



Monroe, Ohio

2007 Water Master Plan Update

May 2007



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Abbreviations

ADD	Average Daily Demand
BCDES	Butler County Department of Environmental Services
BPS	booster pumping station
EA	Each
gcpd	gallons per capita per day
gpd	gallons per day
gpm	gallons per minute
HGL	Hydraulic Grade Line
ISO	Insurance Services Office
LF	linear feet
MDD	Maximum Daily Demand
MG	million gallons
MGD	million gallons per day
msl	mean sea level
NFPA	National Fire Protection Association
PRV	Pressure Reducing Valve
psi	pounds per square inch
SR	State Route
WTP	Water Treatment Plant

1.0 INTRODUCTION

Introduction

The City of Monroe authorized this update of the 2001 Water Master Plan (prepared by ARCADIS, formerly Finkbeiner, Pettis and Strout) to enable City officials to make informed decisions regarding the water distribution system, storage, and treatment facilities. Specifically with respect to the City's planned 0.75 million gallon (MG) elevated storage tank, this update will evaluate the need for and location of addition water storage. This update was authorized in October 2006.

In the 2001 Water System Master Plan, several alternatives were presented to improve water supply and pressure to various parts of the water distribution system. Some improvements, such as the shared Middletown-Monroe Elevated Tank and permanent connections to the Butler County water distribution system, have been constructed and are in service. Other improvements, such as increased elevated storage and supply to the east service area from Middletown, have not been implemented and may no longer be optimal or relevant for various reasons.

This Master Plan Update will review the impact of recent system improvements and develop improvement alternatives based on an evaluation of the current operating state of the water distribution system, water treatment facilities, and supply sources.

During the course of the Master Plan Update, the computer model of the City's water distribution system was updated and used to evaluate various decision alternatives.

Water Master Plan Study Area

The study area for the Water System Master Plan includes all areas inside the corporation limits for Monroe. The service area and the City are bounded on the north by the City of Middletown, on the east and southeast by Warren County, on the south by Butler County, and on the West by the Great Miami River.

Water customers in the study area obtain their water from one of three sources:

- Monroe Water Treatment Plant • Serves areas east of South Yankee Road and north of Hamilton-Lebanon Road (SR 63);

- Butler County • Serves areas south of State Route 63 and areas between Hamilton-Middletown Road (SR 4) and the Great Miami River; or,
- Middletown • Serves area west of South Yankee Road not served by Butler County Department of Environmental Services (BCDES). (The Middletown-Monroe elevated tank is shared between Middletown and Monroe).

Since the 2001 Master Plan, the area served by BCDES has expanded and supplies approximately 40 percent of Monroe's water demand. Middletown provides approximately 17 percent of water demands on the west side of the City, while the Monroe Water Treatment Plant accounts for the remaining 43 percent of water demand for the service area.

2.0 EXISTING WATER FACILITIES

An overview of Monroe’s existing water supply, treatment, distribution, and storage system is provided in this section. Infrastructure for the system includes raw water wells, a water treatment plant, pumping facilities, distribution system piping, pressure reducing facilities, and storage tanks. The locations of these infrastructure components are shown in Figure 2-1. The only pumping facility is located at the City’s water treatment plant (WTP).

Raw Water Supply Wells

Raw water for the WTP is supplied from four groundwater wells drawing from the Great Miami Buried Valley Aquifer System. Total yield for the supply wells is 1,500 gallons per minute (gpm), or 2.16 million gallons per day (MGD). The age, depth and well yields are summarized in Table 2.1.

Table 2.1 Raw Water Supply Well Data				
Well No.	Year Installed	Depth to Bottom of Well Screen	Casing Diameter	Yield (gpm)
3	1953	137 ft.	12 in.	400
4	1961	139 ft.	12 in.	400
5	1967	139 ft. (est.)	12 in.	250
6	1979	139 ft.	12 in.	450
Total Yield				1,500 gpm (2.16 MGD)

Water Treatment Plant

Monroe’s WTP provides iron and manganese removal of ground water. Prior to filtration, the water is pumped from wells and the iron is oxidized by induced draft aerators. After aeration, the water is filtered for iron precipitant and manganese in the pressure filters. Following the filtration process, the water is softened by ion-exchange to remove calcium and magnesium hardness. Before storage in the clearwell, it disinfected with chlorine and fluoridated.

A 1994 WTP expansion increased in the treatment capacity from approximately 1.25 MGD to 1.6 MGD. This expansion also added a maintenance facility incorporating a laboratory, office space, and vehicle storage on the south side of the WTP building.

The WTP incorporates four high service pumps for delivering the treated water to the distribution system. Pumps Nos. 1 and 2 are rated at 300 gpm, Pump No. 3 at 650 gpm and Pump No.4 at 750 gpm. The pumps are controlled by radio telemetry from a level indicator in the Britton Lane Standpipe.

Distribution System Piping and Pressure Reducing Valves

The distribution system piping is comprised of transmission and larger mains located along major roads and through industrial/commercial areas with smaller distribution piping branching out through residential areas. Transmission piping is typically 12 inch diameter but varies from 8 to 16 inches as was needed at the time the improvements were constructed.

Most piping within the distribution system is cast iron or ductile iron. There are some sections of asbestos-cement piping (transite) at various locations.

Following is an inventory of the City’s water distribution piping.

Table 2.2 Distribution Piping Inventory	
Pipe Diameter	Total Length (Feet)
6"	134,044
8"	110,762
10"	29,319
12"	51,391
16"	600

Figure 2-1 shows the existing distribution system piping, service area zones, and location of storage tanks.

Distribution System Service Areas

The service area is currently divided into four separate service areas (zones). These zones are isolated from each other by system valves and either operate under a different maximum hydraulic grade line (HGL) or are supplied from different sources. The maximum HGL is nominally equal to the overflow elevation for the water storage tank in its respective zone. In the absence of a water storage tank, the HGL can be

established by a pressure reducing valve or pumping station that supplies pressure to the zone. The pressure zones are described as follows:

- East • Areas east of South Yankee Road and north of Hamilton-Lebanon Road (SR 63) and all incorporated areas east of Interstate 75. This pressure zone has a maximum HGL of 960 feet above mean sea level (msl);
- South • Areas south of State Route 63 and east of South Yankee Road. This pressure zone has a maximum HGL of 960 feet msl;
- West • Area west of South Yankee Road not including area to southwest between State Route 4 and Great Miami River and areas south of State Route 63. This pressure zone has a maximum HGL of 860 feet msl;
- Southwest • Area between Hamilton-Middletown Road (SR 4) and the Great Miami River and areas south of State Route 63. This pressure zone has a maximum HGL of 1,000 feet msl. Because this zone is currently supplied directly by Butler County and is not metered into the Monroe water system for distribution, no further discussion is required for this zone.

Pressure Reducing Valves

There are three pressure reducing valves (PRVs) related to the distribution system.

- BCDES PRV No. 1 • Located near the intersection of South Main Street (Cincinnati-Dayton Road) and Stillpass Way. This is a metered supply feed from the BCDES distribution system. This PRV and meter is maintained by Butler County DES.
- BCDES PRV No. 2 • Located near the Hankins Road and South Yankee Road. This is a secondary metered supply feed from the BCDES distribution system. This PRV and meter is maintained by Butler County DES.
- Todhunter PRV • Located at the intersection of Todhunter Road and Holman Road. Installed concurrently with the construction of the Middletown-Monroe Elevated Tank to provide back-up supply to the West Zone at the correct zone pressure.

Distribution System Storage

There are four water storage tanks in the distribution system consisting of two standpipes and two elevated storage tanks. The Britton Lane standpipe is 22.5 feet in diameter with a maximum capacity of 400,000 gallons and an overflow elevation of 960. The East Avenue standpipe is 15 feet in diameter with a maximum capacity of approximately 130,000 gallons and has an overflow elevation of 960 feet above sea level. The Cemetery Elevated Tank has a capacity of 400,000 gallons with an overflow elevation of 960. The shared Middletown-Monroe elevated tank in the M.A.D.E. Industrial Park has a total volume of 1.5 MG, of which 500,000 gallons is designated for Monroe and has an overflow elevation of 860.

Although total volume for the standpipes is calculated from ground surface to overflow, usable volume for the standpipe is calculated from the water level that provides 40 psi at the tank base or the nearest customer. This will reduce the estimated usable storage volume cited in previous reports, most notably at the East Avenue Standpipe. The water storage facilities are listed in Table 2.3.

