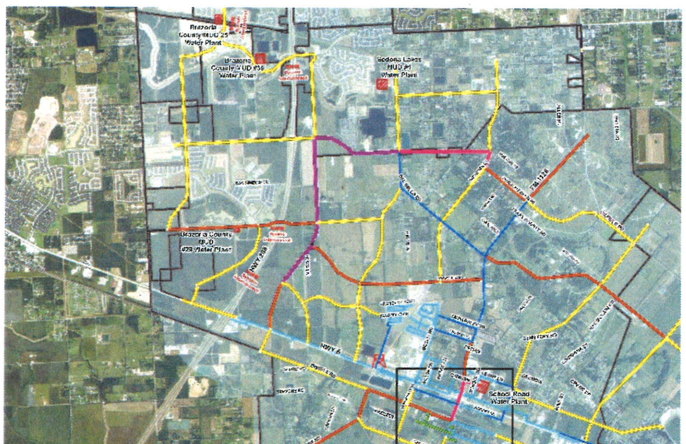

City of Manvel TEXAS

# 2017 Master Water Plan

## City of Manvel

September 12, 2017

STATE OF TEXAS
JOSE D. MALDONADO
96705

9-12-17

[redacted]

# City of Manvel: 2017 Master Water Plan

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# Executive Summary

The purpose of this MWP study is to evaluate the existing water distribution system, identify future water demands to be met by the system, identify recommended improvements, and serve as a guiding document for future capital projects and developer-driven initiatives.

Since its inception, the City of Manvel has been characterized as a rural community. Large acre homesteads and many other area water users typically have relied upon individual water wells. However, the City owns and operates a small water plant on School Road that is being expanded. This water plant provides water and fire protection to residents and businesses in the “Old Manvel” area near SH6 and FM1128.

Continued growth in the greater Houston metropolitan area has resulted in a number of residential subdivisions and commercial developments in and around the City of Manvel. The majority of these developments are served by small individual water plants and package wastewater facilities via Municipal Utility Districts (MUDs).

As the population in the vicinity of the City continues to expand, the City will be required to meet increasing demands for public drinking water and fire protection.

## Existing System Demands

The existing demands are based on the City’s available water billing information from January 2015 to November 2016. Currently, the City provides service to the Lakeland subdivision in addition to the City limit customers. The following is a breakdown of the average flows per day based on residential (meters 1 ½” and smaller) and non-residential (meters greater than 1 ½”) for the City accounts and the Lakeland accounts:

**Table i - Existing Average Water Use**

| Developer | Residential (gpd) | Non-Residential (gpd) | Overall (gpd) |
|---|---|---|---|
| City | 192 | 2,204 | 368 |
| Lakeland | 153 | - | 153 |
| **Total** | **169** | **2,204** | **244** |

## Water Demand Projections for Buildout

The water demands for buildout were projected based on provided information by developers, land use projections or provided information by the City. HDR contacted the engineers for the existing and planned developments for updated projections on ESFC for each community.

The summary of the ESFC projections is provided below.

**Table ii - Buildout Connections and Demand**

| Developer | Connections |
|---|---|
| City (current) | 295 |
| City (future) | 30,288 |
| Lakeland | 818 |
| Southpointe Crossing | 800 |
| Blue Water Lakes | 508 |
| Sowell Properties | 2,000 |
| Presidio | 2,146 |
| Meridiana (MUD 56) | 3,451 |
| Southfork (MUD 25) | 1,340 |
| Newport | 200 |
| Rodeo Palms (MUD 29) | 2,156 |
| Sedona Lakes (MUD 1) | 1,385 |
| Pomona (MUD 39) | 2,892 |
| **Total** | **48,279** |

# Water Supply-Demand for Buildout

Based on the projected 48,279 ESFC at buildout, the estimated average daily supply/demand required is 17.4 million gallons per day (mgd) or 19,470 acre-ft per year.

The City will continue to evaluate the following additional water supply opportunities:

- City of Pearland (treated or raw water)
- Gulf Coast Water Authority
- Sand Pit Harvesting
- Wastewater Reuse

# CIP Recommendations

The proposed 5-Year CIP is shown in **Figure 6** and summarized below.

