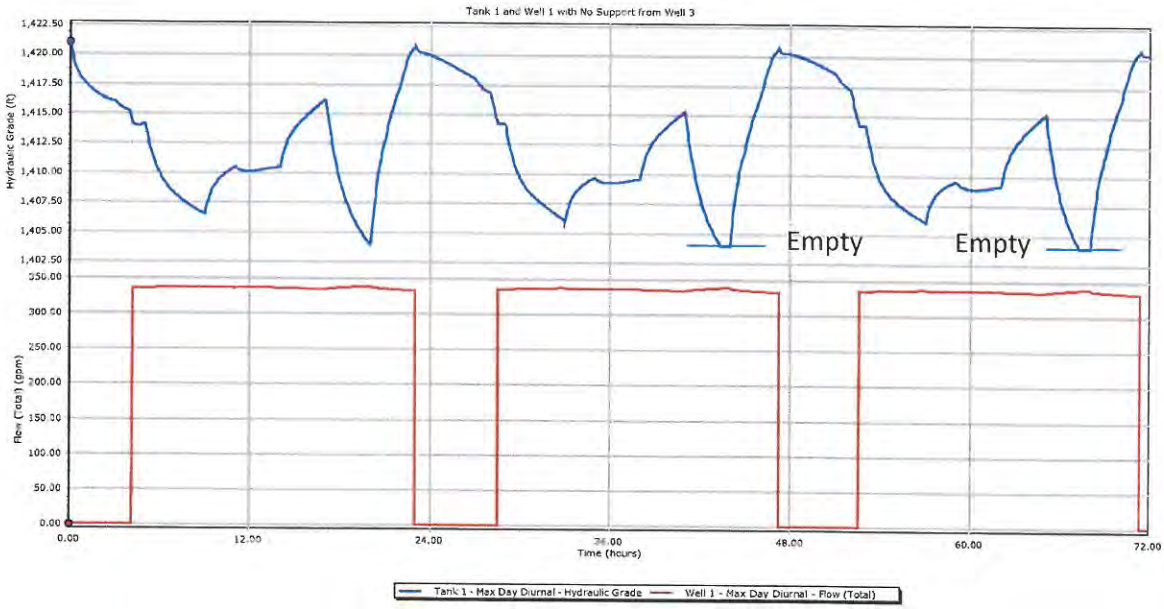


FIGURE IV-3
3-DAY DIURNAL OPERATION, MAXIMUM DAY DEMAND
TANK 1, WELL 1, & WELL 3 (OFF)



The water system hydraulics in the various areas throughout the City that experience low flow availability should be improved to provide the desired level of fire flow while sustaining a residual pressure of at least 20 psi. In general, hydrant flows determined by the Fire Protection District were consistent with the available flows calculated by the computerized hydraulic model. For the purpose of evaluating available fire flows throughout the distribution system in this Master Plan, the results of the hydraulic model were compared to various hydrant tests conducted by the Fire District, but comparisons were viewed with caution due to the following reasons:

- The water level in the storage tanks and the number of pumps running were likely not the same during each hydrant test;
- The area of limiting residual pressure may not have been accurately identified and measured for each hydrant test, whereas the hydraulic model tracks all areas of the distribution system simultaneously.

While utilizing the computerized hydraulic model allowed for greater consistency in system conditions, actual field tests should not be ignored. At the time specific distribution system improvements are being evaluated, it is recommended that the results of the hydraulic

model are compared to localized hydrant testing or that additional hydrant testing be performed in consideration of local constraints, which the model can help identify.

All of the proposed improvements that have been derived through the analysis of the hydraulic model have been discussed in the ensuing sections of this Master Plan.

C. Nearby Water & Wastewater Systems that Affect the City

1. Water Systems

The City of Nixa currently has two major nearby water systems that could potentially affect the City's water distribution system and the ability of the City's existing system to expand into surrounding areas. The RDE Water Company services an area that is mostly north and northwest of the City of Nixa service area. In some cases, areas served by the RDE Water Company either directly border or cross areas served by the City. This is more prevalent along Tracker Road on the north side of Nixa. The RDE Water Company's system currently consists of two groundwater wells rated at 200 gallons per minute (gpm) and 375 gpm, respectively. The location of the RDE service area inhibits the ability of the City of Nixa water system to expand to the north. It is anticipated that in order for the City's system to expand north, it would require an acquisition agreement with the RDE Water Company. However, it appears that if the RDE Water Company was acquired by the City, the City would need to make significant upgrades to provide sufficient fire flow throughout the RDE service area. Preliminary acquisition discussions were initiated several years ago; however, no discussions are currently taking place.

The next closest major water system to the City of Nixa is owned and operated by the City of Ozark, which is located immediately east of the city limits. The City of Ozark's system consists of several groundwater wells and elevated storage tanks and is roughly the same size as the City of Nixa's system. Ozark's service area extends within close proximity to Nixa's city limits by servicing the Fremont Hills Subdivision and extending along State Highway 14 to service the Ozark Technical Community College. It is anticipated that the City of Ozark will continue to expand westward to areas just east of Cheyenne Road. This will limit the City of Nixa's ability to expand its water service area to the east.

Expansion into potential service areas to the south and west are restricted by both natural features and private wells as opposed to other water supply systems. The Planning Area contains several low-capacity, shallow wells that previously and currently

provide water for individual properties, churches, mobile home parks, schools, and restaurants, or served as irrigation wells. MoDNR has records for some of these wells, but others are undocumented. Unfortunately, all of the wells in the area are potential entry points for contamination of the underlying groundwater. The City must remain diligent in its groundwater testing practices, work to educate the public about the risk of unplugged wells, and encourage the owners of abandoned wells to have their well plugged in accordance with MoDNR recommendations.

In discussions with City personnel, the idea of expanding the City's water system beyond the City limits to individual or a small number of rural customers has not been viewed with much enthusiasm due to the minimal return that would be realized on investments that would stretch into rural areas outside the City. Nixa would only have an incentive to provide water service outside its incorporated boundaries if it could also provide electrical service. However, Ozark Electric Cooperative and Empire District Electric surround Nixa on all sides, thereby eliminating any expansion of the City's electrical service outside of the current City limits.

Long-term, the lack of sufficient water service, from both a quantity and quality standpoint, and the lack of desire to operate an independent water system by the RDE Water Company may eventually lead the RDE Water Company to re-visit discussions with the City about either buying water wholesale or overtaking the entire system. Such an arrangement would necessitate significant facility expansions by both parties, especially the City, and would need to be preceded by a specific long-term study that is beyond the scope of this Master Plan. Nonetheless, the City should attempt to position itself as much as practical for the possible realization of supplying at least part of the RDE Water Company's service area in the distant future, likely beyond the planning period considered in this report

2. Wastewater Collection & Treatment Systems

The City of Nixa owns and operates the only centralized wastewater management system in the City's service area. There are approximately 123 miles of pipe in the existing Nixa sewer system. All but approximately 14 miles operate as gravity sewers, and the remainder operates as force main pressurized by a pump station. The collection system is comprised primarily of eight inch branch lines that tie into larger interceptor sewers. Line sizes range from eight to thirty inches in diameter. There are approximately 2,750 manholes in the system with an average spacing of 210 feet. Sewer depths vary but are generally less than ten feet deep. In recent years, the City

has actively sought to repair failing portions of its aging collection system in order to minimize inflow and infiltration.

The City operates its own wastewater treatment facility (WWTF) which is located in the southeastern portion of the City's service area. The existing oxidation ditch type activated sludge treatment facility was last upgraded in 2003. The existing WWTF is not currently located within the City's corporate city limits. The plant currently has a design capacity of four million gallons per day (MGD). The WWTF provides biological nutrient removal via selector basins and the oxidation ditches, and includes final clarification, tertiary filtration, and ultraviolet disinfection facilities. Continuous disinfection of the effluent is required because Finley Creek, the receiving stream, loses its flow to the subsurface and affects shallow groundwater. The plant provides advanced secondary treatment as required by its National Pollutant Discharge Elimination System permit.

The impact of the City's wastewater system on the water system is minimal and consists of the potable water demand from the facility. The City's wastewater system demand consists of domestic uses for the staff and water used in maintenance activities. Currently, water supply for the WWTF is provided via a connection to the main water distribution system at the Cobble Creek Subdivision. The wastewater treatment plant is not equipped with any equipment for reuse of non-potable water so all washing and other maintenance must utilize potable water. The amount of potable water use coupled with the water pressures needed for wash water at the wastewater plant prohibit the cost-effective implementation of a wastewater reclamation system, which would require additional pumping facilities.

V. GEOLOGICAL, SOIL, GROUNDWATER, & CLIMATE CHARACTERISTICS

A. Geology

The U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) has published a soil survey of Christian County, Missouri, and much of the information presented in this section was derived from the study of the county soil survey. Per the soil survey, Christian County is situated on the Springfield Plateau and the Salem Plateau. The majority of the county is on the Springfield Plateau; however, the southeastern part of the county and a small area in the south-central part are on the Salem Plateau. The landscape varies from steep, wooded hillsides and narrow, very gravelly ridge tops to broad, nearly level to gently sloping upland divides. The topography is karst and sinkholes are common. The bedrock surface is quite uneven due to weathering. Pinnacles of dolostone rock covered by a shallow soil layer rapidly transition to areas of very deep soils. Soil depth can range from one foot to over fifty feet within a relatively small area.

From oldest to youngest, the geologic formations in Christian County are the Gasconade Dolostone, Roubidoux Formation, and Jefferson City and Cotter Dolostone, topped by the Mississippian and Pennsylvanian aged strata. The Gasconade Dolomite, informally subdivided into upper and lower units, ranges from 300 to 450 feet thick. The overlying Roubidoux Formation consists of about 140 to 210 feet of dolomite, dolomitic sandstone and sandstone. The Jefferson City Dolomite, which averages about 210 feet, and the Cotter Dolomite, which is approximately 175 to 400 feet thick, is the youngest Ordovician units throughout most of the region. The Cotter Formation is overlain by Mississippian and Pennsylvanian aged strata. These units range in thickness from 0 to over 500 feet thick.

In general, the City of Nixa service area is underlain by deep soils on top of Jefferson City and Cotter Dolostone, followed by the Roubidoux Formation and Gasconade Dolostone. Further down are the Eminence and Potosi Formations, which completes the list of formations that form the Ozark groundwater aquifer. The topography in the area is also karst, resulting in sinkholes, losing streams, and caves. Karst topography is the result of weathering in the underlying, calcium rich limestone. Over time, ground water percolates through fractures in the limestone, slowly dissolving and enlarging the fractures. The Planning Area contains numerous sinkholes which pose an obstacle to be avoided when considering improvement alternatives.

B. Soil

The general soil mapping units in the Nixa service area are the Goss-Clarksville Association, Tonti-Wilderness Association, and the Creldon Association. Landscapes in the Goss-Clarksville Association consist of ridge tops and side slopes on uplands; relatively narrow flood plains and terraces; stony side slopes and rocky escarpments adjacent to the flood plains; and terraces and scattered areas of rock outcrops and sinkholes. The soil for this association is well to somewhat excessively drained with gently to steep sloping soils formed in the cherty residuum from limestone. Goss soils make up about 78 percent of the association, Clarksville soils about 12 percent, and soils of a minor extent about 10 percent. The Goss soils are on side slopes and ridge tops. Typically the surface layer is dark brown and about 6 inches thick. The subsoil is mostly cherty clay and the thickness is approximately 60 inches or more. The Clarksville soils are on side slopes. The surface and subsurface layer of this soil is brown and about 12 inches thick. The subsoil is also typically brown and the thickness is approximately 60 inches or more. Of minor extent in this association are the Cedargap and Secesh soils on the flood plains of small steams, the Wilderness soils on the ridge tops, and the shallow Gasconade soils on rough, broken side slopes and ridge top knobs of uplands. The soils are often quite cherty and acidic (pH < 6); however, bedrock is not typically encountered within the uppermost five feet. Consequently, excavation for pipelines has the potential to involve bedrock excavation; therefore, proper bedding material around the entire pipe should be utilized due to potential bedrock excavation and chert fragments. The soils are compatible with commonly used waterline pipe materials such as PVC and ductile iron. However, if the utilization of ductile iron pipe for waterlines is preferred, then a standard bituminous ductile iron coating coupled with bedding material surrounding the entire pipe will mitigate any potential corrosiveness of the acidic soil.

The Tonti-Wilderness Association is comprised of deep, moderately well drained, gently to moderately sloping soils formed in loess or other silty material and cherty residuum from limestone. The landscapes in this association consist of broad ridge tops and side slopes on uplands, a few narrow flood plains, and some sinkholes. Tonti soils and similar soils make up about 49 percent of the association, Wilderness soils about 41 percent, and soils of minor extent about 10 percent. The gently sloping Tonti soils are on ridge tops, foot slopes, and high terraces. The surface and subsoil about the fragipan, or dense, natural layer of hard soil with relatively slow permeability to water, is approximately 22 inches thick. The fragipan and subsoil is mostly cherty clay and the thickness is greater than 60 inches. The gently to moderately sloping Wilderness soils are on the sides of ridges and on ridge tops.

The surface, subsurface, and subsoil layer above the fragipan is mostly silt loam and approximately 16 inches thick. The cherty clay fragipan is approximately 15 inches thick with a subsoil layer thickness of 60 inches or more. Of minor extent in the association are the noncherty Captina and Needleeye soils on broad ridge tops, the well-drained Goss soils on side slopes and ridge tops, and the well-drained Cedargap soils on flood plains of narrow bottoms. Similar to the Goss-Clarksville association, the soils are acidic (pH < 6) and bedrock is not typically encountered within the uppermost five feet. Therefore, proper coating and bedding material will be required for any new water system improvements in these areas.