Table 2.3 Distribution System Storage and Pressure Zone					
Storage Tank	Total Volume (Gallons)	Usable Volume (Gallons)	Overflow Elevation (msl)	Ground Elevation (msl)	Zone
Britton Lane Standpipe	400,000	130,000	960	825	East
East Avenue Standpipe	130,000	10,000	960	861.5	South
Cemetery Elevated Tank	400,000	400,000	960	823	South
Middletown/Monroe Elevated Tank	1,500,000 (shared)	500,000	860	682	West
Total Volume	2,430,000	1,040,000			

3.0 WATER USAGE AND PROJECTIONS

Population

In the 2001 Water Master Plan, population data were updated and water use projections were made to year 2020. Previous projections were based on 150 housing starts per year, or roughly 2,600 new residents per year. For this update, the actual population for 2005 was added to the table. The previous population projection for 2005 made in the 2001 Water Master Plan was accurate. The census data and population projections are shown in Table 3.1.

Table 3.1 Population History and Projections		
Year	Census Data	Projected
1960	1,475	
1970	3,492	
1980	4,256	
1990	4,372	
2000	7,133	
2005	10,410	
2010		12,600
2015		15,200
2020		17,800
2025		20,400

Historical Water Usage

Table 3.2 shows historical water usage from 1995 to 2005. Water usage had been predicted for 2005 to be 1,400,000 gallons per day (gpd). However, operational records show that only 1,200,000 gallons were produced and/or billed indicating a water loss of approximately 14%.

Table 3.2 Historical Water Usage	
Year	Average Daily Water Use (gpd)
1995	793,000
2000	1,000,000
2005	1,200,000

Current Water Usage

Monroe’s current water usage is approximately 1.2 MGD. As of mid-July 2006, the service area zones have been isolated, which allows for an accurate accounting of water use by zone from billing and production records. From August through November 2006, the average daily demand (ADD) by zone is extrapolated on a yearly basis and presented below.

Maximum day demand (MDD) information is not available from the billing records from BCDES and Middletown. MDDs for the Monroe WTP have historically averaged about 1.75 times average daily demands. Therefore, it will be assumed that MDDs for the system are approximately 1.75 times the average daily demands as shown in Table 3.3.

Table 3.3 2006 Demands by Zone		
Zone	Average Daily Demand (gpd)	Maximum Daily Demand (gpd)
East (Monroe)	540,000	945,000
South (BCDES)	460,000	805,000
West (Middletown)	200,000	350,000
Total	1,200,000	2,100,000

Significant Water Users

Approximately 332,000 gpd is purchased by the City’s top 32 “significant” water customers. For this study, a significant water user is defined as having an average use greater than 50,000 gallons per month over the last 12 months. The following table shows the significant water usage by zone and as a percent of the demand in each zone. Nearly half of the average daily demand in the East Zone is from significant

commercial and industrial users. The breakdown of significant water user demand by zone is shown in Table 3.4.

Table 3.4 Significant Water Usage by Zone			
Zone	Average Daily Demand (gpd)	Significant Water User Demand (gpd)	Percent of zone demand (%)
East (Monroe)	540,000	245,000	45%
South (BCDES)	460,000	30,000	7%
West (Middletown)	200,000	60,000	30%
Total	1,200,000	335,000	28%

Water Usage Projections

The 2005 water use projections of the 2001 Water System Master Plan were calculated using an average demand of 140 gallons per capita per day (gcpd). Based on current usage records, it appears that the average usage may be reduced to 120 gcpd. As stated above, maximum daily demands are assumed to be 1.75 times the average daily projections. Table 3.5 shows the revised water usage projections to year 2025.

Table 3.5 Water Usage Projections		
Year	Avg. Daily Demand	Max. Daily Demand
2010	1,510,000	2,640,000
2015	1,820,000	3,190,000
2020	2,140,000	3,750,000
2025	2,450,000	4,290,000

These revised projections indicate that average and maximum day usage projections for year 2025 are nearly identical to previous projections for year 2020. In order to project water usage by zone, the 2025 water use projections were divided proportionally based on current usage percentages. These projections by zone are shown in Table 3.6.

Table 3.6 2025 Demand by Zone		
Zone	Average Daily Demand (gpd)	Maximum Daily Demand (gpd)
East (Monroe)	1,100,000	1,925,000
South (BCDES)	940,000	1,645,000
West (Middletown)	410,000	720,000
Total	2,450,000	4,290,000

This projection shows that by 2025 the maximum day usage in the East zone served by the Monroe WTP will exceed the 1.6 MG treatment capacity of the WTP. Possible solutions include increasing the City’s water production or moving some of the demand out of the East zone into adjacent zones as geography permits.

4.0 SYSTEM STORAGE EVALUATION

As stated in the Introduction, a key component of this update is to evaluate the City’s plan for constructing additional storage for the East Zone. At this time, the current plan is to erect a 0.75 MG elevated storage tank northeast of the intersection of North Main Street and State Route 63.

Per the Recommended Standards for Water Works (2003), the required storage must meet:

- Average daily consumption of the area served, and;
- Appropriate fire protection requirements as established by the state Insurance Services Office (ISO).

In industrial areas, the minimum fire flow requirement of 1,500 gpm for 4 hours (for large buildings) results in elevated storage tanks of at least 360,000 gallons. Furthermore, excessive storage is discouraged to prevent potential water quality degradation.

At current demand distributions, the required storage by zone (rounded to the nearest 100,000 gallons) is shown in Table 4.1.

Table 4.1 2006 Storage by Zone			
Zone	Average Daily Demand (gpd)	Existing Storage (MG)	Required Storage (MG)
East (Monroe)	540,000	0.40	0.60
South (BCDES)	460,000	0.53	0.50
West (Middletown)	200,000	0.50	0.50
Total	1,200,000	1.43	1.60

The East Zone is currently served by the Britton Lane Standpipe. This standpipe is not currently adequate to meet storage demands for the East zone. The WTP high service pumps pump directly into this zone and are controlled by telemetry to the Britton Lane Standpipe.

The South Zone is entirely served by two PRVs from Butler County DES. Currently the South Zone has adequate storage in the combined Cemetery Elevated Tank and the

East Avenue Standpipe if the total volume of the East Avenue standpipe is considered. However, if the standpipe is demolished, additional storage will be required in the zone. Telemetry controls should be added between the PRVs and the Cemetery Elevated Tank. This will allow the storage tanks in the zone to fill and draw as designed.

The West Zone is served by the Middletown-Monroe Elevated Tank. The 500,000 gallon allotment from that tank is adequate storage for this zone. It has been discussed that the West Zone could benefit from improved system pressures. Map contours show the highest elevations to be about 750 feet msl near State Route 4. The lowest elevations in the zone are about 660 near State Route 63, east of State Route 4. Considering these elevations, the current Middletown-Monroe Elevated Tank having a design HGL of 860 will supply the zone with pressures of 46 to 87 psi. Therefore, the pressures supplied by the elevated tank appear to be adequate for this zone. Fire flow adequacy will be discussed in the following section.

Based on the estimated future demands, Table 4.2 shows the projected storage requirements for year 2025. The table shows that additional storage will be required in the South and East zones by year 2025.

Table 4.2 2025 Storage by Zone			
Zone	Average Daily Demand (gpd)	Existing Storage (MG)	Required Storage (MG)
East (Monroe)	1,100,000	0.40	1.1
South (BCDES)	940,000	0.53	1.0
West (Middletown)	410,000	0.50	0.50
Total	2,450,000	1.43	2.60

In the following Section 5, computer modeling demonstrates that elevated storage located at North Main Street and State Route 63 should be implemented in order to provide the appropriate fire flows to the commercial-industrial area near I-75 and State Route 63. Further discussion in Section 6 indicates that if the Britton Lane Standpipe is rezoned into an area supplied by BCDES at some time in the future, then a storage volume of 0.75 MG at this location is recommended to serve the East Zone.

The elevated storage tank volume serving the West zone will remain adequate for the planning period.

5.0 DISTRIBUTION PIPING EVALUATION

The distribution system was evaluated for pressure, fire protection, redundancy of supply (looping), and transmission capability. Fire flow availability and system pressures were evaluated using the water distribution system computer model.