**Table iii - 5-Year CIP Recommendations**

| Existing 2016-2021 CIP | Project Cost | Trigger |
|---|---|---|
| 250,000 Gallon Elevated Storage Tank | $1,915,000 | 2,500 Connections |
| Purchase Surface Water Rights | $5,000,000 | In progress |
| Rogers Road West Water Line Loop | - | In construction |
| Rogers Road East Water Line Loop | $159,100 | FY2017 |
| Charlotte Water Line Loop | $248,400 | FY2017 |
| Cemetery Water Line Loop | $218,700 | FY2017 |
| Tankersley Water Line Loop | $479,600 | FY2018 |
| SH6 East Water Line Extension | $894,300 | FY2019 |
| FM 1128 Water Line Extension | $1,788,500 | Developer Driven |
| Del Bello Water Line Extension | $1,341,400 | Developer Driven |

The table below and **Figure 7** show the recommend improvements for buildout. Please note that additional improvements such as water plants (including wells, storage tanks, booster pumps) and distribution networks by developers (or City) are not included.

**Table iv - Ultimate Buildout Recommendations**

| Item No. | Qty. | Units | Description | Unit Price | Total |
|---|---|---|---|---|---|
| 1 | 4,220 | L.F. | 8" Water Main | $72 | $303,800 |
| 2 | 181,300 | L.F. | 12" Water Main | $108 | $19,580,400 |
| 3 | 60,450 | L.F. | 16" Water Main | $144 | $8,733,600 |
| 4 | 10,240 | L.F. | 20" Water Main | $180 | $1,843,200 |
| 5 | 15,230 | L.F. | 24" Water Main | $216 | $3,289,700 |
| 6 | 1 | EA. | 0.5 Million Gallon Elevated Storage Tank | $2,200,000 | $2,200,000 |

| Item No. | Qty. | Units | Description | Unit Price | Total |
|---|---|---|---|---|---|
| 7 | 3 | EA. | 1 Million Gallon Elevated Storage Tank | $4,500,000 | $13,500,000 |
| 8 | 1 | EA. | 1.25 Million Gallon Elevated Storage Tank | $5,312,500 | $5,312,500 |
| 9 | 1 | L.S. | 14 Million Gallon Surface Water Treatment Plant | $126,000,000 | $126,000,000 |
| | | | | **Subtotal:** | **$180,763,200** |
| | | | | **Contingencies:** | **$45,191,000** |
| | | | | **Professional Services** | **$33,894,000** |
| | | | | **Project Total:** | **$225,954,200** |

# 1 Introduction

In October 11, 2016, the City of Manvel, Texas ("Manvel" or the "City") requested that HDR Engineering, Inc. ("HDR") update an existing model of the City's existing water distribution system and utilize the model to develop a Water Master Plan (WMP) to guide development of the City's water system to meet the demands of future growth. This MWP describes the work completed and presents a plan for the City's distribution system to serve near-term (5-year) growth projections and conditions at buildout of the system.

This section provides a description of the project and an overview of the 2017 MWP, including a summary of scope of work, a description of the report sections to follow, and a listing of abbreviations and definitions used.

## 1.1 Project Background Description

The purpose of this MWP study is to evaluate the existing water distribution system, identify future water demands to be met by the system, identify recommended improvements, and serve as a guiding document for future capital projects and developer-driven initiatives.

Since its inception, the City of Manvel has been characterized as a rural community. Large acre homesteads and many other area water users typically have relied upon individual water wells. However, the City owns and operates a small water plant on School Road that is being expanded. This water plant provides water and fire protection to residents and businesses in the "Old Manvel" area near SH6 and FM1128.

Continued growth in the greater Houston metropolitan area has resulted in a number of residential subdivisions and commercial developments in and around the City of Manvel. The majority of these developments are served by small individual water plants and package wastewater facilities via Municipal Utility Districts (MUDs).