C. Groundwater

The groundwater aquifers underlying the Nixa service area are part of the Springfield Plateau Groundwater Province of the Ozark Plateaus Aquifer System. There are three significant bedrock aquifers in the Springfield Plateau Province; the St. Francois Aquifer, the St. Francois Confining unit, and the Ozark Aquifer. The St. Francois Confining Unit acts as a hydraulic barrier between the Ozark Aquifer and the St. Francois Aquifer. The St. Francois Aquifer has very low hydraulic conductivity, and because of its depth and generally modest yield potential, few wells produce from the St. Francois Aquifer in the province.

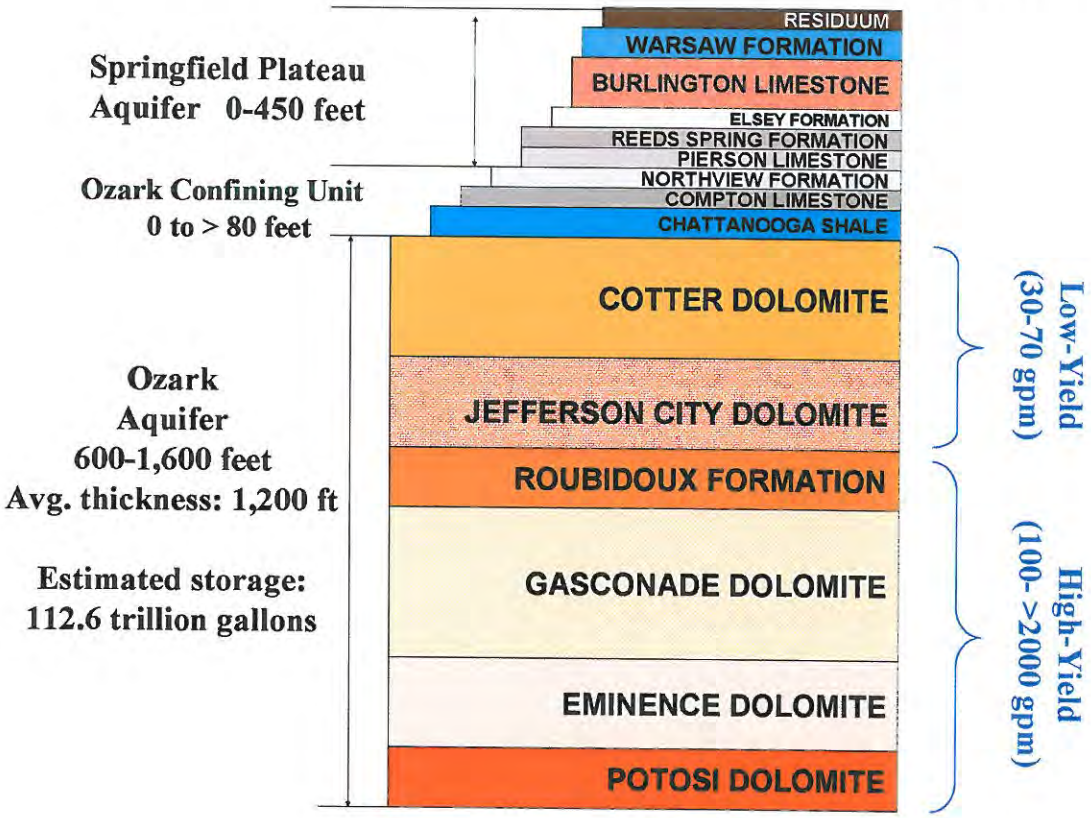
The most widely used and important groundwater supply source in the Springfield Plateau groundwater province and the Nixa service area is the Ozark Aquifer. The geological formations comprising this aquifer are the Derby-Doerun, Eminence, Potosi, Gasconade, Roubidoux, Jefferson City, and Cotter. The Ozark Aquifer is a confined or artesian aquifer throughout most of the province. A common characteristic of an artesian aquifer is that in the case of a tightly encased well, the water level within the well will be above the top level of the aquifer. Yields from wells fully penetrating the Ozark Aquifer range from as low as 200 gallons per minute (gpm) to more than 2,000 gpm. Most wells will yield between 600 gpm and 800 gpm and have moderate drawdowns.

Per a groundwater analysis conducted by the Missouri Department of Natural Resources, the recharge of the groundwater within the Springfield Plateau province is dependent on the location within the aquifer system. Karst conditions throughout the region have developed sinkholes, losing streams, caves, and springs. All of these karst features create direct conduits or pathways to the shallow groundwater aquifers in the province. Sinkholes and losing streams provide pathways for rapid recharge of the shallow groundwater system, and therefore, should be protected from potential contamination sources. Due to the confining characteristics of the Ozark Aquifer, movement of groundwater throughout the

province is quite complicated. Studies have indicated that very little groundwater enters the Ozark Aquifer in the Springfield Plateau from the Salem Plateau, east of the service area. Analysis indicates that there is a divide in the Ozark Aquifer extending northward in west-central Barry County, across eastern Lawrence County and northwestern Greene County. East of the divide, groundwater in the Ozark Aquifer either moves toward the White River Valley or the Springfield pumping cone. West of the divide, groundwater moves west toward Oklahoma and Kansas. Based on this movement, recharge of the Ozark Aquifer in Christian County will typically come from the Salem Plateau area due to Christian County being east of the divide. Additional groundwater recharge is provided through downward leakage of water from the Springfield Plateau aquifer, through the Ozark confining unit, and into the Ozark Aquifer.

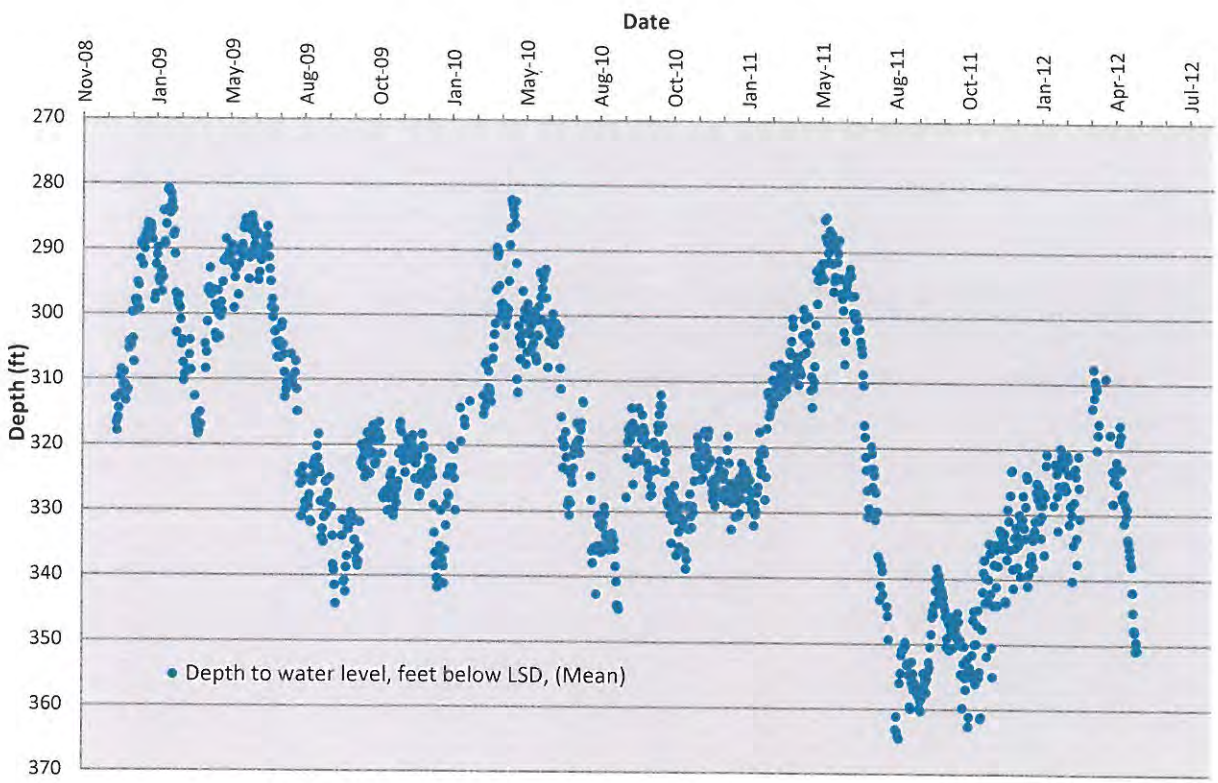
The following Figure V-1 indicates the various zones within the region's aquifer as provided by Missouri Department of Natural Resources.

FIGURE V-1
STRATIGRAPHIC UNITS OF THE SPRINGFIELD PLATEAU & OZARK AQUIFER



Nixa's eight active wells extend deep into the Ozark Aquifer and five of the eight wells are capable of withdrawing over 550 gpm. Groundwater levels in the area are generally moderate, within 400 feet of the ground surface. Groundwater level variations for each well are not consistently recorded but a MoDNR observation well in the City shows that the water table at this location undergoes significant variation throughout the year, sometimes exhibiting a difference of 80 feet between annual high and low water table levels. Figure V-2 shows the depth to water level variations at this observation well (labeled as 'USGS 370236093174401 Nixa'). The sharp peaks and valleys in the graph are likely related to precipitation and/or drought events in the drainage area and various demands on the aquifer throughout the year(s).

FIGURE V-2
WATER LEVELS AT USGS OBSERVATION WELL – NIXA



In general, the groundwater in the county is of acceptable drinking water quality, fit for public consumption assuming reasonable wellhead protection efforts are in place. For the most part, water withdrawal via large wells has a local influence on the groundwater level, but does not impact the overall groundwater flow system in the aquifer. The City should

take extra care that all potential contaminants in the source water area are handled properly to avoid contamination of the drinking water supply.

Based on the topography of the service area and known data from existing wells, future groundwater sources should be pursued in locations that have a limited surface recharge area and that are outside of the areas known to be associated with lineament trends, which indicate major deep-seated faults and fractures in the underlying geology, similar to the area around the Avin Sink, north of the City. Existing and future wells should incorporate wellhead protection zones and accompanying protection programs to better ensure a quality source of groundwater for the treatment methods utilized by the City. For recharge areas outside the corporate city limits, Nixa should work with Christian County to develop guidelines for land use management in these areas, thus promoting long-term protection of the region's groundwater quality.

D. Climate

The City of Nixa service area experiences a moderate climate that is similar to that of the county as a whole. The Christian County and Nixa service area are hot in the summer, especially at the lower elevations. The temperature is moderately cool in winter, especially at higher elevations. Snow falls nearly every winter, but the snow typically lasts only a few days. Per the latest NRCS published for Christian County, the average winter temperature is 33° F, and the average daily minimum temperature is 23°F. The lowest temperature on record, which occurred at Springfield on February 9, 1979, is -17° F. In summer the average temperature is 76° F, and the average daily maximum temperature is 87° F. The highest recorded temperature, which occurred on July 14, 1954, is 113° F. Part of the summertime water demand is associated with lawn sprinkling and garden watering, whereas extreme cold temperatures can result in an increase in water line breaks.

The total annual precipitation is for the City of Nixa is 43.45 inches. Based on long-term averages, approximately 60 percent of this rainfall total usually falls in April through September. The growing season for most crops falls within this period. The heaviest one-day rainfall during the period of record was 4.82 inches at Springfield on June 9, 1975. Thunderstorms occur on about 58 days each year, and most occur in summer. The average seasonal snowfall is 8.1 inches. The greatest snow depth at any one time during the period of record was 17 inches. The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing

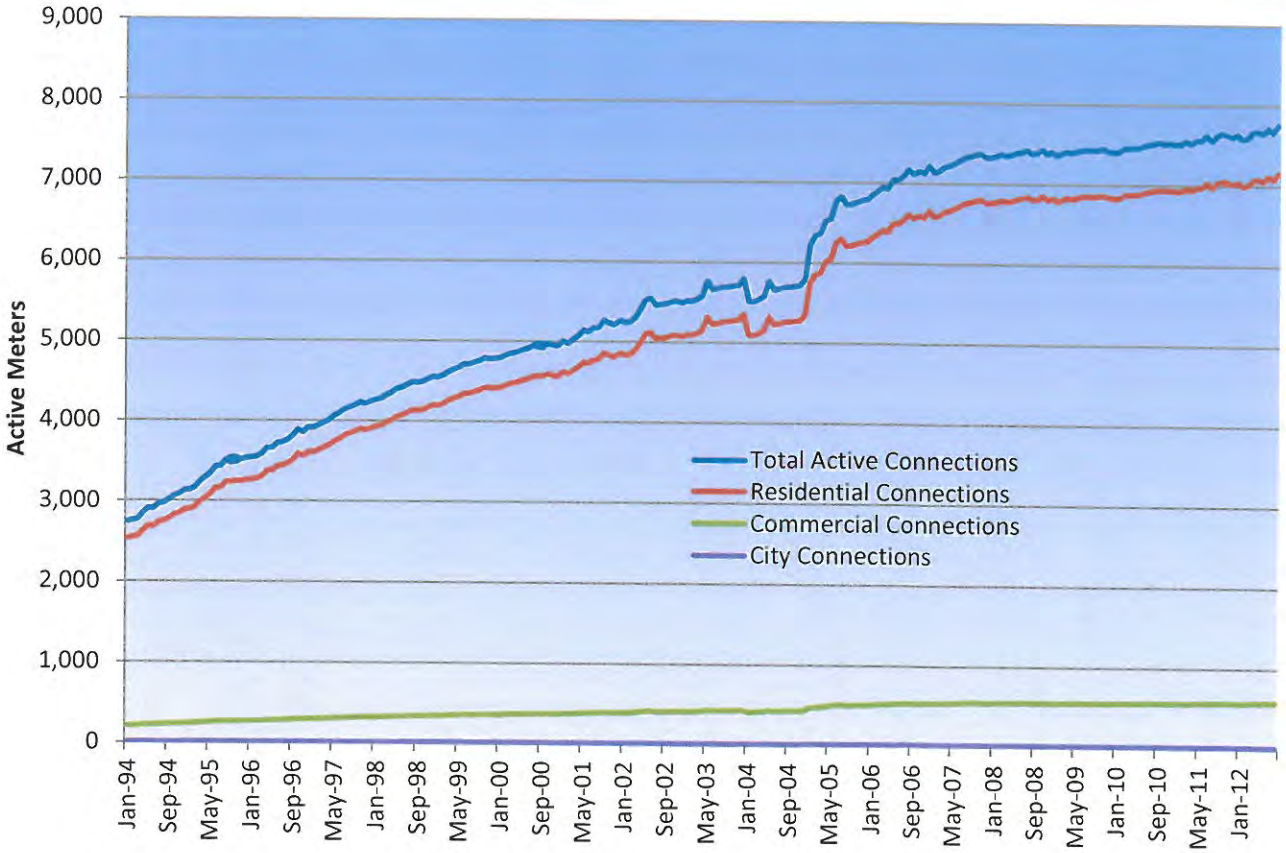
wind is from the south-southwest. Average wind speed is highest, 13 miles per hour, late in winter and early in spring.