As part of the current update, ARCADIS evaluated the ability of the distribution system to provide fire flows. The Assistant Fire Chief was contacted to obtain the City’s fire flow requirements for areas zoned residential, commercial, industrial, and institutional. We were informed that the City has not established fire flow requirements on a group basis as requested and it was recommended that we calculate fire flow requirements using the ISO and NFPA (National Fire Protection Association) methodologies.

Calculating fire flows using these methodologies is a complicated procedure and is beyond the scope of this update. It requires a set of calculations for each building under consideration based on construction materials, distance to adjacent structures, and the type of activity, and processes or chemicals used in each building.

For this update, we evaluated the distribution system using fire flow values that our experience indicates could be appropriate for Monroe. In the following Table 5.1, The City’s zoning map was used to determine where the various fire flow ratings would apply. Residential (R-1, R-2) is for residential lots having between 31 and 100 feet between homes. Residential (R-3) is for residential lots having less than 31 feet between homes. Residential (R-4, R-5) is multi-family dwellings or condominiums. Institutional refers to schools, government buildings, and nursing homes.

Table 5.1 Fire Flow Protection Rates	
Zoning / Occupancy	Fire Flow (gpm)
Residential (R-1, R-2)	750
Residential (R-3)	1,000
Residential (R-4, R-5)	1,500
Commercial	1,500
Institutional	1,500
Light Industrial	1,500
Heavy Industrial	2,500

East Zone

As the system is currently zoned, there are widespread fire flow deficiencies in the subdivision west of the Britton Lane Standpipe. The most critical areas are on Wexford Drive (525 to 620 gpm), zoned R-3 and the north end of Heritage Green Drive (800 gpm), zoned R-5, in the condominium community. If this area is supplied from the South Zone in the future, the fire flows in this area become satisfactory because of increased connectivity across State Route 63. One exception is the east end of Wexford Drive. The 6 inch main on Wexford could be connected to the 8 inch main to the south with an 8 inch pipe, in addition to supplying from the South Zone, to correct the deficiency.

A second area of concern is near Heritage Green Drive and Macready Avenue. Modeling indicates that this area is delivering fire flows of about 1,400 gpm. The recommended fire flow for this area is 1,500 gpm because of the Kroger complex. Replacement of the 6 inch main along Macready Avenue from Heritage Green Drive to Britton Lane with a 12 inch will increase the available fire near Kroger to about 2,500 gpm.

In the industrial-commercial area near I-75, there are widespread deficiencies. This area is zoned commercial, light industrial, and heavy industrial. Available fire flows in this area range from 800 to 1,200 gpm. It was determined through computer modeling that the root cause of the fire flow deficiencies in the area is the transmission distance from the Britton Elevated Tank. Computer modeling indicates that the solution to providing adequate fire flows for this area is to construct an elevated tank closer to the area. An elevated tank placed at North Main and State Route 63 was modeled and found to provide improved fire flows. The addition of a 12 inch water main from Lawton Avenue to N. Main Street in addition to the new tank provided satisfactory fire flows for all areas, including the 2,500 gpm rates in the heavy industrial areas.

Lastly, the north end of Holman Road, zoned heavy industrial, can only deliver 1,500 gpm. Increasing the water main size on Holman Road is not sufficient to increase the fire flow. There are various alternatives to raise fire flows on Holman Road. One alternative is to replace the 6 inch water main from the Britton Lane to the new 12 inch main on Todhunter Road, north of Wicklow Lane and replacing the 6 inch main with 12 inch on Britton Lane from the standpipe to the Todhunter Road.

A summary of fire flow improvements for the East Zone includes:

- 750,000 gallon elevated tank at N. Main Street and State Route 63;
- Construct approximately 4,000 LF of 12 inch water main along State Route 63 between Lawton Avenue and N. Main Street;
- Construct approximately 350 LF of 8 inch water main from east end Wexford Drive to the 6 inch main to the east;
- Replace approximately 2,020 LF of existing 6 inch water main with 12 inch along Todhunter Road, from Britton Lane to new 12 inch main (north of Wicklow Lane);
- Replace approximately 1,920 LF of existing 6 inch water main with 12 inch along Britton Lane, from Deenen Drive to Todhunter Road.
- Replace approximately 3,050 LF of existing 6 inch water main with 12 inch along Macready Avenue from Heritage Green Drive to Britton Lane. (Computer modeling indicates that this improvement is not required if the South Zone is expanded across State Route 63.)

South Zone

In general, the South Zone has good pressure and fire flow availability. An area of lower pressure exists at the highest ground near the East Avenue Standpipe. Because of the fixed HGL of 960, the static pressures in the area will not improve.

An area of concern is in the vicinity of the elementary school on Macready Avenue. Fire flow analysis indicates that about 500 gpm is available in this area. A proposed solution is to replace the 6 inch main that runs from Church Street to Macready Avenue (under the school stadium) with a 12 inch main that runs from Lebanon Street to the intersection of Macready Avenue and Britton Lane. This new main would remain outside of the school stadium area. This improvement will also support water transmission north of State Route 63 if the South Zone is expanded to the north. If the South Zone is expanded northward, the school will have sufficient fire flow (> 1500 gpm) with the existing 6 inch main.

Areas of minor concern include the east end of Randy Drive and along Mason Road to I-75. Randy Drive is currently capable of delivering 900 gpm versus 1,000 gpm from Table 5.1. The 6 inch water main along Mason Road east of Gallaher Road is cast iron and known to be heavily tuberculated. If there are no customers requiring fire

protection along this main, then this improvement could wait until the area develops. No action on these areas is recommended at this time.

A summary of fire flow improvements for the South Zone includes:

- Replace approximately 2,000 LF of existing 6 inch water main with 12 inch main from Lebanon Street to Macready Avenue. (Computer modeling indicates that this improvement will not be required immediately if the South Zone is expanded across State Route 63.)

West Zone

The West Zone is known to have lower pressures and fire flow deficiencies along State Route 4 near the Fire Station and at the north end of the corporation boundary on State Route 4. Computer modeling showed that the entire zone was not capable of delivering the fire flows listed in Table 5.1.

Currently, the 6 inch and 8 inch main along Todhunter Road is being designed for replacement with a 12 inch main from State Route 4 to approximately 1 mile east of South Yankee Road. Computer modeling of the zone following this improvement indicates that nearly the entire zone will have adequate fire flows with few exceptions.

One exception is the north end of State Route 4 by the Garden Manor nursing home. Replacement of the 6 inch main along the east side of State Route 4 from Todhunter Road to north to the end of the system with 8 inch piping (approximately 2450 LF) will provide fire flows along that area above 1,500 gpm.

The second area of concern is the residential development along Dorothy Lane and Amity Lane. This area is supplied by 6 inch water mains. This area requires 750 gpm but is only capable of delivering 500 to 700. An 8 inch connection pipe between the 12 inch main on Salzman Road and the 6 inch main on Dorothy Lane resolves the fire flow deficiencies on Dorothy Lane. An 8 inch interconnect between Dorothy Lane and Amity Lane would correct the fire flows on Amity Lane.

Extension of the Salzman Road water main north to Todhunter Road will complete a 12 inch loop in the West zone. This extension will improve reliability of supply and significantly increase fire flow availability. Computer modeling of this connection shows that fire flows availability will increase to 2,500 gpm or higher along State Route 63 west of Salzman Road and along State Route 4 from State Route 63 to the Fire Station.

A summary of fire flow improvements for the West Zone includes:

- Construct approximately 2,650 LF of 12 inch water main along from the north end of Salzman Road to Todhunter Road;
- Construct approximately 2,450 LF of 8 inch water main on State Route 4 from Todhunter Road north to the corporation boundary;
- Construct 770 LF of 8 inch interconnection piping from Salzman Road to south end of Dorothy Lane;
- Construct 600 LF of 8 inch interconnection piping from south end of Dorothy Lane to south end of Amity Lane.

Figure 5-1 illustrates the piping replacements and additions recommended for improvements for fire flow, looping, and transmission.

6.0 WATER SYSTEM IMPROVEMENT ALTERNATIVES

Several improvement alternatives have been evaluated to improve the supply, conveyance, and storage capabilities of the water system. These improvement alternatives are presented according to the current service areas (zones). For each zone, various improvement alternatives are discussed.

Computer modeling using WaterCAD was used as a tool for evaluating system improvement alternatives. Throughout the discussion of alternatives, the significant results of computer modeling will be presented.