As the population in the vicinity of the City continues to expand, the City will be required to meet increasing demands for public drinking water and fire protection.

## 1.2 Objectives and Scope of Work

This MWP has been developed to assist the City in achieving its objective of providing quality service to its existing and future water customers. The scope of work to develop this MWP includes the following primary tasks.

- Summarize the City's existing and planned water supply facilities
- Analyze historical and current water demands
- Project future water demands in areas to be served by the City
- Develop a hydraulic model of the City's water distribution system
- Evaluate system improvements needed to serve future water demands
- Develop a high-level Capital Improvement Program (CIP) for the water system

## 1.3 Report Organization

This MWP is organized into the following sections:

- Section 1, Introduction - presents a brief overview of the background, scope of work, and data sources used in preparing this report.
- Section 2, Existing and Planned Water Supply Infrastructure - summarizes the City existing water supply infrastructure, its operation and condition along with future needs and background information of in-City and ETJ MUDs.
- Section 3, Water Demand Projections - summarizes the City's historical water use and presents future water use under projected buildout conditions. It also describes the City's current water supplies.
- Section 4, Existing and Buildout Transmission System Hydraulic Analysis - documents model development and the existing and future system evaluations for the water system.
- Section 5, Capital Improvement Program (CIP) Recommendations - lists the recommended system improvements needed and presents the Capital Improvement Program (CIP) for the system.

## 1.4 Acronyms and Abbreviations

ADD – Average Day Demand

BRA – Brazos River Authority

CIP – Capital Improvement Program

DEM – Digital Elevation Model

ETJ – Extraterritorial Jurisdiction

ESFC – Equivalent Single-family Connection

EPANET – Public domain, water distribution system modeling software package developed by the United States Environmental Protection Agency's (EPA) Water Supply and Water Resources Division

FT – Foot (Feet)

GCWA – Gulf Coast Water Authority

GIS – Geographic Information System

GPD – Gallons per day

MGD – Million gallons per day

MDD – Maximum Day Demand

MUD – Municipal Utility Districts

MWP – Master Water Plan

NOAA – National Oceanic and Atmospheric Administration

TCEQ – Texas Commission on Environmental Quality

TWDB – Texas Water Development Board

U.S. EPA – United States Environmental Protection Agency

USGS – United States Geological Survey

## 1.5 Data Sources

City staff supplied several reports, studies, previous planning documents and other sources of information. Below is a list of the documents obtained from the City that were used in the preparation of this MWP:

- City of Manvel Design Criteria Manual
- FY 2016-2020 Capital Improvements Program
- 2007 Comprehensive Plan
- 2014 Comprehensive Plan Update Summary
- 2015 Comprehensive Plan
- 2015 Thoroughfare Plan
- 2016 Update Study of Land Use Assumptions, Capital Improvement Plan & Impact Fees

Other material was obtained from sources such as Census Bureau, City of Manvel Water, Finance and Operations Departments, Texas Commission on Environmental Quality (TCEQ), United States Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), and the Texas Water Development Board (TWDB). Typical information obtained included GIS data, water system maps, planning and development information, historical records, billing data and details on facility information, climate data, and population projections. Several meetings were held with City staff to review and collect the data used to prepare this plan. Several interviews were held with the City's operational staff during the hydraulic model development and calibration stages to incorporate their knowledge of systems, facilities, and operational information.

# 2 Water Supply Infrastructure

This section presents the details about the City's existing and planned water supply infrastructure. The section also includes available information for the current and planned MUDs within the City's corporate limits and ETJ. The City limits, ETJ boundaries, location of existing City infrastructure, and known development areas are shown in **Figure 1** - City of Manvel Service Area Map.

## 2.1 Existing City Water Distribution Infrastructure

The City's current water system consists of the School Road Water Plant and associated pumps, water supply wells, transmission and distribution pipelines, manual and automatic control valves, fire hydrants, and water meters located throughout the system, as represented by the data provided by the City. **Table 1** lists the existing distribution pipe size and length. **Figure 2** shows the location of the water transmission and distribution pipes and the location of the School Road Water Plant.