VI. SUMMARY OF HISTORICAL & PROJECTED CUSTOMER BASE

A. Historical Customer Base

The City of Nixa billing structure is differentiated based on Class assignment to each meter. The Class assignments are categorized into three main areas; residential, commercial, and city-owned connections. Data on the total number of active meters was provided by the City for the time period from January 1994 to August 2012. Over this time period, the total number of active meters increased from 2,746 to 7,758. The 5,012 meter increase between these dates represents an average annual increase of 263 meters per year. Figure VI-1 illustrates the increase in total active meters, which includes residential, commercial, and city-owned connections, showing that the City of Nixa has experienced a solid upward trend in the number of total active meters since 1994. Considering the average number of active meters in each year from 1994 to 2012, the average annual increase in the number of residential, commercial, and city owned water meters combined has been approximately 5.09%.

FIGURE VI-1
ACTIVE WATER METERS BETWEEN JANUARY 1994 & AUGUST 2012



Due to a recent upgrade in the City's water billing accounting system, historical data on the breakdown of the total connections into the three main categories of residential, commercial, and city owned, could not be obtained from the City. Even though historical data was not available for a proper analysis, it is important to estimate the disbursement of the water supply to the various meter connection types. In order to estimate the number of meters into each billing category, more recent, limited data was used to determine a percentage breakdown for each meter category. The calculations based on this information resulted in a percentage of total active meters being 92.2%, 7.5%, and 0.3% for residential, commercial, and city-owned meters, respectively. These percentage allocations are used to determine historical (Figure VI-1) and projected active connections (Table VI-1) for each billing category.

The steady increase in the number of active water meters experienced between January 1994 and August 2012 was primarily due to two separate population influxes that resulted in the construction of several new residential subdivisions, which coincided with the construction of additional commercial businesses, restaurants, and shopping areas. The first population influx occurred in the mid to late 1990s and the second influx occurred in the mid-2000s. These specific periods of rapid growth can skew the overall average annual growth rate.

As previously stated, the average annual increase in total active water meters over the indicated timeframe was approximately 5.09%; however, the average annual increase in the number of total active meters over the last five years has been approximately 1.04%. There is a significant difference between the overall (over the last 18 years) annual total meter increase percentage and the annual total meter increase percentage over the last five years. This statistical variance must be considered when evaluating and projecting future water demands and the effect on needed supply, storage, and distribution system improvements to prevent potential oversizing and installation of unneeded equipment and materials.

B. Projected Customer Base

The City of Nixa's water service area is mostly compact with very few extended areas that require water service. However, those areas, most notably the Bluebird Hills development to the northeast and the Kelby Creek development to the south, extend quite a distance from the City's supply and storage sources. In order for water to reach these extended areas, it must past through a network of distribution lines which causes a great deal of capacity and headloss prior to reaching these developments. The City's existing boundaries do contain some areas of infill that can accommodate development without significant

strain on the existing water supply system. Also, the outlying developments previously listed have resulted in gaps that create development opportunities within the City's water service area. It is a goal of the City to develop these vacant areas which will infill areas within the existing city limits. Nixa is expected to continue growing in these undeveloped areas which will increase population and subsequently increase the number of water meter connections in both the residential and commercial categories.

Another important factor when projecting the future water customer base is the historical and projected trend for the number of persons associated with each residential water connection. This figure is calculated by dividing the population by the total number of active residential water meters. This methodology assumes that everyone counted in the City's population is associated with a residential water connection. This data can indicate anticipated demographic trends for the number of persons per household. This data can also be compared to typical unit values as recommended by the Missouri Department of Natural Resources (MoDNR) for planning of future water system needs per capita.

As previously indicated, the historical annual increase in total active meter connections has fluctuated a great deal over the past several years. The City of Nixa has experienced times of rapid growth followed by periods of much slower growth rates. The growth rate from 1994-2012 averaged 5.09% with a maximum annual increase of 16.03% and a minimum annual increase of 0.41%. The annual increase of water connections averaged 1.04% over the last five years. Although it is anticipated that growth and development will not occur at the overall historic trend, it is projected that growth and development will increase from the 1.04% experienced over the most recent years.

Just as the average number of people per household is expected to show little increase or in some instances even decline as families have fewer children and retirees come back into town to simplify their livelihood, the number of persons per residential water customer should see minimal, if any, increase. Accordingly, a more appropriate annual growth rate of 2.75% will be assigned to the residential water meter customers to more closely follow the population projections. It is also anticipated that commercial and city-owned meters will maintain the same ratio as previously determined. The calculation of these growth rates will start with the 2012 customer totals.

Based on the historical information and projection calculations determined by a 2.75% annual increase, Table VI-1 summarizes the projected average number of active water meter connections for the residential, commercial, and city owned billing categories to be served by the City of Nixa throughout the planning period. The projected average number

of residential connections was compared to the population projections for the determination of a persons per residential connection over the planning period. It is anticipated that over the planning period, the number of persons per residential connection will increase slightly from historic numbers.

TABLE VI-1
RECENT WATER CUSTOMER TRENDS AND PROJECTIONS

Year	Total Average Connections	Average Residential Connections	Average Commercial Connections	Average City-Owned Connections	Historic & Projected Population**	Persons per Residential Connection
2009*	7,416	6,837	556	22	18,332	2.68
2010*	7,487	6,903	562	22	19,022	2.76
2011*	7,589	6,997	569	23	19,303	2.76
2012	7,668	7,070	575	23	20,083	2.83
2013	7,879	7,264	591	24	20,635	2.84
2014	8,095	7,464	607	24	21,202	2.84
2015	8,318	7,669	624	25	21,785	2.84
2016	8,547	7,880	641	26	22,384	2.84
2017	8,782	8,097	659	26	23,000	2.84
2018	9,023	8,319	677	27	23,633	2.84
2019	9,271	8,548	695	28	24,282	2.84
2020	9,526	8,783	714	29	24,950	2.84
2021	9,788	9,025	734	29	25,636	2.84
2022	10,057	9,273	754	30	26,341	2.84
2023	10,334	9,528	775	31	27,066	2.84
2024	10,618	9,790	796	32	27,810	2.84
2025	10,910	10,059	818	33	28,575	2.84
2026	11,210	10,336	841	34	29,361	2.84
2027	11,518	10,620	864	35	30,168	2.84
2028	11,835	10,912	888	36	30,998	2.84
2029	12,161	11,212	912	36	31,850	2.84
2030	12,495	11,521	937	37	32,726	2.84
2031	12,839	11,837	963	39	33,626	2.84
2032	13,192	12,163	989	40	34,551	2.84

* Historical Data

**2009-2011 is based on US Census data. Remaining years are based on 2.75% annual growth rate.

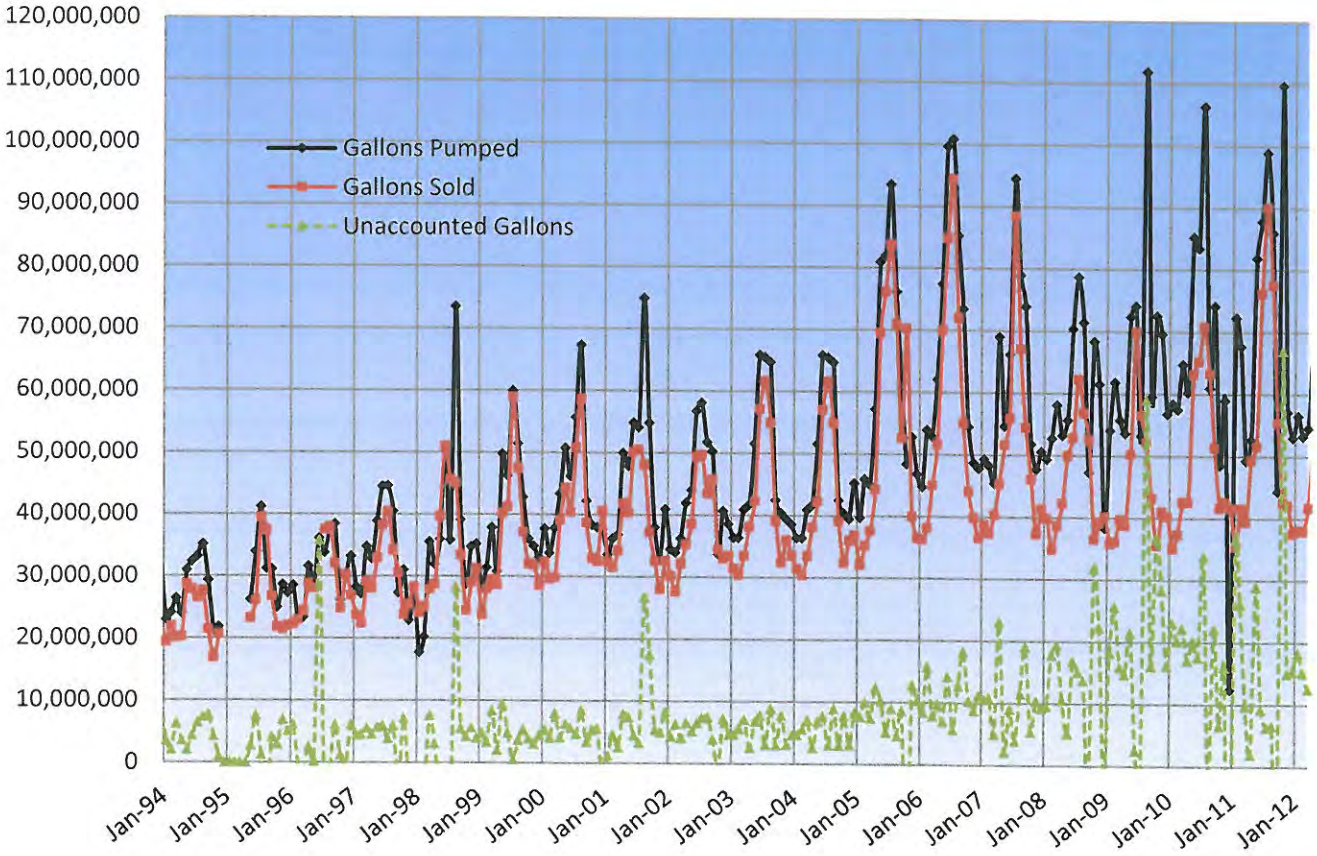
***The breakdown for each meter category is based on percentages previously discussed in Section VI.A.

VII. SUMMARY OF HISTORICAL & PROJECTED WATER USAGE

A. Historical Water Usage

Monthly well pump data and water usage records from January 1994 through August 2012 were analyzed to determine the historical water demands for the City of Nixa, as well as water loss data. Figure VII-1 shows the recent relationship between well water pumped and water sold and Table VII-1 shows the yearly trends in more detail. Major water users that are not billed, such as the City's water usage and water used by the fire district are monitored by the City and taken into account in the development of the following data. Other than City and fire district usage, there are no other entities or point sources that would account for a large amount of undocumented water usage.

FIGURE VII-1
WATER PUMPED, WATER SOLD, AND WATER LOST (JAN. 1994 – AUG. 2012)



As seen in both Figure VII-1 and Table VII-1, the amount of water pumped is, at times, significantly more than the amount of water sold. The City recognizes that the water

system has a higher than ideal amount of water loss, averaging about 15% per year based on the available data from January 1994 to August 2012. However, in order to get an accurate picture of today's water system, an average water loss percentage was calculated for the last five years. This calculation resulted in an average annual water loss of 23% with the highest yearly average occurring in 2009 at 30%. This is the cumulative result of aging water lines and meters along with unbilled water use throughout the City. The City is continually working towards ensuring that all authorized unbilled usage by fire departments, City facilities (public pools, sprinkler systems, wastewater treatment plant, etc.), and routine line flushing are properly and fully documented. There may also be a small number of active meters in the system that have mistakenly been excluded from the City's regular meter readings, thus not being properly billed.