East Zone

Current maximum day demands in the East Zone are approaching 1.0 MGD. By 2025, the maximum day demand for the zone is projected to be 1.9 MGD. The existing water treatment plant has a rated capacity of 1.6 MGD. Therefore, if demand increases at a constant rate, the WTP will be unable to meet the maximum day demands for the East Zone in year 2014. Three improvement alternatives are discussed to plan for this situation:

- Rezone part of the East Zone to be served by Butler County DES;
- Increase the water production capacity;
- Augment water supply from an emergency outside source.

East Alternative No. 1 – Rezone Part of East Zone to Butler County

Currently the East Zone and the South Zone share the same design hydraulic grade line (HGL) of 960 feet msl. This situation provides for the possibility of moving the demand for the area west of North Main Street and north of State Route 63 out of the East Zone and assigning it to the Butler County DES supplied South Zone. This would also have the effect of continuing the service area of the South Zone north across State Route 63 to form a new “Central Zone”.

If rezoned, it is estimated that approximately 1,500 acres of residential and industrial development would be transferred from the East Zone to the Central Zone representing an average daily demand of approximately 260,000 gpd in 2006 and 530,000 gpd in year 2025.

In order to estimate the revised zone demands for year 2006, the demands listed in Table 3.2 were used as a basis and 260,000 gpd of average day demand was shifted from the East Zone to the proposed Central Zone as shown in Table 6.1.

Table 6.1 2006 Rezoned Demands and Storage			
Zone	Average Daily Demand (gpd)	Maximum Daily Demand (gpd)	Required Storage (MG)
East (Monroe)	280,000	490,000	0.50
Central (BCDES)	720,000	1,260,000	0.75
West (Middletown)	200,000	350,000	0.50
Total	1,200,000	2,100,000	1.75

To arrive at a demand distribution for year 2025 following rezoning, the demands listed in Table 3.6 were used and 530,000 gpd of average day demand was shifted from the East Zone to the proposed Central Zone. The resulting demand distribution is shown in Table 6.2.

Table 6.2 2025 Rezoned Demands and Storage			
Zone	Average Daily Demand (gpd)	Maximum Daily Demand (gpd)	Required Storage (MG)
East (Monroe)	570,000	1,000,000	0.60
Central (BCDES)	1,470,000	2,570,000	1.50
West (Middletown)	410,000	720,000	0.50
Total	2,450,000	4,290,000	2.60

If rezoning occurs, the Britton Lane Standpipe will no longer be located within the East Zone. Therefore, a new elevated storage tank will be required for the zone. At year 2025 demands, the East zone is projected to need 600,000 gallons storage. A 750,000 gallon elevated tank would be recommended.

Currently, a location near the intersection of North Main Street and State Route 63 is being considered for future elevated water storage. This location is the most logical since it is the highest ground within the redefined zone. The location has a weakness in that it is only served by the 10 inch water main that runs along North Main Street. If a tank were constructed at this location, a 12 inch main running west along State Route 63 from Lawton Avenue to North Main Street would be recommended for looping and

redundancy. As discussed earlier, this connection would improve fire flow availability to the commercial-industrial area near I-75.

By rezoning as described, the existing WTP would have adequate capacity to meet maximum daily demands through 2025. Following discussion with the City, it was determined that the East Zone would remain at HGL 960 to facilitate a future cross connection to the Central Zone and to maintain system pressures for business and industry in the area.

Improvements for this alternative include:

- 750,000 gallon elevated tank at N. Main Street and State Route 63;
- Approximately 4,000 LF of 12 inch water along State Route 63 between Lawton Avenue and N. Main Street.

Figure 6-1 shows the rezoning and recommended improvements for the East Zone.

East Alternative No. 2 – Increase Water Production Capacity and Storage

Since the 2001 Water Master Plan, nearly half of the water demand previously served by the Monroe WTP is now served by Butler County DES. While this has relieved the demand on the existing WTP, the projected maximum day demand of 1.9 MGD for the East Zone (Table 3.6) will ultimately surpass the existing 1.6 MGD production capability of the Monroe WTP.

An updated list of alternatives for increasing water production capacity include:

- Upgrade the existing Monroe WTP and well field for greater capacity;
- Acquire the abandoned Warren County WTP on Union Road.

In the 2001 Water Master Plan, improvements costs for the Monroe WTP were estimated for an increase in plant capacity from 1.6 to 3.5 MGD. This improvement alternative required that softening be eliminated from the plant process to accommodate additional pressure filters. In addition, two new wells and a 16 inch raw water transmission main were recommended. Total cost of these improvements in 2001 was \$3.03 million. On a pro-rata basis, and adjusting for the construction cost index, the cost of increasing the WTP capacity from 1.6 to 2.0 MGD would be approximately \$1.0 million.

In October 2006, the Warren County Union Road WTP was taken out of service, which is located about 1.3 miles north of the Monroe WTP on Union Road. The property is

approximately 16 acres and includes two production wells. The ground water source is the same aquifer shared by the Monroe WTP. The treatment capacity of the plant is 1.2 MGD.

Treatment processes at the Union Road WTP include aeration, iron and manganese removal using pressure filtration, fluoridation, and disinfection using sodium hypochlorite. No softening is performed. Improvements needed to restart water production have not been determined and are beyond the scope of this report. Whether this facility would be acquired, leased, or utilized under other arrangements has not been determined by the City at this time.

A 10 inch transmission main will be required from the WTP to the point of connection with the Monroe distribution system near SR 63 and Union Road, having an approximate length of 7,300 feet. The transmission main is the only known cost at this time.

In addition to increased production capacity, the East Zone will require elevated water storage of 1.1 MG by year 2025 (Table 4.2). Current storage in the zone is 400,000 gallons in the Britton Lane Standpipe. Thus, an additional 700,000 gallons of storage is projected, requiring a nominal 750,000 gallon elevated tank. The transmission main along SR 63 from Lawton Avenue to Main Street would be needed to improve fire flow availability to the commercial-industrial area near I-75.

East Alternative No. 3 – Augment Water Supply from Emergency Source

There is currently an emergency connection to the Middletown water distribution system on North Main Street near Greentree Road. The hydraulic grade line serving this portion of the Middletown system is at 900 feet. Since the East Zone operates at an HGL of 960 feet, this connection has limited usefulness, except in an extreme emergency.

This alternative was investigated in the 2001 Water Master Plan. At that time, pumping from Middletown, or creating a lower pressure zone at HGL 900 were suggested as alternatives. Since the writing of 2001 Water Master Plan, it seems that opening valves between the South Zone supplied by Butler County and the East Zone is the most logical backup source for the East Zone.

South Zone

As discussed previously, the South Zone is supplied by Butler County DES through two PRV connections at the south end of the City. The zone has 530,000 gallons of total storage in the Cemetery Elevated Tank and the East Avenue Standpipe.

The zone is currently functioning well with few areas of low system pressure. The area near the East Avenue Standpipe is at the highest elevation in the City. Static pressures in the area are approximately 40 psi. The other area of concern is near the elementary school in the vicinity of Macready Avenue and Sands Avenue. Computer modeling indicated that this area has insufficient fire flow availability. Improvements to correct this situation are discussed in the Distribution Piping Evaluation section.

Another observation for this zone is that the Cemetery Elevated Tank is not “turning over” under the operation of the PRVs. The PRVs are currently maintaining a fixed water level in the elevated tank that prevents it from achieving a fill and draw cycle. It is recommended that the primary PRV should be operated in order to allow the water level in the Cemetery Tank to fill and draw. This could also be accomplished with an altitude valve at the elevated tank, although not as reliably. It will be assumed that this work will be performed by Butler County DES.

Lastly, the East Zone may be rezoned as discussed above so that the area west of Main Street and north of State Route 63 is merged with the South Zone to form a Central Zone. Following is a description of improvements needed to support the proposed rezoning.

South Alternative No. 1 – Create Central Zone

The current South Zone could be extended north across State Route 63, occupying a portion of the East Zone that is west of North Main Street and north of State Route 63. This appears feasible because the two areas are currently on the same design hydraulic grade line (HGL) of 960 feet msl as discussed above. Expansion of the Butler County Zone to the north across State Route 63 to form the Central Zone would relieve some of the future demand from the City's WTP as discussed previously.