The City's transmission and distribution systems consist of a variety of pipe types, sizes and ages, and reflect ongoing growth of the system. Based on the information contained in the hydraulic model provided by the City and GIS created by HDR, pipe sizes and materials were compiled for the hydraulic distribution system. This information is shown in the tables below. Note that the City's system is currently being expanded by the Lakeland subdivision (those quantities are not included below).

**Table 1 - Existing Distribution Pipe Size and Length**

| Pipe Size (inch) | Pipe Length (ft) |
|---|---|
| 2 | 382 |
| 3 | 879 |
| 4 | 10,843 |
| 6 | 22,965 |
| 8 | 22,566 |
| 12 | 30,533 |
| 16 | 9,037 |
| Unknown | 4,713 |
| **Total** | **101,918** |

*Source: City's GIS data

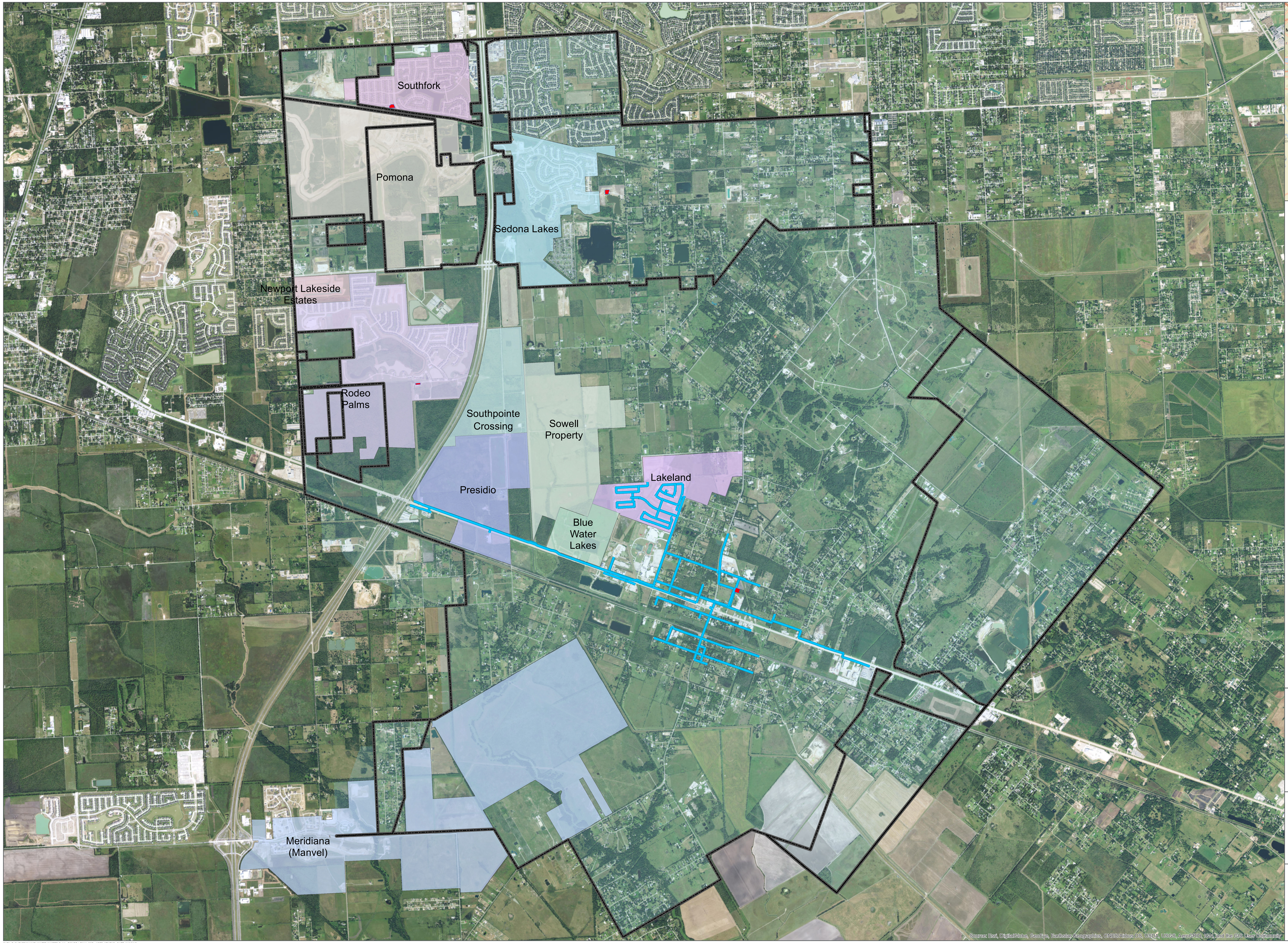
This report summarizes the operating pressures, pumping capacities, and storage volumes of the City's existing distribution infrastructure assets, including all City wells, storage tanks, pumps and pipes. This data is compared to the TCEQ rules and regulations for distribution system (Chapter 290, Subchapter D, Sections 290.44, 290.45) in **Table 2**.