TABLE VII-1
YEARLY TOTALS FOR WATER PUMPED, WATER SOLD, & WATER LOSS

Year	Total Water Pumped (gal.)	Total Water Sold (gal.)	City & Fire District Usage (gal.)	Total Water Loss (gal.)	Total Water Loss (% of Pumped)
1994	334,458,300	273,434,990	2,251,780	58,771,530	18%
1995	217,358,500	196,170,713	2,066,669	19,121,118	9%
1996	364,302,500	310,953,444	3,130,750	50,218,306	14%
1997	406,197,000	355,443,289	2,835,280	47,918,431	12%
1998	430,632,000	402,416,349	1,968,730	26,246,921	6%
1999	485,433,000	430,022,484	2,198,840	53,211,676	11%
2000	524,439,000	457,561,188	1,807,180	65,070,632	12%
2001	551,784,000	467,042,663	1,523,680	83,217,657	15%
2002	523,011,000	451,797,217	4,973,103	66,240,680	13%
2003	564,057,000	490,015,264	8,818,350	65,223,386	12%
2004	564,057,000	490,015,264	8,818,350	65,223,386	12%
2005	728,745,000	648,821,169	5,624,790	74,299,041	10%
2006	800,623,000	667,438,431	3,958,420	129,226,149	16%
2007	727,888,100	599,093,002	6,577,292	122,217,806	17%
2008	717,407,700	546,816,238	4,932,340	165,659,122	23%
2009	777,017,200	539,081,534	5,369,470	232,566,196	30%
2010	815,375,600	595,866,799	7,820,510	211,688,291	26%
2011	820,076,100	642,726,385	10,949,190	166,400,525	20%
2012(Aug)	619,549,100	502,937,553	9,244,180	107,367,367	17%
				Average:	15%
				Average (2008-2012):	23%

The peak year for water loss occurred in 2009 at a rate of 30%. However, the data would indicate that the amount of water loss has steadily been dropping since the peak in 2009. The downward trend in the annual water loss percentage could be contributed to several factors. One, when an existing faulty or leaking waterline has been identified, the City has either repaired or replaced the insufficient section. Also, in 2010, the City began to document the amount of water the fire district uses from the distribution system that does not get billed each month. Proper and thorough documentation of all water usage helps to accurately identify the enormity of actual water loss in the water system. Year to date in 2012, the records indicate a 17% water loss, which is a relatively low number for a water distribution system the size of the Nixa's. However, ideal water loss for a municipal water system would be less than 15%.

B. Water Usage by Large Users

The City of Nixa has a significant number of water customers that can be considered large water users – those that are routinely billed for at least 100,000 gallons of usage per month. Table VII-2 summarizes the large water users between April 2010 and April 2012 identified by the City of Nixa, defined as those customers who routinely use at least 100,000 gallons a month on average. The large water users listed are located all throughout the City and are not concentrated in one particular area. The large users are typically either commercial customers, multi-family establishments such as mobile home parks, or large irrigation system accounts.

TABLE VII-2
LARGE WATER USER SUMMARY (>100,000 GALLONS/MONTH)

Account Name	Average Gallons per Month	Average Gallons per Day
Diversified Plastics	1,063,625	34,968
Morelock-Ross	439,333	14,444
Life Enhancement Village-Care Ave.	319,750	10,512
New High School	302,754	9,954
Triple S Properties	250,513	8,236
S T Auto Spa LLC	248,013	8,154
Regional Care of Nixa	232,888	7,657
Autumn Corners HOA - Irr.	232,821	7,654
Life Enhancement Village-Gregg Rd	152,020	4,998
Price Cutter	135,483	4,454
Villas at Wicklow - Irr.	134,563	4,424
Walmart	128,854	4,236
Ye Olde Buggy Bath	124,629	4,097
Villas at Copper Leaf	117,221	3,854
Casey's - Carwash	113,154	3,720
Nixa Residential Care	111,858	3,678
Nixa North School Baseball	105,625	3,473
445500 Fresenius	104,979	3,451

The largest water user is Diversified Plastics at an average of over one million gallons per month. This user is located at 120 W. Mt. Vernon Street. This location is in the central portion of the City and in close proximity to more than one water supply well and elevated storage tank. This allows the system to provide the demand to this entity while still maintaining a sufficient pressure and flow to the remainder of the water supply system; although, due to the size of Tank No. 1, it is difficult to maintain a high level of system pressure for sustained periods of time, especially during high demand periods. The issues concerning the size of Tank No. 1 have been discussed in previous sections.

C. Projected Water Usage

Typically, future water use is based on the trends of historical water usage and the projected number of future water customers. Adjustments are then made to account for any anticipated large-use developments or subtractions may be needed to offset an existing high water demand facility. Accordingly, Table VII-3 lists the average gallons per day

demanded by water users, from January 1994 through August 2012, for the three types of billing categories in terms of gallons per day 'sold' or, in the case of the City and Fire District usage, 'meter reading', and gallons per day 'pumped' under the assumption of the percentage of water loss that was calculated for the corresponding year. This table combines the total historical meter count information, some of which is listed in Table VI-1, and the annual data used to develop Table VII-1.

TABLE VII-3
AVERAGE GALLONS PER DAY SOLD & PUMPED PER CUSTOMER
SORTED BY BILLING CATEGORY

	Residential		Commercial		City & Fire	
Year	Average Water Sold (GPD/Conn.)	Average Water Pumped (GPD/Conn.)	Average Water Sold (GPD/Conn.)	Average Water Pumped (GPD/Conn.)	Average Water Meter Reading (GPD/Conn.)	Average Water Pumped (GPD/Conn.)
1994	188	229	1,173	1,423	694	842
1995	208	228	906	993	921	1,010
1996	166	193	971	1,126	764	887
1997	178	202	945	1,072	633	718
1998	186	198	1,016	1,082	407	433
1999	192	216	953	1,070	424	477
2000	194	222	992	1,132	333	380
2001	187	220	1,003	1,181	268	315
2002	180	206	781	894	822	942
2003	184	208	831	940	1,421	1,607
2004	184	208	829	938	1,419	1,604
2005	212	236	945	1,053	766	853
2006	219	261	757	903	507	605
2007	190	228	669	804	813	977
2008	166	216	651	846	605	787
2009	164	235	630	900	656	936
2010	181	245	673	909	950	1,284
2011	190	238	751	943	1,306	1,638
2012	238	288	821	993	1,726	2,088
Average:	190	225	858	1,011	812	967
Average ('08-'12):	188	244	705	918	1,049	1,347

As expected, there is a variation in the average daily usage for the three meter categories, but each category has exhibited a consistent average usage for the last four years. The numbers listed for 2012 are slightly higher than past years due to the data only available through August 2012 and the typically lower average usage month from October through December not factored into the calculation. Since the number of active water customers has been projected for all three meter categories in Table VI-1, an average usage can be applied to the customers in each billing category to develop the projected water use. The required average pumping rate per meter connection to meet the residential requirements was calculated at 225 gallons per day (GPD) per connection over the entire timeframe of available data. However, the most recent five-year average was much greater at approximately 244 GPD/connection. Another factor to take into account is the number of persons per household times the unit factor designated by MoDNR. For residential connections, MoDNR typically recommends a unit flow rate of 80 gallons per capita-day (gpcd). Based on the per household data calculated for the most recent five years (this information has been indicated in Table VI-1), the average persons per connection is approximately 2.72. This equates to a usage per meter connection of 218 GPD/connection; however, when factoring in the corresponding water loss percentage of 23%, it equated to an average of 268 GPD/connection pumped for residential customers.

Commercial customers average billed usage was 858 GPD/connection, which when factoring in the corresponding water loss percentage, equated to an average of 1,011 GPD/connection pumped for commercial customers. The trend for commercial usage was slightly lower when averaging the most recent five years. The City and Fire District billed usage and pumped per connection averaged 812 and 967 GPD/connection, respectively, over the entire data set timeframe. However, there is a significant increase when calculating the most recent five year average. This is largely due to the City keeping more accurate records on the amount of water used by the Fire District, which began in 2010. Therefore, it is anticipated that the more accurate data for these types of connections would be the averages calculated for the most recent five years. While reductions in water loss will result in the need to pump less water to meet the daily usage, for the purpose of projecting future water use, the calculated annual averages for unaccounted water loss was assumed to be approximately 23%.

Future water use by the City of Nixa will be projected based on the following conclusions:

- Average water to be pumped per residential connection is 275 GPD;
- Average water to be pumped per commercial connection is 1,100 GPD;

- Average water to be pumped per city owned connection is 1,350 GPD;
- Number of residential, commercial, and city owned customers will increase as shown in Table VI-1;
- Maximum day water usage (based on water to be pumped) will be 1.95 times average day demand;
- Peak hour water usage (based on water to be pumped) will be 1.7 times maximum day demand, refer to peak diurnal demand multiplier illustrated in Figure IV-1.

In consideration of these parameters, Table VII-4 summarizes the projected water pumped usage for the City of Nixa through the planning period ending in 2032. In summary, the design average day, maximum day, and peak hour demands for 2032 are 5.19 MGD, 10.13 MGD and 17.22 MGD (11,960 gpm), respectively. These demand figures represent the total projected water pumped usage for the entire Planning Area and will be considered for evaluating water supply, treatment, and storage improvements.

TABLE VII-4
PROJECTED WATER PUMPED USAGE THROUGH 2032

Year	Projected Average Connections	Projected Average Residential Connections	Projected Average Commercial Connections	Projected Average City-Owned Connections	Average Day Demand (MGD)	Maximum Day Demand (MGD)	Peak Hour Demand (MGD)	Peak Hour Demand (GPM)
2012	7,668	7,070	575	23	2.61	5.09	8.66	6,011
2013	7,879	7,264	591	24	2.68	5.23	8.89	6,176
2014	8,095	7,464	607	24	2.75	5.38	9.14	6,346
2015	8,318	7,669	624	25	2.83	5.52	9.39	6,520
2016	8,547	7,880	641	26	2.91	5.67	9.65	6,700
2017	8,782	8,097	659	26	2.99	5.83	9.91	6,884
2018	9,023	8,319	677	27	3.07	5.99	10.19	7,073
2019	9,271	8,548	695	28	3.15	6.16	10.47	7,268
2020	9,526	8,783	714	29	3.24	6.33	10.75	7,468
2021	9,788	9,025	734	29	3.33	6.50	11.05	7,673
2022	10,057	9,273	754	30	3.42	6.68	11.35	7,884
2023	10,334	9,528	775	31	3.51	6.86	11.67	8,101
2024	10,618	9,790	796	32	3.61	7.05	11.99	8,323
2025	10,910	10,059	818	33	3.71	7.24	12.32	8,552
2026	11,210	10,336	841	34	3.81	7.44	12.65	8,788
2027	11,518	10,620	864	35	3.92	7.65	13.00	9,029
2028	11,835	10,912	888	36	4.03	7.86	13.36	9,278
2029	12,161	11,212	912	36	4.14	8.07	13.73	9,533
2030	12,495	11,521	937	37	4.25	8.30	14.10	9,795
2031	12,839	11,837	963	39	4.37	8.52	14.49	10,064
2032	13,192	12,163	989	40	4.49	8.76	14.89	10,341

The entire City of Nixa water system is on one pressure plane; therefore, future expansion of the system should not require coordination of vastly varying operating parameters. The location of growth for the City's water system has been previously discussed, which gives an indication of how the projected customer connections will be distributed throughout the current and future service area.

VIII. PROPOSED IMPROVEMENTS & ALTERNATIVES

A. Water Supply Sources

The City of Nixa currently has a total developed well capacity of approximately 5,650 gallons per minute (gpm) and a firm well capacity of 4,550 gpm with the largest well out of service. Section 3.2.1 of the MoDNR Design Guide for Community Water Systems states that the total developed groundwater source capacity shall be equal to or exceed the design maximum day demand. Furthermore, Section 3.2.1.2 states that for public drinking water systems serving 500 or more people, the groundwater source capacity shall be capable of meeting the design maximum day demand with the largest producing well out of service (i.e. firm capacity). All of the existing wells appear to be in good condition and operating satisfactorily; therefore, the current pumping rates for each of the existing wells indicated in Table IV-1 will be used in the analysis of future needs.

Table VIII-1 shows the additional well capacity that is needed to meet the MoDNR Design Guide requirement over the planning period until 2032 based on the maximum day demand being approximately 1.95 times the projected average day demand, which was previously discussed in earlier sections of this report and is consistent with Nixa's records on maximum day water pumping of the supply wells. The MoDNR Design Guide requirements for the quantity of groundwater supply sources does not regulate the number of hours per day a well can run to supply the necessary demand. A particular groundwater well can run 24 hours per day, if needed; however, in locations with several large producing wells (i.e.>250 gpm) in close proximity to one another (i.e.<1.5 miles), it is good practice to provide a sufficient number of groundwater sources so that a well pump will not have to run constantly. This practice allows for recharge of the groundwater system and prevents overstressing the groundwater supply.

In the previously referenced sanitary survey conducted by MoDNR for the City of Nixa, MoDNR recommended that a sufficient number of groundwater supply sources be provided so that each well would only be required to run a maximum of 8 hours per day, allowing for 16 hours per day for the groundwater supply to recover. Although this scenario would allow sufficient recovery time for the groundwater source, this design criterion typically requires a great number of additional groundwater sources (i.e. new wells) to meet these requirements in the near and distance future. Typical design criteria for well run times are based on a 12 to 14 hour per day run time to meet average day demand. However, in determining the future need for water supply wells, it is important to take into consideration the number of higher producing wells in Nixa's service area and surrounding

water supply systems (City of Ozark and RDE Water Company), and the proximity of each of those wells to the current and future well locations. Another important factor that was more prevalent in recent years is the drought conditions that have been experienced over the past several summers, with the most extreme occurring in summer 2012. Drought conditions put much more of a stress on not only the water supply system, but also the groundwater supply source. It takes much more time for the groundwater source to recharge during the extreme drought conditions. An example of this is the need for the recent lowering of Well No. 3 and No. 5.

In order to ensure that ample time is being provided at each well site for sufficient groundwater supply recharge and to reduce the potential to have to lower future wells due to a diminishing groundwater level, future water supply source projections will be based on a 10 hour per day run time to meet average day demand. This design criterion allows for sufficient recovery time for the groundwater source in an average day demand event. The maximum day events are less frequent; therefore, well pump run times can be designed for longer durations during these sporadic periods of higher demands. Therefore, the projected well capacity to meet the maximum day demand will be based on an 18 hour per day run time. The additional firm capacity required, as shown in Table VIII-1, is based on the existing firm capacity of the system (i.e. the largest well out of service). Using these design parameters should provide sufficient safety factors in the event of future drought conditions or when high peak demand periods are experienced by the system.