Computer modeling of this expanded Butler County served area shows that pressures and fire flows will be adequate for the new Central Zone for 2006 average day and maximum day demands. However, modeling predicts that the Britton Lane Standpipe will respond poorly because of the transmission distance from the Butler County PRVs to the Britton Lane Standpipe. The result is that the standpipe water level will drop approximately 15 feet under 2006 maximum day demands and may drop more than 40 feet under the 2025 maximum day demands.

Improvements to the transmission capacity along Britton Lane will be needed for the Britton Lane Standpipe to function adequately and to maintain adequate system

pressures in the subdivisions north of State Route 63 when supplied from the Butler County PRVs. The needed improvements are:

- Britton Lane – Replace approximately 4,000 LF of existing 6 inch with 12 inch main from Macready Avenue to elevated tank;
- Replace approximately 2,000 LF of existing 6 inch water main with 12 inch main from Lebanon Street to Macready Avenue;
- Elevated storage of at least 750,000 gallons to 1,250,000 gallons in the future. (A 750,000 gallon elevated tank will be assumed for the development of the alternative cost opinion).

Figure 6-1 shows the rezoning and recommended improvements for the Central Zone.

Central Zone Storage

If rezoning occurs, the new Central Zone would presently contain 930,000 gallons of storage. This is adequate storage for 2006 average day demands. By 2025, the service area will require a total storage of 1.5 million gallons.

Because of the small diameter and limited useful volume of the 130,000 gallon East Avenue Standpipe, it is recommended that this standpipe be dismantled. Under this assumption, the additional storage needed is a minimum of 750,000 gallons. It may be prudent to plan for at least 1.1 MG of additional storage to plan for the eventual replacement of the Britton Lane Standpipe.

Supplying water north of SR 63 from the south requires transmission of water to the Britton Lane Standpipe through a network of 6 and 8 inch water mains. For the Britton Lane Standpipe to function adequately, improvements to the transmission capacity along Britton Lane will be needed as described previously.

A preliminary evaluation for the location of additional storage in the Central Zone was made as part of this Master Plan update. This evaluation is not considered to be exhaustive in identifying and evaluating all potential locations for the additional storage. In general, construction of additional storage should be near the area where the water is demanded. Therefore, the location of the existing Cemetery Elevated Tank was not thought to be a good location for additional storage. Two alternatives are presented for additional storage for the Central Service Area:

- Near North Main Street and State Route 63;

- Near Britton Lane and Macready Avenue.

Additional Elevated Storage Near North Main Street and State Route 63

Discussions with the City indicate that this location is currently under consideration for the placement of elevated storage. Computer modeling indicates that the water level in an elevated tank at this location will float approximately 2 feet lower than the Cemetery Tank level under 2006 maximum day demand conditions and approximately 6 feet below the Cemetery Tank level under 2025 maximum day demand conditions. Thus, a tank at this location will provide adequate pressures under 2006 and 2025 average day and maximum day demands for the Central Zone. The modeling assumed that the Cemetery Tank water level was maintained above elevation 954 by the Butler County PRVs. A critical connection between Overbrook Court and the cul-de-sac to the north is required for conveyance from the new elevated tank location into the zone.

This location is also evaluated for the placement of elevated storage to serve the East Zone in the following section. Thus, the proposed East Elevated Tank and the proposed Central Elevated Tank could be placed next to each other.

Additional Elevated Storage Near Britton Lane and Macready Avenue.

If the distribution piping improvements along Britton Lane are made to improve the transmission capacity to the north, the location near Britton Lane and Macready Avenue, near the elementary school, would provide a good location for future elevated storage.

Computer modeling indicates that a storage tank at this location will float approximately 3 feet lower than the Cemetery Tank level under 2006 maximum day demand conditions and approximately 7 feet below the Cemetery Tank under 2025 maximum day demand conditions. Thus, a tank at this location will provide adequate pressures under 2006 and 2025 average day and maximum day demands for the Central Zone. It was assumed that the Cemetery Tank water level was maintained above elevation 954 by the Butler County PRVs.

West Zone

The West Zone is experiencing problems with system pressures and fire flow adequacy as discussed in the previous section. Several alternatives for permanently

improving pressures and fire flows in this zone have been discussed with the City. Three alternatives are discussed in this update:

- Remain on the Middletown-Monroe Elevated Tank;
- Construct a booster pumping station (BPS) after the Middletown-Monroe Tank;
- Obtain feed from Butler County through PRV at higher pressure.

The West Zone currently has a redundant source of supply for emergency conditions. The PRV located on Todhunter Road, near Holman Road, would be capable of supplying the West Zone with adequate pressure in the event of a problem with the Middletown-Monroe Elevated Tank. This connection was not evaluated for the capacity to supply the West Zone for extended periods.

West Alternative No. 1 – Remain on Middletown-Monroe Elevated Tank

The West Zone is currently supplied from Middletown. The shared Middletown-Monroe Elevated Tank provides an HGL of 860 feet msl for the zone. Areas along State Route 4 have ground elevations slightly above elevation 750, resulting in lower static pressures (46 psi) at the highest elevations. This condition has been exacerbated by the fact that the primary transmission piping to State Route 4 has been an 8 inch main along Todhunter Road causing pressures to drop further under high demand conditions.

Currently the Todhunter Road water main is being scheduled for replacement as a 12 inch main. Computer modeling was performed for the zone with the new main in service. The modeling indicates that the fire flows for the entire zone and along State Route 4 will be significantly improved by the Todhunter water main. Thus, it will be assumed that the improvements along Todhunter Road are already completed (sunk cost) for developing the alternative cost opinion.

When this improvement is combined with the Salzman Road water main extension (recommended in the previous section) and other smaller water main improvements, the fire flow deficiencies for the entire zone are resolved. Therefore, modeling indicates that the pressure and fire flow deficiencies in the West Zone are the result of inadequate transmission capacity. Thus, this alternative is recommended for further consideration.

Improvements for this alternative include:

- Approximately 2,650 LF of 12 inch water main extension from the north end of Salzman Road to Todhunter Road;
- Approximately 2,450 LF of 8 inch water main on State Route 4 from Todhunter Road north to the corporation boundary.

West Alternative No. 2 – Construct BPS after Middletown-Monroe Tank

The construction of booster pumping station (BPS) immediately downstream (south) of the Middletown-Monroe elevated tank was discussed as a solution to correct the low pressures in the zone. A BPS with the capacity of pumping the average daily demands would raise system pressures to more acceptable levels for customers at higher elevations. Consideration should be given to placing the zone on an HGL of 960 to facilitate cross connection with the South or Central Zone.

If fire flows are to be delivered at the higher pressure, then the BPS would need to have fire pump capacity of at least 1,500 gpm with redundancy. If fire pumps are not installed, fire flows could be provided from the elevated tank at lower pressure, bypassing the BPS, in the event of a fire. Under these circumstances, the fire flows and pressures during a fire demand would be at the current 860 HGL of the Middletown-Monroe Tank.

Computer modeling was performed to simulate the effect of providing a higher HGL for this zone. It was found that raising the zone HGL to 960 (through booster pumping, or raising the elevated tank) improves static pressures but would not greatly improve fire flow availability. Distribution piping improvements are needed to convey the water with lower friction losses in order to improve fire flows. Thus, this alternative is not recommended for further consideration.

West Alternative No. 3 – Obtain Feed from BCDES through PRV

Butler County DES currently supplies the South Zone and the Southwest Zone as described in Section 2. The HGL in the Butler County system is at elevation 1,000. Thus, it is possible that the West Zone could be supplied by one or more PRVs from Butler County DES. It is anticipated that there would be two PRVs, one located at State Route 63 and Salzman Rd, and the other PRV located near State Route 63 at State Route 4.

Connection at these locations would significantly boost pressures and fire flow availability along State Route 63 and State Route 4. Computer modeling was performed with a PRV located at the intersection of State Route 63 and State Route 4. This PRV connection (modeled with a 930 HGL) resolved all pressure and fire flow deficiencies in the zone with the exception the south ends of Dorothy and Amity Lanes.

The potential drawback to this alternative is that a 500,000 gallon storage tank would probably be required within the zone at the higher hydraulic grade. If this alternative is selected, consideration should be given to placing the zone on an HGL of 960 to facilitate cross connection with the South or Central Zone. For providing an opinion of cost, it will be assumed that this alternative will require a new 500,000 gallon elevated storage tank. It is assumed that the PRV construction costs will be included in the cost of the unit water delivery charge from BCDES.