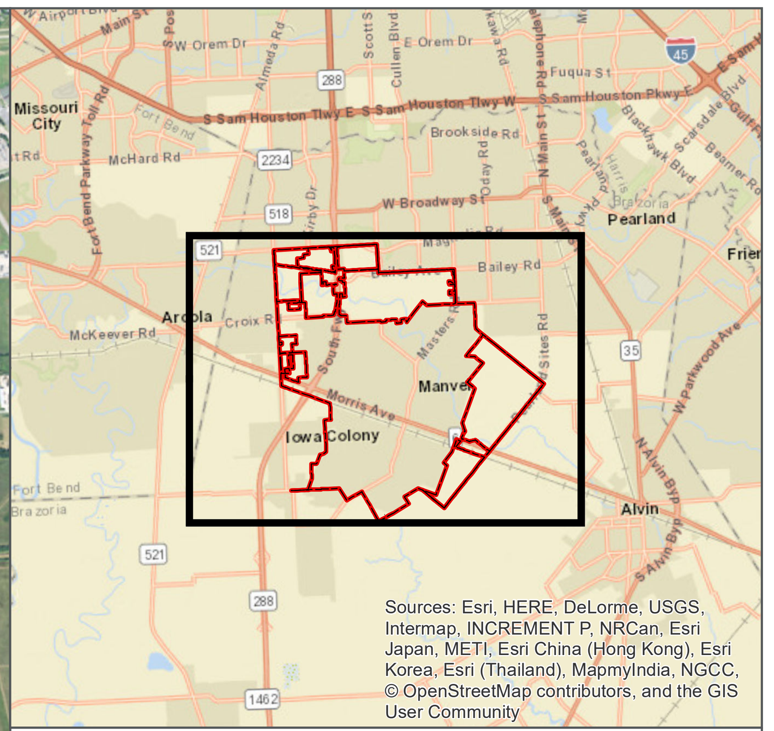
**Table 2 - City Water Infrastructure Evaluation Summary**

| TCEQ Parameter | TCEQ Regulation (Standard Value) | Manvel Existing 2017 Distribution System |
|---|---|---|
| **Supply Requirements** | Two or more wells having a total capacity of 0.6 gpm per connection | 1,400 gpm<br>(can serve a maximum 2,333 ESFC) |
| **Total Storage** | 200 gallons per connection | 425,000 gallons<br>(2-125,000 tanks and 1-175,000 tank)<br>(can serve a maximum 2,125 ESFC) |
| **Elevated Storage** | 100 gallons per connection | Not elevated storage (met with hydroneumatic tanks) |
| **Hydropneumatic Tank** | 20 gallons per connection with the maximum capacity of 30,000 gallons for up to 2,500 connections | 30,000 gallons (1-10,000 gal. tank and 1-20,000 gal. tank)<br>(can serve a maximum 2,500 ESFC) |
| **Pumping Capacity** | Two or more pumps with a total capacity of 2.0 gpm per connection | 3,000 gpm (Pumps replaced in 2017)<br>(can serve a maximum 1,500 ESFC) |

The City relies entirely on groundwater from the Gulf Coast Aquifer System. The City holds 4 groundwater well permits from the Brazoria County Groundwater Conservation District, but currently only 2 wells are used for potable water supply. These wells supply water to the School Water Plant from where it is distributed to the system. The City has another well that is used to service a city park as non-potable water.