In Table VIII-1 below, the fourth column represents the required firm well capacity based on a maximum run time of 10 hours per day to provide the projected average day demand, shown in the second column. Similarly, the sixth column shows the required firm well capacity to meet the projected maximum day demand, shown in the third column, based on a well run time of 18 hours per day. For design purposes, the fifth and seventh columns show the additional well capacity needed for Nixa to meet the average day and maximum day demand, respectively, based on the 10 hour and 18 hour per day run time for each demand, which is appropriate for design. The additional well capacity required is based on a current firm capacity of 4,550 gpm to meet both the average day and maximum day demand. During drought conditions, however, the City's firm pumping capacity may be less as well yields are directly related to groundwater table depths.

TABLE VIII-1
PROJECTED AVERAGE & MAXIMUM DAY FIRM WELL CAPACITY REQUIREMENTS

			Average Day Demand		Maximum Day Demand	
Year	Projected Average Day Demand (GPD)	Projected Maximum Day Demand (GPD)	Required Firm Well Capacity (10 hr/day run time, GPM)	Additional Required Firm Well Capacity (GPM)	Required Firm Well Capacity (18 hr/day run time, GPM)	Additional Required Firm Well Capacity (GPM)
2012	2,607,802	5,091,400	4,346	0	4,714	164
2013	2,679,516	5,231,414	4,466	0	4,844	294
2014	2,753,203	5,375,277	4,589	39	4,977	427
2015	2,828,916	5,523,097	4,715	165	5,114	564
2016	2,906,711	5,674,983	4,845	295	5,255	705
2017	2,986,646	5,831,045	4,978	428	5,399	849
2018	3,068,779	5,991,398	5,115	565	5,548	998
2019	3,153,170	6,156,162	5,255	705	5,700	1,150
2020	3,239,882	6,325,456	5,400	850	5,857	1,307
2021	3,328,979	6,499,406	5,548	998	6,018	1,468
2022	3,420,526	6,678,140	5,701	1,151	6,183	1,633
2023	3,514,590	6,861,789	5,858	1,308	6,354	1,804
2024	3,611,242	7,050,488	6,019	1,469	6,528	1,978
2025	3,710,551	7,244,377	6,184	1,634	6,708	2,158
2026	3,812,591	7,443,597	6,354	1,804	6,892	2,342
2027	3,917,437	7,648,296	6,529	1,979	7,082	2,532
2028	4,025,167	7,858,624	6,709	2,159	7,277	2,727
2029	4,135,859	8,074,736	6,893	2,343	7,477	2,927
2030	4,249,595	8,296,791	7,083	2,533	7,682	3,132
2031	4,366,459	8,524,953	7,277	2,727	7,893	3,343
2032	4,486,536	8,759,389	7,478	2,928	8,111	3,561

Another factor to consider is the system's ability to meet the anticipated peak hour demand. This demand typically is very short in duration; therefore, the total capacity of all wells operating is used to evaluate the system's ability to meet this peak hour demand. Per Table VII-4, the calculated peak hour demand for 2012 is approximately 6,000 gpm. The total capacity of the existing wells is approximately 5,650 gpm. Therefore, during a peak hour demand, all well pumps would be running and the elevated storage tanks would be draining. This scenario was experienced by the City as recently as summer of 2012. Ideally, the necessary amount of pumping would be provided so that the total capacity of the

system can meet the peak hour demand for short durations; however, the amount of storage within the system will help to weather these peak hour demand events for short periods of time.

Increasing the City's total and firm well capacity to meet the projected average day and maximum day demand of 4.5 MGD and 8.8 MGD, for 2032, based on a 10 hours per day and 18 hours per day pump run time, respectively, will require the construction of additional groundwater wells or the development of another water source such as a surface water reservoir. Another option for increasing the City's firm well capacity is installing bigger pumps to increase the well output to the water distribution system. Each of these options is considered in more detail below

1. New Water Supply Wells

Even though the figures calculated in Table VIII-1 indicate that additional well capacity is needed to meet both current and future demands, it does not mean the current system is not able to provide the necessary water supply for today's demand. The conclusion from these calculations would indicate that the groundwater supply wells are either running more than 18 hours per day to meet maximum day demands or that all wells are operating, in lieu of the largest well out of service. The calculations use a worst case scenario approach so that sufficient supply will be available should a well pump malfunction during an extremely high peak demand condition.

In order to meet the design criteria indicated and incorporate sufficient safety factors, the City should install a new groundwater well within the next year. The first new well should be designed to yield approximately 1,000 to 1,100 gpm. This will allow the City to provide a sufficient water supply source that will meet the current and near future average and maximum day demands based on a 10 hour and 18 hour per day pump run time, respectively. This added well would also allow the City to meet the current peak hour demand without draining of the storage tanks.

A second well, producing another 1,000 to 1,100 gpm, constructed by 2020 will give Nixa the capacity to meet the projected maximum day demand based on 18 hour per day pumping until approximately 2025, when the system can be re-evaluated to determine when another well is needed to meet the projected 2032 maximum day demands with firm supply capacity. A third additional well may be needed by 2030 to meet the projected maximum day demands for the entire planning period. Any currently active wells that can no longer be kept in service should be upgraded or

replaced with a new well that meets or exceeds its current pumping capacity to maintain sufficient firm well capacity.

2. Develop a Surface Water Reservoir

An alternative to developing additional groundwater wells with associated structures and piping is for the City to develop a surface water reservoir for subsequent treatment. This option was evaluated to determine the necessary steps and resulting water system changes required to meet drinking water regulations. The treatment requirements for a surface water source, per MoDNR's Design Guide for Community Water Systems, include at least a two-stage clarification treatment process consisting of primary rapid mixing, flocculation and sedimentation followed by secondary rapid mixing, flocculation and sedimentation. The City does not currently have any full sized surface water treatment facilities or potential locations for such a facility. Therefore, a monumental effort would be needed to develop a surface water reservoir and provide the required two-stage clarification treatment to meet surface water requirements.

In addition to constructing a new water treatment plant to meet the requirements of treating surface water, the following items would need to be designed, constructed and/or implemented to utilize surface water as an alternative or supplemental water source for the City's potable water needs:

- A surface water reservoir would need to be designed and constructed in accordance with State and Federal regulations, requiring the use of dozens of acres of land;
- An intake structure with high-capacity pumps would need to be designed and constructed for extracting the surface water from the reservoir;
- A raw water line would need to be designed and constructed from the intake structure at the reservoir to the new treatment plant;
- A source water protection program would need to be developed and implemented to protect the reservoir as a drinking water source;
- Additional Surface Water Treatment Rules will apply to the drinking water system, affecting operation and maintenance routines and the required operator certification level.

Given the costs associated with the obligations listed above, developing a surface water reservoir is not a feasible option for the City to pursue for the given planning period and is therefore not recommended. However, there are local not-for-profit groups that have begun to address potential regional water shortages in the future and are seeking alternatives for future water supplies. The City of Nixa is currently a member of the Tri-State Water Resource Coalition which is an organization that is monitoring and evaluating current water supplies and potential future water sources. It is recommended that the City of Nixa continue to be involved in any planning efforts for future regional water supply alternatives so that the City has positioned themselves to participate in such programs should the future need arise.

3. Improvements to Existing Water Supply Wells

Another option for improving the water supply that is typically investigated is increasing the pumping capacity of the existing wells. This is typically limited by the size of the casing, which limits the size of pump that can be inserted into the drilled groundwater well. Upgrading existing wells eliminates the need to drill a new well since the existing hole can be fitted with a larger pump. This is only the case if the existing well pump has not already been sized to the full capacity of the well casing. Also, the drawdown of the well and the ability of the well to provide additional water supply is an important factor to consider when potentially upgrading an existing well motor size. When determining whether an existing well can produce more flow, pump tests should be performed using the desired sized pump and motor. Typically, the flow of the well and the associated water level drawdown should be measured for a test period of 24 hours or until conditions have stabilized for at least 4 hours. The pump tests should be performed during dry periods since precipitation in the area will begin to recharge the aquifer, thereby affecting the results of the testing. Subsequent to the pump test, the recovery of the well should also be measured until full recovery has been achieved. Special attention will need to be given to the management and disposal of the pump test water during the tests.

Typically, ample room should be provided from the inner diameter of the casing pipe and the outer diameter of the well pump piping so that space is available for the diameter of any couplings, power cables, and fittings associated with the well pump. A rule of thumb is to provide approximately 4" from the casing inner diameter measurement to the outer diameter of the well pump. The inside diameter casing size for the existing wells range in size from 8" to 12" with the pump sizes ranging from 4" to 6". The only well locations that would be candidates for a pump size upgrade would be

Well No. 6, No. 7, and No. 9. At each of these locations the casing is 12" in diameter and the well pump is 6" in diameter. Based on the casing size for each of these wells, a larger 8" pump could conceivably be installed for a higher production rate; however, these three wells are the highest producing wells within the system. Any additional demand on these wells could prove to be detrimental to the large yield already being obtained by this portion of the aquifer, as well as potentially degrading the water quality.

Another option for upgrade of the existing wells would be to increase the motor horsepower (hp) of the existing well pumps. Currently, Well No. 1, No. 6, No. 7, and No. 8 are at the maximum motor horsepower for that size of pump. The only way to increase production of these wells would be to install a larger pump. The remaining wells all have the potential to increase motor horsepower. The motor horsepower was recently increased for Well No. 3 and No. 5, each of which were increased to 100 hp motors. Well No. 4 and No. 9 are already at 100 hp and 150 hp, respectively.

With all of the existing wells that are eligible for a motor horsepower increase currently at, or above, 100 hp, increasing the motor size any more at these locations could potentially have a detrimental effect on the production and operation of the well. The water supply source will have a limited yield and increasing motor size from the original design does not necessarily equate to an increase in well production. Due to these factors, it is recommended that the City not upgrade any well locations with larger pumps and/or motors. However, should the City decide to install larger pumps and/or motors at any of the existing well sites, it is recommended that extensive well yield testing be performed to insure the well can consistently produce the increased production.

As previously discussed, the condition of the existing wells appeared to be in good shape; therefore, no major repairs are needed. However, in order to maintain the wells, routine maintenance and inspection should be performed. The following list indicates recommended items that should be inspected on a regular basis.

- Routinely check the status of heaters and thermostats to confirm proper operation.
- Have a certified electrician test and inspect the electrical components of the pump motor's power supply and controls and make upgrades as recommended, including adding protective safeguards to the electrical system, if necessary.

- A certified electrician should test and inspect the adequacy of the existing stand-by generators at each of the well sites to confirm that each existing generator has been sized properly and that there is sufficient capacity to operate the associated well pump. The generator should be exercised on a regular basis.
- Check accuracy of flow meter, calibrate the existing flow meters on a periodic basis, verify upstream and downstream straight-runs of pipe, and replace or modify as necessary.
- Inspect all fluoride dosing equipment for proper operation and upgrade equipment as needed.
- Install containment areas for the fluoride chemical storage tanks.
- Install security fencing at Well No. 1 and inspect security measures at each of the well sites for protection against tampering and/or damage.
- Inspect building exterior for any deterioration that would be detrimental to the water supply well.

B. Treatment

The Missouri Department of Natural Resources has implemented a regulation intended to require improved monitoring and compliance for water systems that use groundwater as their water supply source. The purpose of the Groundwater Rule (GWR) is to reduce the risk of illness caused by microbial contamination in public groundwater systems (GWS). The GWR establishes a risk-targeted approach to identify GWS susceptible to fecal contamination and requires corrective action to correct significant deficiencies and source water fecal contamination in all public GWS. The GWR applies to all public water systems (PWS) that use groundwater. The GWR is based around a standard of achieving 4-log treatment of viruses (99.99% inactivation). While bacterial contamination is more common in groundwater than viral contamination, achieving 4-log treatment of viruses is a standard established to ensure that a high degree of both viruses and the most rugged of bacteria are inactivated. However, instead of requiring disinfection for all GWS, the GWR establishes a risk-targeted approach with monitoring being a key element. The main means of monitoring and action-steps include Sanitary Surveys, Source Water Monitoring, Compliance Monitoring, and Corrective Actions. While Sanitary Surveys are the responsibility of the State, GWS are responsible for the other requirements.

Each GWS that is required to show it can achieve 4-log treatment of viruses can do so by submitting Contact-Time (CT) calculations similar to a surface water treatment plant. For most groundwater sources, which are around 10 degrees C with a pH between 6 and 9, the CT value associated with 4-log treatment of viruses using free chlorine as a disinfectant is 6 mg*min/L, as shown in MoDNR's 1992 "Guidance Manual for Surface Water System Treatment Requirements". A GWS would determine its own achieved CT value by multiplying the free chlorine residual near the point of disinfection by the detention time provided prior to the water reaching the first customer. For example, a free chlorine residual of 1 mg/L would require a detention time of 6 minutes to achieve a CT of 6 mg*min/L and therefore provide 4-log treatment of viruses. Baffling factors should also be considered when determining detention time. The ability of the system to prove it can meet 4-log inactivation of viruses must be done on a continual basis. Therefore, any GWS required to provide Compliance Monitoring will need to continually monitor the disinfectant residual, pH, temperature, and detention time during peak flow rates in order to continually verify that the 4-log treatment is being provided by the system. Another option for GWS's is to choose a Triggered Source Water Monitoring route, which is essentially a "do as you're currently doing" approach but with the added monitoring requirements associated with the GWR if any water sample tests positive for Total Coliform. This route primarily pertains to systems that are not currently disinfecting their water supply, such as the City of Nixa.

The Sanitary Survey completed by MoDNR in May 2010 indicated that "It is the Department's strong recommendation that Nixa continuously disinfect its water supply with chlorine, immediately." The basis for their recommendation is that history has shown that water supply systems in karst type topography have a better chance of contamination from a variety of sources. Also, if contamination were to occur, a public water system the size of Nixa's has the potential to affect a large number of users. If the City chose to provide disinfection, it would need to do so at each of the well sites. The City would remain under the Triggered Source Monitoring portion of the GWR. This requires the City to continue to perform their normal sampling regimen. In the event the City would produce a positive sample for coliform, then the City would fall under Compliance Monitoring which requires the City to prove the 4-log inactivation of viruses on a continual basis. In order to perform this calculation, additional equipment and modification to the existing water supply system is needed.