Improvements for this alternative include:

- 500,000 gallon elevated tank.

7.0 RECOMMENDATIONS AND COST OPINIONS

Recommended Fire Flow Improvements

The following listed improvements in Tables 7.1 through 7.3 are recommended in order for the distribution system to provide fire protection at the recommended flow rates listed in Table 5.1. Several of the fire flow improvements are also contained within the Water System Improvement Alternatives.

Fire flow improvement recommendations for East Zone are listed in Table 7.1. The deficient fire flows in the commercial-industrial area near I-75 were found to have a root cause due to excessive transmission distance from the Britton Lane Standpipe. As discussed previously, computer modeling showed that a new elevated tank located at N. Main Street and State Route 63 combined with a 12 inch transmission main along State Route 63 would resolve fire flow deficiencies in this area.

The improvements listed in the Table 7.1 along Britton Lane and Todhunter Road were solely to increase available fire flows on Holman Road. This may of may not be a priority for the City. The improvement along Macready is to increase available fire flows in the area of Macready and Heritage Green Drive near Kroger. This improvement will not be necessary if the South Zone is expanded northward across State Route 63.

Table 7.1 East Zone Fire Flow Improvements			
	Quantities	Rate	Amount
750,000 gallon elevated storage tank at N. Main Street and State Route 63	1 EA	\$1,400,000.00	\$1,400,000.00
Construct 12 inch water along State Route 63 between Lawton Avenue and N. Main Street	4,000 LF	\$88.00	\$352,000.00
Replace existing 6 inch water main with 12 inch along Todhunter Road, from Britton Lane to new 12 inch main (north of Wicklow Lane)	2,020 LF	\$88.00	\$177,760.00
Replace existing 6 inch water main with 12 inch along Britton Lane, from Deenen Drive to Todhunter Road	1,920 LF	\$88.00	\$168,960.00
Replace existing 6 inch water main with 12 inch along Macready Avenue from Heritage Green Drive to Britton Lane	3,050 LF	\$88.00	\$268,400.00
Construct 8 inch from east end Wexford Drive to the 6 inch main to the east	350 LF	\$67.00	\$23,450.00

Fire flow improvements for the South Zone are listed in Table 7.2. This improvement provides adequate fire flow to the Elementary School on Macready Avenue. This improvement will not be immediately necessary if the South Zone is expanded to the north across State Route 63.

Table 7.2 South Zone Fire Flow Improvements			
	Quantities	Rate	Amount
Replace existing 6 inch water main with 12 inch main from Lebanon Street to Macready Avenue	2,000 LF	\$88.00	\$176,000.00

The fire flow improvements in the West Zone are listed in Table 7.3. The Todhunter Road water main improvements scheduled for 2007 will improve fire flows throughout the entire zone. By constructing the Salzman Road extension to Todhunter Road, the zone will experience improved fire flows and supply reliability.

Table 7.3 West Zone Fire Flow Improvements			
	Quantities	Rate	Amount
Construct 12 inch water main along from the north end of Salzman Road to Todhunter Road	2,650 LF	\$88.00	\$233,200.00
Construct 8 inch water main on State Route 4 from Todhunter Road north to the corporation boundary	2,450 LF	\$67.00	\$164,150.00
Construct 8 inch interconnection piping from Salzman Road to south end of Dorothy Lane	770 LF	\$67.00	\$51,590.00
Construct 8 inch interconnection piping from south end of Dorothy Lane to south end of Amity Lane	600 LF	\$67.00	\$40,200.00

Water System Improvement Alternatives

The cost opinions for the Water System Improvement Alternatives are presented in Tables 7.4 through 7.6.

For the East Zone, it was found that the zone demand would eventually become greater than the capacity of the Monroe WTP production capacity. Three alternatives as summarized in Table 7.4 were developed to plan for this situation. The first alternative was rezoning so that a portion of the current East Zone served by the Monroe WTP could be served by Butler County DES in the future.

Other alternatives included making improvements at the Monroe WTP to increase water production capacity, or to purchase or lease the Warren County Union Road WTP. It was determined that detailed evaluations of these alternatives were beyond the scope of the Water Master Plan Update. Additional elevated storage and distribution system improvements are also required.

The third alternative looked at augmenting the zone supply with water from an outside source. This is currently available by opening a valve between the East Zone and the South Zone served by Butler County. This ability, however, should be used as a backup plan. The rezoning as described in East Alternative No. 1 is recommended as a long term plan.

Table 7.4 East Zone Alternatives			
	Quantities	Rate	Amount
Alternative No. 1 – Rezone part of East Zone to Butler County			
750,000 gallon elevated storage tank at N. Main Street and State Route 63	1 EA	\$1,400,000.00	\$1,400,000.00
12 inch water main along State Route 63 between Lawton Avenue and N. Main Street	4,000 LF	\$88.00	\$352,000.00
Total Cost Opinion			\$1,752,000.00
Alternative No. 2A – Increase Water Production Capacity and Storage			
Monroe WTP Improvements	1 LS	\$1,000,000.00	\$1,000,000.00
750,000 gallon elevated storage tank at N. Main Street and State Route 63	1 EA	\$1,400,000.00	\$1,400,000.00
12 inch water main along State Route 63 between Lawton Avenue and N. Main Street	4,000 LF	\$88.00	\$352,000.00
Total Cost Opinion			\$2,752,000.00
Alternative No. 2B – Increase Water Production Capacity and Storage			
Warren County WTP Improvements			Beyond report scope
Construct 10 inch water main from Warren County Union Road WTP to SR 63.	7,300 LF	\$400,000.00	\$400,000.00
750,000 gallon elevated storage tank at N. Main Street and State Route 63	1 EA	\$1,400,000.00	\$1,400,000.00
12 inch water main along State Route 63 between Lawton Avenue and N. Main Street	4,000 LF	\$88.00	\$352,000.00
Total Cost Opinion (not including Warren County WTP Improvements)			\$2,152,000.00
Alternative No. 3 – Augment Water Supply From Emergency Source – Already in service. No improvements required.			

The improvement alternative for the South Zone is summarized in Table 7.5. If the City chooses to implement East Alternative No. 1 as described previously, the result is that the existing South Zone, supplied by BCDES, will expand northward across State Route 63. The following improvements support the South Zone expansion to form the Central Zone as discussed in this update.

Two locations for a new elevated tank were evaluated in this update; at the intersection of N. Main Street and State Route 63 and near the intersection of Macready and Britton Lane. Both of these locations performed satisfactorily in computer modeling. However, this evaluation was not exhaustive, and other suitable locations may exist.

The distribution improvements listed below improve the transmission capacity north of State Route 63 and maintain system pressures under present and future maximum day demand conditions.

Table 7.5 South Zone Alternatives			
	Quantities	Rate	Amount
Alternative No. 1 – Create Central Zone			
Britton Lane – Replace existing 6 inch with 12 inch main from Macready Avenue to elevated tank	3,950 LF	\$88.00	\$347,600.00
Replace existing 6 inch water main with 12 inch main from Lebanon Street to Macready Avenue	2,050 LF	\$88.00	\$180,400.00
750,000 gallon elevated storage tank	1 EA	\$1,400,000.00	\$1,400,000.00
Total Cost Opinion			\$1,928,000.00