As shown in **Table 2**, the City currently complies with the TCEQ requirements for public water systems, serving approximately 700 connections. However, the rapid growth anticipated for the City will result in greater than 1,500 connections by year 2020, which will require either additional booster pump capacity or the addition of elevated storage.




## Legend

- ETJ
- Existing Water Lines

### Developments

- Blue Water Lakes
- Lakeland
- Meridiana (Manvel)
- Newport Lakeside Estates
- Pomona
- Presidio
- Rodeo Palms
- Sedona Lakes
- Southfork
- Southpointe Crossing
- Sowell Property
- Service Area

DATA SOURCES: ESRI, HERE, DELORME, USGS, INTERMAP, INCREMENT P CORP., NRCAN, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), ESRI (THAILAND), TOMTOM, MAPMYINDIA, (c) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

# SERVICE AREA MAP

MASTER WATER PLAN
CITY OF MANVEL

N

0.4 0.2 0 0.4
Miles

MANVEL CITY ON THE RISE

HDR

FIGURE 1


DATA SOURCES: ESRI, HERE, DELORME, USGS, INTERMAP, INCREMENT P CORP., NRCAN, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), ESRI (THAILAND), TOMTOM, MAPMYINDIA, (c) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

## EXISTING CITY WATER DISTRIBUTION SYSTEM

MASTER WATER PLAN
CITY OF MANVEL

FIGURE 2

## 2.2 Existing MUDs Water Supply Infrastructure

In addition to the School Road Water Plant, there are an additional 4 existing MUD water plants within the City's ETJ, and two others either in the design or planning phase, as shown in **Table 3**. The Pomona, Rodeo Palms, Sedona Lakes, and Southfork MUD systems are not anticipated to be integrated into the City until the surface water plant is built. Town Center will connect to the City system as soon as it is online.

**Table 3 -** Existing MUDs Water Supply Infrastructure:

| Water Plant | Well Pump Capacity | Total Storage (gallons) | Hydropneumatic Tank (gallons) | Booster Pumping Capacity |
|---|---|---|---|---|
| Pomona (MUD 39) | 1,500 gpm | 125,000 | 15,000 | 3,300 gpm |
| Rodeo Palms (MUD 29) | 1,200 gpm | 318,000 | 30,000 | 3,916 gpm |
| Sedona Lakes (MUD 1) | 1,550 gpm | 330,000 | 30,000 | 2,250 gpm |
| Southfork (MUD 25) | 1,100 gpm | 280,000 | 20,000 | 2,250 gpm |
| Meridiana Phase I (MUD 56)* | 1,230 gpm | 500,000 | 30,000 | 3,150 gpm |
| Town Center* | 1,800 gpm | 400,000 | 30,000 | 4,000 gpm |

* Design Only

## 2.3 Water Infrastructure CIP for FY 2016-2020

The City has 10 planned water infrastructure projects in its CIP for fiscal years 2016-2020 as shown in **Table 4**. The need for these projects was evaluated during the course of this study, as presented in Section 4.

**Table 4 - Water Projects Identified for 2016-2020 CIP**

| CIP 2016-2020 | Description |
|---|---|
| Elevated Storage Tank | 100 Gallons per Connections when exceeding 2,500 Connections |
| Purchase Surface Water Rights | Negotiate and purchase surface water rights needed for buildout water supply |
| Cemetery Water Line Loop | 2,500 linear feet of 8-inch water line |
| Charlotte Water Line Loop | 2,500 linear feet of 8-inch water line |
| Rogers Road East Water Line Loop | 1,500 linear feet of 8-inch water line |
| Rogers Road West Water Line Loop | 3,300 linear feet of 8-inch water line |
| Tankersley Water Line Loop | 3,000 linear feet of 12-inch water line |
| SH6 East Water Line Extension | 6,000 linear feet of 12-inch water line |
| FM 1128 Water Line Extension | 9,000 linear feet of 12-inch water line |
| Del Bello Water Line Extension | 12,000 linear feet of 12-inch water line |