As previously indicated, the City has not received any "bad" samples since 1996; therefore, MoDNR's only mandatory requirement regarding disinfection is that the City performs

triggered source monitoring of the water supply system. Even though it appears the City is not required by MoDNR to install disinfection equipment and to perform extensive 4-log inactivation monitoring, it is recommended that the City seriously consider the installation of necessary improvements to provide disinfection at each of the well sites and begin to budget for monitoring equipment that would be needed should Compliance Monitoring be required in the future. Due to the number of water customers that could potentially be affected by groundwater contamination, disinfection will provide additional protection to those customers to prevent the spread of any potential water-borne diseases.

The initial equipment needed to provide disinfection capabilities at each of the well sites would consist of a dual cylinder gas chlorinator system with automatic switchover. The chlorinator includes regulators, an ejector with check valve, the necessary tubing and water piping, meter panel, pressure relief valve, and miscellaneous accessories. In addition to the chlorinator, a dual cylinder scale would be needed to independently weigh the contents of two compressed chlorine gas cylinders. Due to the extreme toxicity of the chlorine gas, all of this equipment and the gas storage cylinders would be required to be housed in either a separate, sealed off room added to each of the existing well houses or a separate structure installed at each of the well house sites.

The ideal water supply configuration that will provide the most efficient contact time for the chlorine disinfectant of a GWS that provides a disinfection process is to provide a chlorine injection point at each of the well sites and then have the wells pump directly to a nearby tank via a dedicated raw water line with no service connections so that ample contact time can be provided prior to the water supply entering the distribution system. While pumping directly into the distribution system can provide some contact time in the piping prior to the first service connection on the line, the ability to reliably calculate this contact time is cumbersome and, typically, this arrangement does not provide an adequate amount of contact time due to pipe size and distance to the first service connection.

Each of the existing wells is directly connected to an adjacent elevated water storage tank, except for Well No. 3. Typical operation of the wells is to have connections to both the tanks and distribution system. The water level in the tanks float with the system pressure, but each well has the ability to pump directly into the distribution system. The closest storage tank to Well No. 3 is Tower No. 2 which is approximately 0.5 miles from the well. However, there are several customer connections between Well No. 3 and Tower No. 2.

In order to provide sufficient contact time in each of the existing storage tanks, each tank must be equipped with a separate inlet and outlet pipe to prevent short circuiting of the

incoming flow. The needed improvements for the existing storage tanks to accomplish this operation is discussed in subsequent sections of this master plan. Since Well No. 3 is not directly adjacent to a storage tank, then a contact tank should be constructed nearby if disinfection equipment is installed, in lieu of installing a raw water line to the nearest storage tank. Based on the most recent pumping rate for Well No. 3, in order to provide a typical standard minimum of 30 minutes of disinfection contact time, a new 18,000 gallon storage tank would be needed at the Well No. 3 site, along with a various amount of yard piping modifications. Another option for providing treatment at the remote Well No. 3 site would be to install in-line UV equipment which would eliminate the need to install a contact tank and chlorine disinfection equipment.

There are other options for providing disinfection of the groundwater supply source. However, in year's past, chlorine disinfection has typically been the most cost effective solution. In the event the City would move forward with implementing disinfection treatment at the well sites, it is recommended that a preliminary review of these various options be conducted to establish the most economically feasible solution for each specific well site.

C. Storage

The City of Nixa currently has a total of 3,500,000 gallons of water storage throughout the water distribution system. As previously discussed, Section 7.1 of the MoDNR Design Guide for Community Water Systems recommends that public water systems provide nominal finished water storage capacity equal to or greater than one day's average demand as well as a minimum design needed fire flow volume for the length of the fire duration. Table VIII-2 lists the projected average day demand and the additional storage recommended during the planning period for the entire system.

TABLE VIII-2
PROJECTED AVERAGE DAY DEMAND & RECOMMENDED ADDITIONAL STORAGE

Year	Average Day Demand (GPD)	Additional Storage Rec. (gallons)
2012	2,607,802	0
2013	2,679,516	0
2014	2,753,203	0
2015	2,828,916	0
2016	2,906,711	0
2017	2,986,646	0
2018	3,068,779	0
2019	3,153,170	0
2020	3,239,882	0
2021	3,328,979	0
2022	3,420,526	0
2023	3,514,590	14,590
2024	3,611,242	111,242
2025	3,710,551	210,551
2026	3,812,591	312,591
2027	3,917,437	417,437
2028	4,025,167	525,167
2029	4,135,859	635,859
2030	4,249,595	749,595
2031	4,366,459	866,459
2032	4,486,536	986,536

As indicated in Table VIII-2, the City of Nixa currently has an adequate amount of storage capacity throughout the water supply system to meet the current MoDNR requirements for storage. The recent installation of the new 1,000,000 gallon High Pointe Elevated Storage tank in 2011 greatly increased the total capacity of the storage system. Since all of the overflow elevations are relatively the same, and the fact that the storage capacity is elevated, then all of the storage volume can be considered useable. Typically, only the storage volume that produces a pressure of 20 psi at the base of the tank can be considered as useable storage volume. Even though it appears that additional storage is not immediately required, it is recommended that a new storage tank be considered for installation either at the same time, or in the next few years after a new well installation.

As previously discussed, the relatively small volume (100,000 gallons) and location of Tank No. 1 has caused issues with the volume of the tank being quickly depleted during higher demand periods. An option to alleviate this issue, and at the same time providing more storage in the central, higher demand areas of the service system, would be to replace the existing 100,000 gallon tank with a 300,000 gallon tank at the same location. This alternative would provide added storage in the central area of the City, potentially reduce the required runtimes of the corresponding well pumps, and ease the concern of the tank becoming completely empty during high demand periods.

At the time the City chooses to install their next water storage tank, there are options of which type of tank is constructed in order to provide the necessary water storage. Elevated storage can be constructed in several different styles and is typically the easiest to operate. The most common styles for the recommended sizes are multi-legged, single pedestal, fluted, and composite. Examples of multi-legged tanks can be found in the City of Rogersville, Sparta, and Springfield. The City of Ava, Republic, and Ozark; as well as the City of Nixa, contain examples of single pedestal tanks. Also, the water storage systems of the Nixa and West Plains are equipped with examples of a 1,000,000 gallon composite style elevated tank. Ground storage tanks are also a viable solution to additional storage needs, but require the installation of booster pumping equipment. Typically, the initial capital cost associated with a ground storage tank and booster pump station is lower than that of an elevated tank; however, long term operation and maintenance costs are typically lower for elevated storage tanks. Prior to the installation of the High Pointe Elevated storage tank, the City conducted a study to compare the various styles of elevated tanks and ground storage tanks. This document would be a good reference for determining the type and style of the future water storage tank. At the time of detailed design of the recommended additional water storage tank, all options should be at least preliminarily investigated.

Any future tanks should be provided with a separate inlet and outlet pipe of the water supply. This is needed to prevent short circuiting of the flow should future disinfection of the groundwater source be installed. Separate piping will facilitate the necessary contact time in the storage tank for the chlorine disinfectant chemical. Some of the existing tanks; however, are not currently equipped with a separate inlet and outlet pipe. Existing Tanks No. 1 through No. 4 are not equipped with a separate inlet and outlet pipe. Modifications to the existing tanks would require the installation of a new pipe for each, as well as modification of the yard piping so that raw groundwater would pass through the adjacent storage tank prior to entering the distribution system.

In addition to adding storage capacity to the system and infrastructure improvements to the existing tanks, it is also very important that the existing tanks be inspected and maintained on a regular basis. This is important to the continued operation of the existing tanks and proper maintenance will provide for a longer useful life of each of the existing tanks. Therefore, it is recommended that each of the tanks be inspected on a rotational basis so that no tank goes more than five years between inspections. This will allow the City to discover potential small problem areas prior to those issues growing into larger and more costly maintenance items. Based on previous records, it appears Tank No. 4 and No. 5 are in need of the next overall inspection, both on the coating system and miscellaneous accessories associated with the tank.

D. Distribution System

In general, the City of Nixa's water system appears to have sufficient water line sizes throughout the service area to effectively move water to customers under the average and maximum day demand events. However, some areas served by only 6-inch diameter or less lines are limited in regards to pressure and available fire flow. In a perfect scenario, all of the existing, smaller diameter water lines would be replaced with larger diameter lines (i.e. 6-inch and larger) to allow better distribution of water flow, especially during maximum day and fire demand events. However, due to the vast size of the City's water system and the number of existing, smaller diameter lines, replacement or upgrade of all of these lines would not be economically feasible. While increasing the water pressure in high-elevation areas will also be difficult and/or expensive with the current water tank overflow elevations, strategic water line improvements throughout the City can improve pressures during times of high demand and increase the available fire flow to under-served areas.

One of the objectives of this study's analysis was to determine strategic water line improvements that would assist areas that, as indicated by the hydraulic model, are experiencing lower than the desired fire flow during a maximum day event and areas that have reduced pressures during the maximum day events. Another item that was considered when determining potential water line improvements was long-term needs that will be development driven. The proposed water line improvements listed as development driven are those the City should be aware of and take into consideration as development occurs within these areas. This will allow the City to plan for the proper expansion of the water distribution system to provide the most efficient operation as development occurs within the service area. These water line improvements are shown in Exhibit 6A and 6B along with the approximate length and diameter of the new or replacement water line proposed. Table VIII-3 summarizes each proposed water line improvement.

TABLE VIII-3
SUMMARY OF PROPOSED WATERLINE IMPROVEMENTS

Area # per Exhibit 6A & 6B	Description of Distribution System Improvement
Proposed Short-Term Improvements	
1	Upgrade ex. 6" W.L. to 10" W.L. from Tank 2 west along Tower St. to McCroskey St.
2	Upgrade ex. 4" W.L. to 8" W.L. along Fort Ave. from W. Aven Ave. to McConnell St.
3	Upgrade ex. 4" & 6" W.L. to 10" W.L. along Main St. from Hillside Dr. to Gene St.
4	Upgrade ex. 4" W.L. to 10" W.L. along Main St. from Gene St. to Walnut St.
5	Install 8" W.L. along Tracker Rd. from N. Gregg Rd. to Eaglecrest St.
6	Install 8" W.L. along Tracker Rd. from Eaglecrest St. to Hwy 160
7	Upgrade ex. 6" W.L. to 8" W.L. along S. Nicholas Rd. from Hi-Mac Rd. to Vintage Ln.
8	Install 8" W.L. at the south end of Truman Blvd. to S. Bryant St.
9	Install 8" W.L. from Tank No. 5 site south to Bluegrass Rd.
10	Install 12" W.L. along Inman Rd. from S. Ballard Dr. to Nicholas Rd.
Development Driven Improvements*	
A	Along Ozark St. from SE Hills Dr. to Old Bittersweet Rd.
B	Extension along Northview Rd. west to Nicholas Rd.
C	Looped line north along Cheyenne Rd. from Tank No. 7 then west along Hwy CC to Wicklow
D	Looped line west along Hwy CC from Wicklow Sub. To Main St. then south to Tracker Rd.
E	Along future extension of Hwy CC west of Main St. to Bentwater Sub.
F	Along future extension of Old Castle Rd. south to the Springs Sub.

* Sizes of the proposed development driven waterline improvements have not been established due to the unknown type of development (residential, multi-family, commercial, industrial, etc...) that may be constructed in these areas. A thorough analysis is recommended at the time each development type occurs.

The ideology used when determining the initial proposed improvements was based on improving the main lines that feed specific areas throughout the City. It would not be beneficial to upgrade the smaller lines serving smaller areas if the main lines feeding these areas were insufficient in size. Improvements 1 and 2 are necessitated by the need to provide better distribution of flow from the supply and storage of Well No. 4 and Tank No. 2 located at the old City park. Currently, there are 6" diameter mains feeding the system from the water supply source. Upgrading these lines will allow for better flow distribution to the north and to the older sections of the City along Aven Avenue, Bennet Street, Park Street, and McConnell Street that have lower than the desired fire-fighting flow rate. Additional upgrades will be needed that service these areas; however, the water main

improvements listed will allow less restricted flow to these areas. Improvements 3 and 4 were selected to improve flow to, not only, the older portion of the City along State Street and Walnut Street, but also, to provide better flow distribution to the areas and subdivisions along south Main Street.

Improvements 5 and 6 are identified as improvements that will provide more direct looping of the water mains from the Well No. 8 and Tank No. 6 site along Tracker Road, which will allow the distribution system to utilize the supply source and storage more effectively. There are sinkholes located along Tracker Road; therefore, precaution will need to be taken when installing these lines for proper stabilization or easements to avoid the sinkhole altogether. Improvements 7 and 8 either upgrade existing smaller lines or install new lines that provide better flow distribution or additional water system looping. Improvement 9 is identified so that the distribution system can better utilize the water supply and storage from Well No. 7 and Tank No. 5 site. This improvement will allow for a more direct feed to the areas south of this well and tank site, increasing the flows to these areas.

All of the proposed improvements listed in Table VIII-3 were input into the hydraulic model and run under the maximum day demand scenario so that the benefits of the proposed improvements could be quantified. Upgrades 1 and 2 provided better flow distribution from the well and tank site at the old City park; however, in order to fully benefit from these improvements, the City will need to methodically upgrade the existing 2" and 4" water lines in the areas from Aven Avenue south to Walnut Street. Upgrades 3 and 4 improved the flow distribution along Main Street from Walnut Street south to Pinehill Street. All of the connection points to this main line had increased flow. Installations 5 and 6 not only provided better looping of the water mains in the north portion of the service area, but also increased the available flow to the Bentwater Subdivision located on the extreme north end of the distribution system. Upgrade 7 eliminated the 6" bottleneck between two 8" mains which improved flow to the subdivisions located on the western edge of the distribution system. Installation 8 provided for additional looping of the water distribution system in the central portion of the system. And, installation 9 provided improved utilization of the well and tank site at the high school. This improvement increased flow to the areas south of the well and tank site and provided a secondary feed from the site in the event the main to the north is not available. Exhibit 8 indicates the available flow analysis with the proposed distribution system improvements 1 through 9 implemented into the system under the maximum day demand scenario.