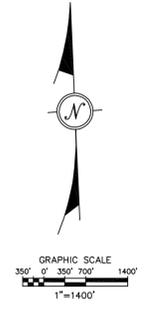
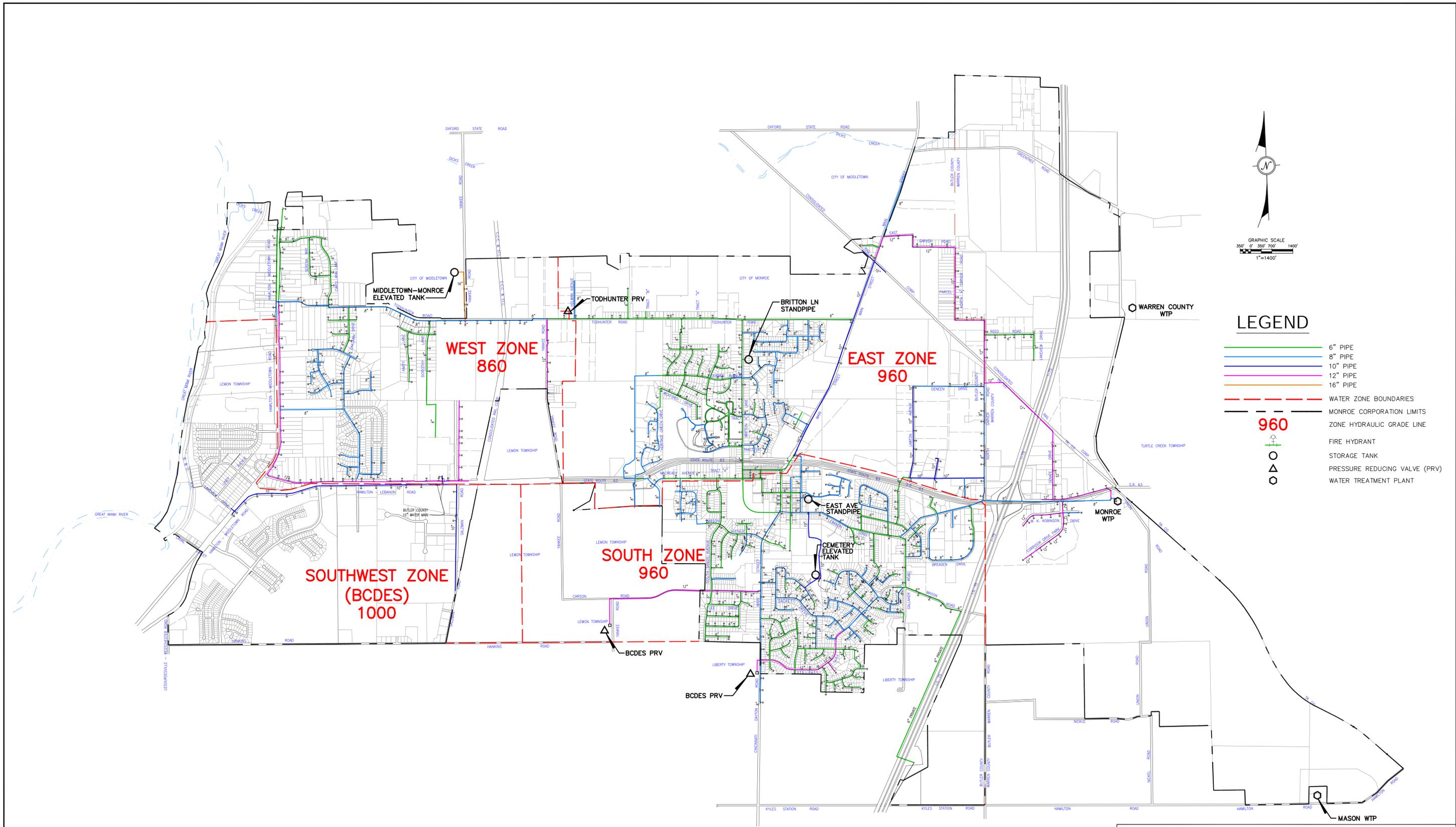
The West Zone has historically suffered from lower system pressures and inadequate fire flows. Three alternatives were developed to address this situation as summarized in Table 7.6. The first alternative was to have the zone remain on the Middletown-Monroe Elevated Tank and improve the distribution piping in the zone. Computer modeling indicated that this situation is largely due to insufficient transmission capacity of the water mains. Furthermore, the scheduled improvements along Todhunter will significantly improve the fire flows throughout the zone.

The second alternative was to construct a booster pumping station to raise the water pressure downstream of the Middletown-Monroe Elevated Tank. Computer modeling showed that raising system pressures did not significantly improve fire flows. In addition, fire flows would have to be pumped by the BPS at the higher pressure or delivered at the lower existing pressure directly from the elevated tank, and bypassing

the pump station. This alternative did not seem to provide any significant advantages and is not recommended for further evaluation.

The third alternative was supply from Butler County DES through one or more PRVs. Discussions with BCDES indicated that potential locations for pressure reducing valve (PRV) were at Salzman Road and State Route 63 and at State Route 63 and State Route 4. A PRV was modeled at the latter location and found to significantly improve fire flows along State Route 4 and State Route 63 due to the larger water mains in these areas. Pressures were also improved throughout the entire zone. It was anticipated that a new 500,000 gallon elevated tank would be constructed within the zone to support the average daily demands and provide local storage for fire flows. Although, this alternative has the added benefit of raising static pressures as well as improving fire flow; the elevated tank makes this alternative more costly than the distribution system improvements listed in Alternative No. 1. Thus, West Alternative No. 1 is recommended.

Table 7.6 West Zone Alternatives				
	Quantities		Rate	Amount
West Alternative No. 1 – Remain on Middletown-Monroe Elevated Tank				
12 inch water main extension from the north end of Salzman Road to Todhunter Road	2,650	LF	\$88.00	\$233,200.00
8 inch water main on State Route 4 from Todhunter Road north to the corporation boundary	2,450	LF	\$67.00	\$164,150.00
Total Cost Opinion				\$397,350.00
West Alternative No. 2 – Construct BPS after Middletown-Monroe Tank: Not recommended for further evaluation				
West Alternative No. 3 – Obtain Feed from BCDES through PRV				
500,000 gallon elevated storage tank	1	EA	\$1,000,000.00	\$1,000,000.00
Total Cost Opinion				\$1,000,000.00



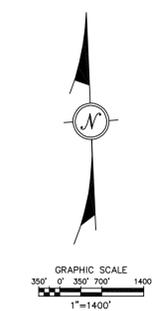
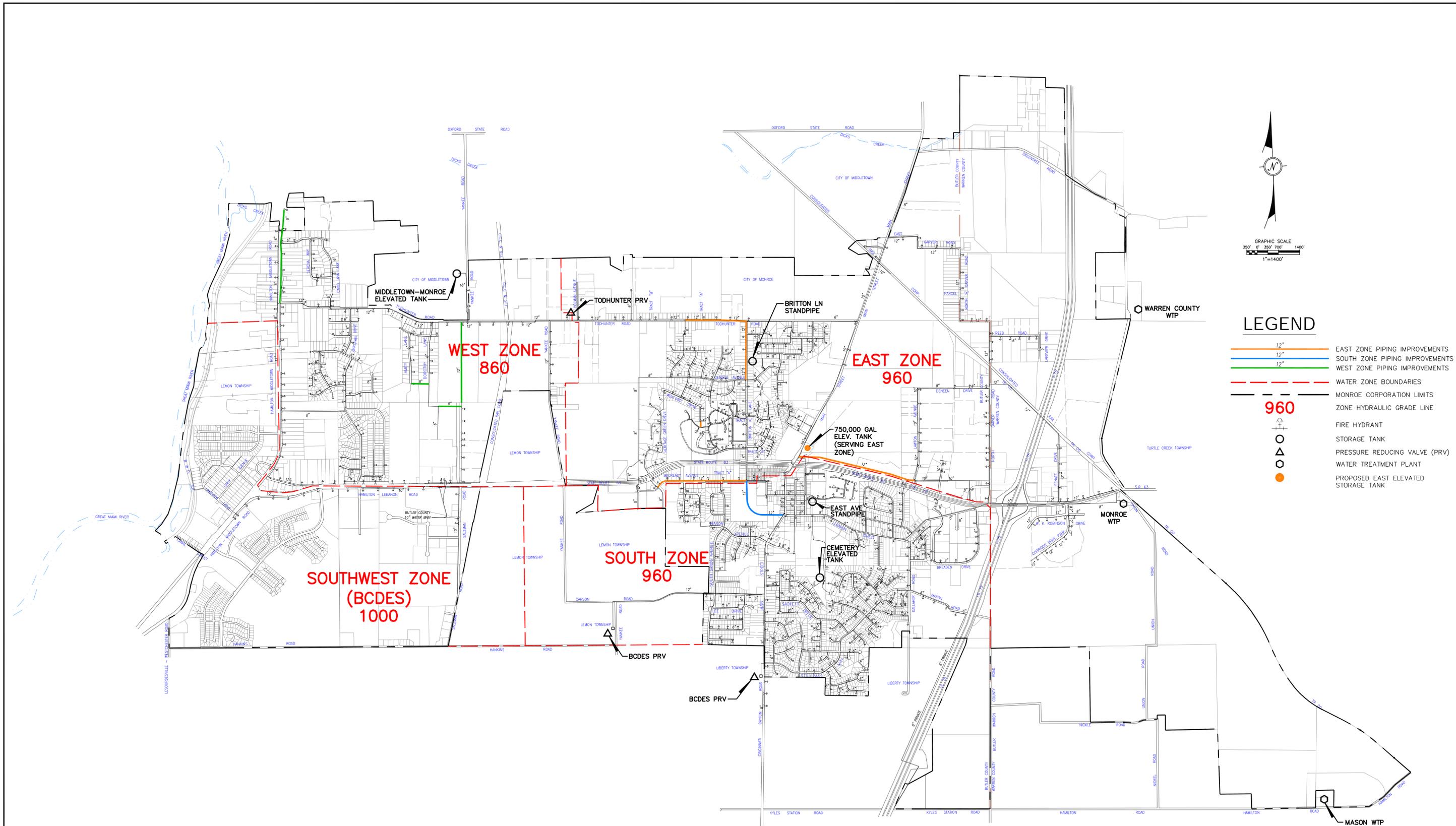
LEGEND