# 3 Water Demand Projections

## 3.1 Existing System Demands

The existing demands are based on the City's available water billing information from January 2015 through November 2016. Currently, the City provides service to the Lakeland subdivision in addition to the City limit customers. The City serves a total estimated 700 connections. Water demands for developments not served by the City were not evaluated. **Table 5** summarizes the average water use per day based on residential (meters 1 ½" and smaller) and non-residential (meters greater than 1 ½") for the City accounts and the Lakeland accounts. The overall average of all the meters is also shown.

**Table 5 - Existing Average Water Use per Connection**

| Developer | Residential (gpd) | Non-Residential (gpd) |
|---|---|---|
| City | 192 | 2,204 |
| Lakeland | 153 | - |
| **Total** | **169** | **2,204** |

## 3.2 Water Demands at Buildout

The water demands for buildout were projected based on information provided by developers and land use projections provided by the City. HDR contacted the engineers for the existing and planned developments for updated projections on ESFC planned for each community. This information was used to supplement data from the City's projections. Note that the projections for the Sowell development was based solely on information received from the City.

Land use data were used for the areas outside of the known/planned developments, based on information obtained from the City's GIS. As per the 2007 Comprehensive Plan, the areas are divided into different Intensity of Development Zones. Water demands for each zone were developed by estimating future ESFC for buildout conditions within each zone.

Water demands for these future areas were projected using the TCEQ's recommended water demand of 360 gallons per day per ESFC, which is considered a blended demand for a representative mix of residential and non-residential connections.

The summary of the ESFC and demand projections is provided in **Table 6**. The water demand per connection and the connection projections should be revised in the future as more information becomes available for areas outside current planned developments.

**Table 6 - Buildout Connections and Demand**

| Developer | Connections | Demand (gpm) |
|---|---|---|
| City (current) | 295 | 74 |
| City (future) | 30,288 | 7,572 |
| Lakeland | 818 | 205 |
| Southpointe Crossing | 800 | 200 |
| Blue Water Lakes | 508 | 127 |
| Sowell Properties | 2,000 | 500 |
| Presidio | 2,146 | 537 |
| Meridiana (MUD 56) | 3,451 | 863 |
| Southfork (MUD 25) | 1,340 | 335 |
| Newport | 200 | 50 |
| Rodeo Palms (MUD 29) | 2,156 | 539 |
| Sedona Lakes (MUD 1) | 1,385 | 346 |
| Pomona (MUD 39) | 2,892 | 723 |
| **Total** | **48,279** | **12,070 (17.4 mgd)** |

* Demands for areas outside of current planned developments are based on Intensity of Development Zones from the City's 2007 Comprehensive Plan

## 3.3 Water Supply Needed to Meet Buildout Condition Conditions

Based on the projected 48,279 ESFC at buildout (Table 6), the estimated average daily demand will be 17.4 million gallons per day (mgd) or 19,500 acre-ft per year.

The City's system and those of the existing developments are supplied by groundwater. Upcoming developments such as MUD 42 (Town Center) and Meridiana will also be supplied by groundwater. The Brazoria County Groundwater Conservation District does not require current permittees to develop a groundwater reduction plan to mitigate expected future land subsidence. However, based on the requirements of the adjacent Harris-Galveston and Fort Bend County Subsidence Districts and current ground subsidence trends in the area, it is anticipated that groundwater reduction program requirements similar to those of the Harris-Galveston Subsidence District may be adopted by the Brazoria County Groundwater Conservation District. These would require that no more than 20 percent (30 percent in the Fort Bend County District) of a City's water demand be met from groundwater sources. If Manvel is required to implement a groundwater reduction program in the future, alternative supplies will need to be developed to replace or offset future groundwater production. Based on expected buildout water demands, Manvel will need to develop 14 mgd (80% of 17.4 mgd) of alternative supplies. Note that the City of Pearland is currently using a 70/30 ratio of surface water to groundwater.