In general, the City currently installs 8-inch or greater diameter water line to sustain fire-flow hydraulic capabilities. Of course, whenever an opportunity arises to upgrade the size

of a water line, it is recommended to do so. Ideally, the cost for water line extensions along the major highway corridors should be paid, at least in part, by the developer. For instance, as more development occurs along south Highway 13, north Highway 13, Highway CC, east Highway 14, and Cheyenne Road, significant waterline extension costs will be incurred. The City should expect at least some of this burden to be shouldered by the developers of the area.

The City should continue to budget for and perform distribution system improvements on an annual basis. Any existing, older iron or transite pipe in the distribution system should be replaced with the City's current standard piping material, ductile iron or PVC, to mitigate line breaks and to improve the integrity of the system. Transite pipe is known for being brittle and subject to cracking over time. Older iron lines should be inspected whenever possible to determine if replacement is warranted. As old and small diameter water lines are replaced, the water loss exhibited by the system will decrease, and the City will be in a better position to meet peak demands while maintaining appropriate system pressures.

To ensure adequate water line sizes and proper design analysis is performed for future developer-driven water system improvements, Nixa should continue to enforce the requirement that developers are to submit construction plans, specifications, and calculations showing that the proposed water system improvements will provide adequate pressure to the area of development as well as the minimum fire flow dictated by the City. If sufficient pressures cannot be provided due to elevation or water line constraints, the City and developer should work together to determine what improvements are needed and how the cost should be allocated. The City's hydraulic model can be used to evaluate improvement options.

The City should dictate water line improvements based on long-term objectives such as those outlined in this Master Plan and utilize cost-sharing opportunities with developers to increase water line sizes for major transmission lines. All water system improvements for new developments should be designed by an engineer registered in the State of Missouri and subsequently constructed as needed, either by City forces or by the developer with City inspection. Additional loops and interconnections within the distribution system should be proposed as part of future projects as practical. The ability to complete additional improvements may depend on accessibility to right-of-way and the existing water lines.

E. Available Fire Flow

One method for evaluating a water system's ability to provide fire protection involves using the Fire Suppression Rating Schedule provided by the ISO. This method uses information on the supply and storage facilities of the existing system along with current and projected maximum day usage to calculate the system supply capabilities based on a given fire flow duration. The capabilities of the system, or Supply Works Capacity (SWC), is determined by adding the minimum storage (MS) available, divided by the fire flow duration, to the pumping capacity (PU) of the groundwater wells. The maximum daily consumption (MDC) is then subtracted from this total to determine the final system capacity. For a 2-hour duration, the available supply should be up to 2,500 gpm and for a 3-hour duration, the available supply should be 3,500 gpm, per the ISO Fire Suppression Rating Schedule.

The minimum storage (MS) is based on the current available storage volume of 3,500,000 gallons. However, due to the fact this analysis is calculated during a maximum consumption event, the minimum storage available for fire suppression will be based on only 30% of the current storage capacity to represent the likelihood of low water levels in the tanks when the fire flow is demanded. This equates to a minimum storage volume of 1,050,000 gallons. Conversion of this volume for the 3-hour duration equates to 5,833 gpm. The pumping capacity (PU) of the existing groundwater well pumps is based on all of the wells pumping except for the largest well being out of service. This flow rate is 4,550 gpm, as previously discussed. The maximum daily consumption (MDC) is based on the maximum day demand that has been calculated for the current and projected demands on the system. A detailed discussion of the current and calculated maximum day demand is located in Section VII.C. Based on this information, the following Table VIII-4 indicates the calculated supply works capacity (SWC) of the water system over the planning period.

TABLE VIII-4
FIRE SUPPRESSION RATING SCHEDULE ANALYSIS
SUPPLY WORKS CAPACITY

Year	Minimum Storage (MS)	Pumping Capacity (PU)	Minimum Daily Consumption (MDC)	Supply Works Capacity (SWC)
2012	5,833	4,550	3,536	6,847
2013	5,833	4,550	3,633	6,750
2014	5,833	4,550	3,733	6,650
2015	5,833	4,550	3,835	6,548
2016	5,833	4,550	3,941	6,442
2017	5,833	4,550	4,049	6,334
2018	5,833	4,550	4,161	6,222
2019	5,833	4,550	4,275	6,108
2020	5,833	4,550	4,393	5,990
2021	5,833	4,550	4,513	5,870
2022	5,833	4,550	4,638	5,745
2023	5,833	4,550	4,765	5,618
2024	5,833	4,550	4,896	5,487
2025	5,833	4,550	5,031	5,352
2026	5,833	4,550	5,169	5,214
2027	5,833	4,550	5,311	5,072
2028	5,833	4,550	5,457	4,926
2029	5,833	4,550	5,607	4,776
2030	5,833	4,550	5,762	4,621
2031	5,833	4,550	5,920	4,463
2032	5,833	4,550	6,083	4,300

Table VIII-4 indicates that the current system meets the minimum 3,500 gpm fire flow requirement for a 3-hour duration through 2031. Also, note that the storage capacity available and pumping capacity is based on the current system and does not include the addition of future wells and storage tanks. These additional facilities will provide ample storage and pumping capacities to meet the Fire Suppression Rating Schedule requirements. Also, using only 30% of the available total storage is a conservative estimate, indicating that the ability of the system to provide the required fire flow for a 3-hour duration is better than that shown in Table VIII-4.

F. Water System Facilities Maintenance

The existing well and well house sites should be regularly inspected for routine maintenance and a wellhead protection program should be implemented based upon recommendations from the MoDNR's Source Water Assessments. The electrical service provided to each supply well should be inspected annually by a certified electrician and maintenance performed based on the inspection recommendations. Raw water lines should be maintained similar to potable water distribution system lines, including easement documentation and enforcement.

Water supply, storage, and distribution system maintenance should be included in each annual budget and performed as needed based on deficiencies or improvements noted by water department staff. The back-up power supplies should be regularly exercised and inspected by a certified electrician and maintained for optimum performance. The water system's controls and SCADA equipment should be regularly inspected and maintained by the equipment manufacturer's trained representatives.

The City should continue efforts to reduce water losses by replacing inadequate water lines, fire hydrants and meters, and identifying meters that are not being read or billed regularly. Additional water system maintenance that should continue to be undertaken by the City includes implementing a valve locating and routine preventive maintenance plan, cutting in additional isolation valves as well as updating the City's water system map as improvements are installed to improve its accuracy and sharing information and resources with the Nixa Fire District to achieve adequate fire protection. As previously discussed, the City should regularly inspect the system's elevated storage tanks and should budget for the improvements recommended in the inspection reports and as discussed in the previous sections and consult with a properly licensed and qualified engineering firm if any questions or concerns arise from the recommendations.

In consideration of the above recommended maintenance items, it is recommended that the City develop a standard Operation & Maintenance (O&M) Manual for periodic maintenance of the above referenced items. This manual will provide a document that can serve as a checklist to be referenced and updated, as needed, for the routine operation and maintenance of the water system. The manual should include schedules for the regular maintenance of the water system's equipment and facilities; fire hydrant testing; procedures for water line, valve, and meter replacements; inspections; etc... This will assist the City with establishing standards for which to operate and maintain the water system

and allow new water department staff to quickly understand the responsibilities associated with running the water system.

G. SCADA Controls

As the existing SCADA technology fails or becomes unsupported by vendors, the module components will need to be replaced and/or upgraded to the latest SCADA technology. The SCADA equipment the City currently uses to control and monitor the water supply and storage system is outdated and lacks the capability to incorporate all of the current water system components. It is recommended that the City budget for the replacement of the existing SCADA telemetry system to the most up to date software and components. The new SCADA system should have the ability to control and monitor the water system wells, storage tanks, and system pressures. An upgraded system will promote more efficient operation of the current and future water system. Provisions should be implemented into the new SCADA equipment so it has the ability to be expanded in the future should new technology be developed. In addition to the installation of a new system, the City should routinely inspect the SCADA components and research any potential future upgrades that may be available that would provide a more efficient operation of the system. It is important for the City to properly budget, on a yearly basis, for maintenance of the SCADA system and any potential future upgrades, should the need arise.

Another motivation for the City to properly plan and budget for upgrades to the existing SCADA system is the potential for installation of disinfection equipment for water supply system. The implementation of disinfection practices will require a certain level of monitoring and control. As previously discussed, currently, the City is under the triggered monitoring as defined by the MoDNR Groundwater Rule. However, in the event a sample 'triggers' a violation, the City would then fall under the Compliance Monitoring portion of the MoDNR Groundwater Rule, which would require additional monitoring equipment and programming to prove the 4-log inactivation of viruses on a continual basis. This would require additional monitoring equipment, such as free chlorine and pH probes, and SCADA equipment with the ability to accept this new data and provide output of the 4-log calculation results. If the additional monitoring is required and equipment needed, it is recommended that the City coordinate with a registered professional engineer and equipment supplier to develop a control system specification for the needed equipment that can be used for the solicitation and bidding for the proposed project.

IX. RECOMMENDED SITES TO ACCOMMODATE PROPOSED IMPROVEMENTS

A. Supply

When additional raw water supply well sites are pursued by the City of Nixa, the new wells should be located approximately one mile away from any existing active City wells and in an area that is less susceptible to any known geologic peculiarities that may exist in the service area. Consideration must also be given to the amount of raw water line that would be required to transport the raw water from the supply well to an existing storage tank. Ideally, the new well would be installed at the same location as a newly constructed storage tank. According to correspondence with the MoDNR Department of Geology and Land Survey and investigation of groundwater data within the City's service area, it appears that the majority of the area is suitable for the supply of a usable amount and quality of groundwater. The main sources of potential contamination that should be considered when selecting a location for a future well is the abundance of sinkholes throughout the City's service area. These are typically direct conduits to shallow groundwater supply sources from surface runoff and have the greatest potential to contaminate the water supply. Therefore, the main items that should be considered should be the proximity to the existing producing wells, areas that are less susceptible to contamination, and anticipated areas of future growth for the City.

The City's existing wells likely have overlapping areas of influence with regards to the groundwater table. Any new groundwater supplies should be constructed away from this area of influence due to the fact that this overlapping effect puts an additional strain on the ability of the groundwater supply to recharge sufficiently, especially during drought or high demand conditions. Drawing a one-mile radius circle around each of the eight active wells establishes an inner boundary, outside of which a potential new well site can be examined, as indicated in Exhibit 7A and 7B. In an attempt to avoid man-made and natural obstacles such as major highways, railroads, sinkholes, and the Finley and James Rivers, which will increase the cost of sufficient water lines needed to connect the new well to the remainder of the distribution system, several locations were analyzed as potential well sites. Also, when determining the feasibility of a potential site, it was important to consider a potential elevated storage tank at the same site.

Upon examination of Exhibit 7A and 7B, it appears there are two most notable locations for a future groundwater well. The first location would be on the southern end of the existing distribution system. This would include locations along State Highway 13, the southern end of Main Street, the southern end of Gregg Road, and along Rosedale Road. The second

most general area would be located on the northeastern end of the existing distribution system. This would include areas along State Highway CC from Cheyenne Road to Main Street and the areas immediately south and east of the Wicklow Subdivision. All of the referenced areas are outside of the anticipated zone of influence of any of the existing groundwater supply wells. Both of the referenced areas do not appear to contain near as many sinkholes that could potentially serve as contamination sources as other areas throughout the City.

The amount of development within a specific direction will influence the final location for a new water supply well; however, based on the anticipated area for new growth for the City, it is recommended that the next new groundwater supply well be installed on the southern end of the City's service area. This location would provide coverage for the southern portion of the City's service area, and, due to the larger main line along Main Street, this location would provide another feed into the central portion of the water distribution system. The larger main lines along Rosedale Road, Gregg Road, and Main Street make it ideal for locating a new well in this general area. Also, this location is not on the extreme boundary of the City's potential growth area. This lends itself to being able to provide service in all directions of the groundwater source should the City's growth continue south.

A geohydrologic investigation of any potential well site along with a determination of well casing depth should precede construction of a future well. Exhibit 7A and 7B shows the potential locations described above for future groundwater wells to supply the City with future groundwater supply sources.

B. Treatment

The ideal location for future disinfection equipment would be immediately adjacent to the existing or future well sites. Due to the hazards associated with gas chlorination treatment, the new equipment and chemical supply would need to be housed in a room that can be isolated from the well house. This can come in the form of an expansion to the existing well houses that add an additional room to the existing buildings, using the same interior and exterior type of construction. Most of the existing well houses are brick and block type buildings; therefore, it is anticipated that an additional room could be added with modest effort.

Another option would be to house the disinfection equipment in a separate structure, such as a fiberglass type structure. This arrangement has been used quite extensively and could be adapted to each of the well sites. Each of the existing well sites appears to consist of

sufficient land area should either the well house expansion or separate structure option be chosen for housing the disinfection treatment equipment and chemical storage. It is recommended that future well houses be constructed with an integral, isolated room that will be designated for the installation of gas chlorine dosing equipment and chemical storage.

C. Storage

There are several criteria that must be considered when determining the most feasible location for a proposed elevated water storage tank. For the City of Nixa's water system, the criteria for locating new water storage facilities should include:

- Near large-diameter water lines;
- Situated at a high elevation to provide the greatest usable pressure with the shortest structure;
- Near heavy demand areas and/or areas anticipated to contain the most future development;
- Able to work hydraulically with the existing tanks and equipment;
- Readily accessible by tank erection equipment and City personnel;
- Land already owned by the City or available for purchase by the City.