	6" PIPE
	8" PIPE
	10" PIPE
	12" PIPE
	16" PIPE
	WATER ZONE BOUNDARIES
	MONROE CORPORATION LIMITS
	ZONE HYDRAULIC GRADE LINE
	FIRE HYDRANT
	STORAGE TANK
	PRESSURE REDUCING VALVE (PRV)
	WATER TREATMENT PLANT

NOTES:

- 12 INCH WATER MAIN ALONG TODHUNTER ROAD FROM STATE ROUTE 4 TO 2000 FEET WEST OF BRITTON LANE TO BE COMPLETED IN 2007 AND 2008.
- BCDES: BUTLER COUNTY DEPARTMENT OF ENVIRONMENTAL SERVICES

FIGURE 2-1
EXISTING WATER DISTRIBUTION SYSTEM
2007 WATER MASTER PLAN UPDATE
MONROE, OHIO

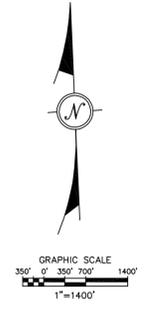
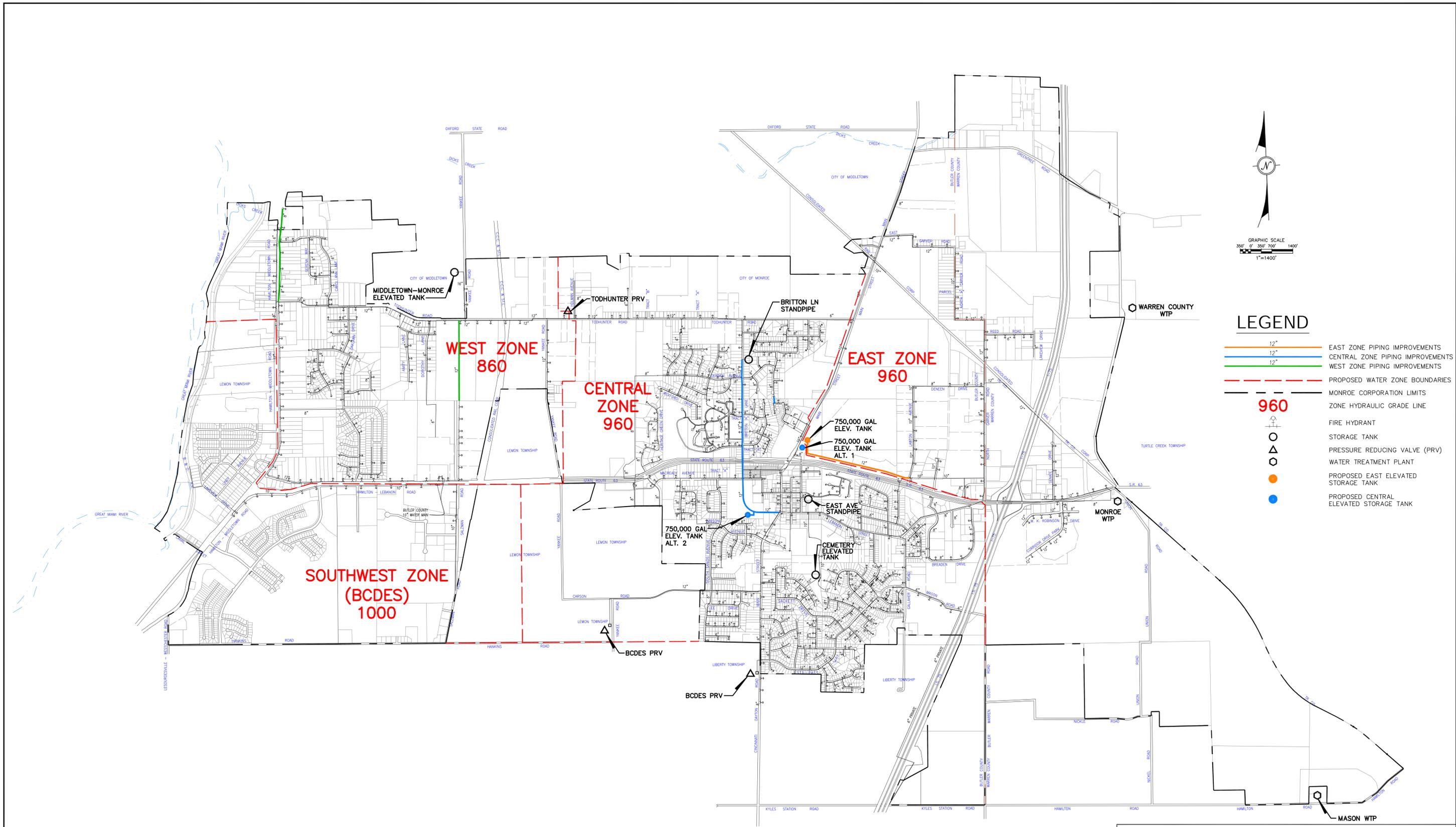


LEGEND

	12"	EAST ZONE PIPING IMPROVEMENTS
	12"	SOUTH ZONE PIPING IMPROVEMENTS
	12"	WEST ZONE PIPING IMPROVEMENTS
		WATER ZONE BOUNDARIES
		MONROE CORPORATION LIMITS
		ZONE HYDRAULIC GRADE LINE
		FIRE HYDRANT
		STORAGE TANK
		PRESSURE REDUCING VALVE (PRV)
		WATER TREATMENT PLANT
		PROPOSED EAST ELEVATED STORAGE TANK

- NOTES:
1. 12 INCH WATER MAIN ALONG TODHUNTER ROAD FROM STATE ROUTE 4 TO 2000 FEET WEST OF BRITTON LANE ASSUMED TO BE COMPLETED.
 2. BCDES: BUTLER COUNTY DEPARTMENT OF ENVIRONMENTAL SERVICES

**FIGURE 5-1
PROPOSED FIRE FLOW IMPROVEMENTS
2007 WATER MASTER PLAN UPDATE
MONROE, OHIO**



LEGEND

	12"	EAST ZONE PIPING IMPROVEMENTS
	12"	CENTRAL ZONE PIPING IMPROVEMENTS
	12"	WEST ZONE PIPING IMPROVEMENTS
		PROPOSED WATER ZONE BOUNDARIES
		MONROE CORPORATION LIMITS
		ZONE HYDRAULIC GRADE LINE
		FIRE HYDRANT
		STORAGE TANK
		PRESSURE REDUCING VALVE (PRV)
		WATER TREATMENT PLANT
		PROPOSED EAST ELEVATED STORAGE TANK
		PROPOSED CENTRAL ELEVATED STORAGE TANK

NOTES:
 1. 12 INCH WATER MAIN ALONG TODHUNTER ROAD FROM STATE ROUTE 4 TO 2000 FEET WEST OF BRITTON LANE ASSUMED TO BE COMPLETED.
 2. BCDES: BUTLER COUNTY DEPARTMENT OF ENVIRONMENTAL SERVICES

**FIGURE 6-1
 PROPOSED WATER SYSTEM
 IMPROVEMENT ALTERNATIVES
 2007 WATER MASTER PLAN UPDATE
 MONROE, OHIO**