A general area that meets many of the criteria listed above are similar locations as those described for the new groundwater supply wells. These areas are located on the southern and northeastern end of the existing distribution system, as previously described. The southern area is the location best suited for a future tank site due to the greatest potential for the City to grow in this area and direction. There are three locations in this southern portion of the service area that appear to be ideal for a new tank site. The first is the area immediately surrounding the City of Nixa's existing electrical substation along Rosedale Road. The elevation of the existing land immediately to the north and west of the substation site is approximately 1,300± feet (based on USGS mapping). With an overflow elevation of the existing water distribution system at 1,428.70 feet, that would equate to a tank height of approximately 130 feet. Another area is located on all corners of the intersection between Main Street and Rosedale Road. The elevation within this area is approximately 1,290± feet, which would equate to a tank height of approximately 140 feet.

The third location in the southern portion of the service area is located approximately ½ mile north of Rosedale Road along State Highway 13. This area has an elevation of 1,280± feet, which equates to a required tank height of approximately 150 feet. There is an area of higher elevation located north of the existing electrical substation along S. Norton Road; however, this area overlaps the zone of influence of an existing groundwater supply well as indicated by the one-mile radius boundaries illustrated on Exhibits 7A and 7B.

The other location discussed in Section IX.A is to the south and east of the existing Wicklow Subdivision on the northeastern end of the water distribution system. The elevation in this area ranges from approximately 1,290± feet to 1,320± feet. Even though this area is located at a relatively good elevation, and is outside of the anticipated zone of influence of the other well sites, it appears that this northern portion of the distribution system does not present the most pressing need for the immediate benefits that would be provided by a new storage tank. Growth in this direction appears to be limited to the north by existing county subdivisions and development to the east could be fed from the existing High Pointe elevated storage tank along Cheyenne Road.

All of these sites are located on existing agricultural land that is currently not developed, which generally makes it easier to acquire the necessary area for a tank and groundwater well installation. Also, there are already existing, larger diameter (12") water mains either immediately adjacent to or within close proximity to each of these locations. All of the proposed locations are shown on Exhibits 7A and 7B.

D. Distribution

The locations and descriptions of the proposed distribution system improvements within the planning area are summarized in Table VIII-3 and shown in Exhibit 6. The recommended improvements are based on providing additional flow to areas that currently are experiencing less than adequate flow rates, especially for fire suppression. Some of these locations will require construction along existing streets in densely populated areas; however, these improvements are needed to meet the fire flow capacity requirements of an adequately sized water system. In locations where new water lines are proposed, it is recommended that the City immediately begin discussions with property owners for obtaining the necessary easements for construction of the proposed improvements. In areas of line replacement/upgrade, existing easements should be available, but the City should verify the adequacy of any existing easements.

In addition to proposed improvements needed to increase flow to certain portions of the City, new water line extensions will be required as development occurs. The location and size of water line improvements will be dictated by the type of development and nearest surrounding utilities. It is anticipated that future growth of the City will occur in several infill areas throughout the current City limits. This will allow for the use of existing water lines, as well as looping/connection of existing water lines with new ones. As new development occurs in the infill areas, the adequacy of existing water lines should be evaluated to determine any needed upgrades. Also, it is anticipated that future development will extend south of the current City limits. Several additional water mains will be required to service these areas. Ideally, the development that occurs along the City's southern border and in infill areas within the current City limits will result in some cost-sharing opportunities for the City.

There will also be a certain level of unplanned development along with replacement and repair efforts that will occur both in the short-term and long-term that will necessitate distribution system improvements beyond what is described in this report. The City should continue to budget for a baseline level of water line improvements, including replacements and repairs, as well as insist on a cost-sharing strategy with developers when appropriate. This approach can be useful when an existing water line needs to be increased in size to meet a developer's specific needs. Other water line replacements should be considered on a case-by-case basis as cost-saving opportunities arise, such as during road or sidewalk replacement projects.

X. IMPLEMENTATION

A. Schedule

The improvements outlined in this Master Plan are proposed to allow the City to meet projected water demands through 2032, improve the efficiency of areas within the existing water distribution system, and provide maintenance of the existing assets of the water supply, storage, and distribution system. Accordingly, the improvements should be prioritized and phased into service based on the timeliness of impact and available funding. In consideration of the projections summarized in this report, Table X-1 associates a timeframe with the proposed water system improvements based upon the anticipated urgency and beneficial impact of each improvement. This schedule serves as a planning tool for use in the City's budget and funding strategy.

TABLE X-1
IMPLEMENTATION SCHEDULE FOR PROPOSED WATER SYSTEM IMPROVEMENTS

Water System Improvement	Proposed Timeframe for Completion
Construct additional groundwater supply well (Well No. 10).	2013
Construct new elevated storage tank (Tank No. 8)	2015
Construct new piping for Tank No. 1, No. 2, No. 3, and No. 4 to provide separate inlet/outlet piping.	2013 - 2014
SCADA System Upgrade	2013
Install disinfection equipment at each existing well site, including new chemical storage room/building.	2014 - 2015
Inspect, clean, and repaint Elevated Storage Tanks No. 4 and No. 5.	2013 - 2014
Construct additional groundwater supply well (Well No. 11).	2017
Construct new elevated storage tank to replace existing Tank No. 1.	2016
Distribution system improvements.	2013 - 2018
Obtain land/easements for future well and elevated storage sites.	Ongoing

B. Opinion of Cost

Based on the timeframe for completion, the water system improvements listed in Table X-1 can be further categorized as short-term, on-going, and development driven projects with

associated costs to facilitate budgeting and planning. Table X-2 summarizes the projects in this manner and associates a cost opinion with each of the proposed projects. A detailed breakdown of the cost opinions given is included in Appendix G. The short-term improvements listed in Table X-1 are projects that should be implemented within the next 5 to 6 years. The on-going projects include such items as yearly maintenance of the wells, well houses, storage tanks, and existing distribution system elements. The long-term projects consist of those that would be required based on additional development that occurs. These items are included in Table VIII-3, items A through G.

TABLE X-2
SCHEDULE AND CONSTRUCTION COST BREAKDOWN FOR PLANNED WATER SYSTEM IMPROVEMENTS

Short-term Projects	Anticipated Date of Award	Opinion of Cost	Date for Completion
Construct Well No. 10	2013	$494,000	2014
Construct Existing Tank Inlet/Outlet Piping	2013	$367,000	2014
Inspect, Clean, & Paint Tank No. 4 & No. 5	2013	$489,000	2014
SCADA System Upgrade	2013	$100,000	2013
Install Disinfection Equipment	2014	$503,000	2015
Construct Tank No. 8	2014	$2,066,000	2015
Replace Tank No. 1	2015	$1,264,000	2016
Construct Well No. 11	2016	$564,000	2017
Distribution System Improvements (1 - 9, Table IX-2)	2013 -2017	$1,916,000	2014 - 2018
Total Opinion of Cost for Short-Term Projects:		**$7,596,000**	
Long-Term and On-Going Projects	**Anticipated Date of Award**	**Opinion of Cost**	**Date for Completion**
Construct Well No. 12	2025	$700,000	2026
Construct Tank No. 9	2028	$2,200,000	2029
Distribution System Improvements (A - G, Table IX-2)	Development Driven	Unknown	Development Driven
Existing Well & Well House Maintenance	On-going	$25,000/yr	On-going
Existing Elevated Storage Tank Inspection	On-going	$30,000/yr	On-going
Existing Distribution System Maintenance	On-going	$45,000/yr	On-going

The costs presented in Table X-2 are for capital improvements that can be incorporated into the City's water department budget. The City should work towards budgeting for the planned improvements associated with the water system throughout the planning period accordingly.

C. Project Financing

In the previous sections of this Master Plan, the recommended improvements to the City of Nixa's water supply, treatment, storage, and distribution system were analyzed and developed. In order to proceed with the proposed water system improvements, the City will need to approve the Water System Master Plan and its recommendations. Upon approval of the proposed improvements by the City, the Master Plan should be submitted to the Missouri Department of Natural Resources (MoDNR) for review and then proceed with engineering detailed design plans and pursue project financing for the improvements listed in Table X-2. The City will need to include in the water system's yearly operating budget provisions for operation and maintenance of, not only the existing facilities, but also any newly installed facilities. It is anticipated that the majority of the financing for the proposed improvements will be provided through loans, secured by Bonds. A portion of the funding may be available from current funds in the City's Water Fund. However, the passage of a bond issue may be required to secure the proper amount of loans. The City should investigate all avenues for potential funding/loan sources, including MoDNR-SRF, United States Department of Agriculture-Rural Development (USDA-RD), Community Development Block Grants (CDBG), and private funding sources. The City of Nixa may not be eligible for all of the funding sources listed. The most probable source for funding of the proposed improvements is through the MoDNR-SRF loan program.

User charges will need to be adjusted accordingly to ensure that water system revenues are adequate to fund the proposed improvements. The City currently sells water to areas both inside and outside the City Limits. Different user rates have been established for each category of user. Residential customers inside the City Limits are charged $6.59 for the first 2,000 gallons and $2.25 for each additional 1,000 gallons for the next 3,000 gallons used, which equates to a monthly charge for a typical usage of 5,000 gallon of $13.34. Customers outside the City Limits are charged $9.89 for the first 2,000 gallons and $3.37 for each additional 1,000 gallons which equates to a 5,000 gallon monthly charge of $20.00. The City of Nixa currently has a total of 7,688 current customer connections. Based on the amount of improvements that will be implemented, the City will need to increase the current water rates to the amount needed to cover the projected loan payment for the length and terms of the acquired loan.

It is typically undesirable to increase water billing rates by significant amounts in short periods of time. However, the need for the proper amount of water system improvements required to provide the City's water customers the necessary services are of the utmost importance. Based on the results of this report, the short-term construction items included in Table X-2 are high priority public improvements needed to meet current and future system demands. Using the opinion of probable construction cost developed for each proposed project, the following Table X-3 was developed to indicate potential yearly increases to the existing water rate structure:

TABLE X-3
WATER RATE INCREASE CALCULATION FOR PROPOSED WATER SYSTEM IMPROVEMENTS

2013	
Anticipated Capital Improvements:	
Well No. 10	$494,000
Existing tank Improvements (Inlet/Outlet Piping)	$367,000
Inspect, Clean, & Paint Tank No. 4 & No. 5	$489,000
Distribution System Improvements (1/4 of total)	$479,000
SCADA System Upgrade	$100,000
Annual Well, Storage, & Distribution Maintenance	$100,000
Subtotal:	$2,029,000
Debt Service:	
Annual Payment (Principal & Interest)(Assumed Loan Terms – 20 yrs, 5.0%)	$105,946
Annual Payment per Connection (2012 Total Connections = 7,688)	$13.78
Monthly Rate Increase per Connection	$1.15
Water Rate:	
Proposed 2013 Base Rate	$7.74

2014	
Anticipated Capital Improvements:	
Disinfection Equipment at Existing Well Sites	$503,000
Tank No. 8	$2,066,000
Distribution System Improvements (1/4 of total)	$479,000
Annual Well, Storage, & Distribution Maintenance	$100,000
Subtotal:	$3,148,000
Debt Service:	
Annual Payment (Principal & Interest)(Assumed Loan Terms - 20 yrs, 5.0%)	$164,376
Annual Payment per Connection (2013 Total Connections = 7,879)	$20.86
Monthly Rate Increase per Connection	$1.74
Water Rate:	
Proposed 2014 Base Rate	$9.48
2015	
Anticipated Capital Improvements:	
Distribution System Improvements (1/4 of total)	$479,000
Annual Well, Storage, & Distribution Maintenance	$100,000
Subtotal:	$579,000
Debt Service:	
Annual Payment (Principal & Interest)(Assumed Loan Terms - 20 yrs, 5.0%)	$30,233
Annual Payment per Connection (2014 Total Connections = 8,095)	$3.73
Monthly Rate Increase per Connection	$0.31
Water Rate:	
Proposed 2015 Base Rate	$9.79

2016	
Anticipated Capital Improvements:	
Replace Tank No. 1	$1,264,000
Distribution System Improvements (1/4 of total)	$479,000
Annual Well, Storage, & Distribution Maintenance	$100,000
Subtotal:	$1,843,000
Debt Service:	
Annual Payment (Principal & Interest)(Assumed Loan Terms – 20 yrs, 5.0%)	$96,234
Annual Payment per Connection (2015 Total Connections = 8,318)	$11.57
Monthly Rate Increase per Connection	$0.96
Water Rate:	
Proposed 2016 Base Rate	$10.75
2017	
Anticipated Capital Improvements:	
Well No. 11	$564,000
Annual Well, Storage, & Distribution Maintenance	$100,000
Subtotal:	$664,000
Debt Service:	
Annual Payment (Principal & Interest)(Assumed Loan Terms - 20 yrs, 5.0%)	$34,671
Annual Payment per Connection (2016 Total Connections = 8,547)	$4.06
Monthly Rate Increase per Connection	$0.34
Water Rate:	
Proposed 2017 Base Rate	$11.09

There are several unknown or assumed variables that were assigned when calculating the proposed water rate increases. The projected number of connections for each corresponding year was based on the calculated values indicated in Table VI-1. The terms of a potential long term loan were assumed be 20 years at a 5.0% annual interest rate. More favorable loan terms (i.e. longer term, lower interest rate) would potentially result in smaller yearly rate increases. Over the five year period indicated in table X-3, the calculated results indicate that the City would need to increase their base rate from $6.59 to approximately $11.09 for a total increase of approximately $4.50. In order to keep yearly rate increases low, but yet still providing the necessary revenue to pay for the proposed

improvements, it is recommended that, at a minimum, the City consider a base rate increase of $1.00 per year for the next 5 years.

The calculations performed to develop Table X-3 used a simplistic approach to an increase in the base residential rate. It is recommended that the City of Nixa conduct a detailed rate study for the water system based on the recommended short-term and long-term improvements listed in this Master Plan, the current rate structure, and the required rate structure to fund both short and long-term projects, as well as operation and maintenance of these facilities. This will allow the City to define more specifically the water rate structure for each category (residential, commercial, inside city, outside city) and could allow the City to increase rates in a much more gradual manner by implementing smaller, yearly rate increases.