Regardless of the level of conversion to surface water, all groundwater wells should be kept operational to provide supply during times of emergency or operational shutdowns of the surface water sources.

### 3.3.1 Long Term Water Supply Opportunities

The surface water plant is anticipated to be located near the purchased sand pit location off Croix Road, as shown in **Figure 3**. This location provides not only access to the sand pit but it is also near the other supply opportunities (GWCA American Canal and Lateral 10 and the Pearland 30" Transmission Main).

#### Pearland

The City of Pearland invited the City of Manvel and City of Iowa Colony to a meeting on December 20, 2016 to discuss interest in treated or raw water supplies from Pearland. Pearland estimates they will have 6 mgd of available capacity on peak day at buildout. They are interested in making that water available to Manvel or Iowa Colony. Pearland has the ability to expand its surface water treatment plant to 40 to 50 mgd. If there is sufficient demand for treated water, it would be factored into the types of process options being piloted.

The City submitted a letter to the City of Pearland March 7, 2017 describing its anticipated water supply need and interest in either the treated or raw water. The coordination and negotiations will continue after the completion of this report.

#### Gulf Coast Water Authority

HDR met with Mr. Ivan Langford with GCWA and the City on April 10, 2017 to discuss the current availability of surface water supply from the Brazos River Authority (BRA) delivered through the GCWA system. As stated by BRA, all surface water in Texas is owned by the state. The water can be obtained by 1. being a landowner with property adjacent to a waterway (for limited riparian uses), 2. obtain a water right from the state, or 3. purchase water supply from a person or organization (such as GCWA) that currently holds water rights. Currently, BRA has only interruptible supply available for long term contracts. BRA interruptible contracts are issued for terms up to five years. The amount of interruptible water available for contracting is site specific and varies annually. The BRA Board has authorized the sale of 90,588 acre-feet of interruptible water for calendar year 2017. The rate for interruptible water is the BRA System Rate, which is $72.00 per acre-foot in fiscal year 2017.

BRA is currently conducting a study to determine if the agency might be able to make additional interruptible water available for sale. As with the City of Pearland, the City sent a capacity request letter to GCWA on March 7, 2017. Mr. Langford also recommended sending a capacity request directly to BRA.

## Sand Pit Water Harvesting

The City of Manvel has contracted with LRE Water, LLC (LRE) to investigate the possible use of the Manvel Sand Pit as a surface water supply. The following is a summary of information from LRE as provided by the City.

The sand pit is located approximately 1 mile east of State Highway 288, see **Figure 3**. The property is bounded to the south by County Road 58 (Croix Rd), to the west by private residences and County Rd 90 (Del Bello Rd), to the north by Mustang Bayou, and to the east by Oak Crest Dr. The property spans approximately 106 acres. Nearby drainage infrastructure includes various street-side drainage ditches, Mustang Bayou, and the Lateral-10 canal owned by the GCWA.

The pit is in direct connection to the underlying groundwater system and use of water from the pit would likely constitute use of groundwater. To determine the sustainability of water withdrawals from the Manvel Sand Pit, LRE Water limited pit drawdown to 1.6 ft. LRE Water used the MODFLOW groundwater model to determine the allowable pumping rates that could be sustained without causing drawdown greater than the 1.6 ft threshold. **Table 7** presents sustainable pumping rates under two alternative operations – continuous pumping and a weekly pumping cycle at greater pumping rates following a "one-week on, one-week off" schedule. The weekly pumping schedule would allow time for the water levels to recover in the pond. Under the weekly pumping cycle, water levels would be maintained for a period of 6 months, but would not be sustainable at those greater pumping rates for a longer period of time.

**Table 7 - Sand Pit Sustainable Pumping Rates**

| Scenario | MGD |
|---|---|
| Continuous | 0.115 |
| One Week Cycle | 0.72-1.08 |

The report from LRE also discusses options such as sale of water to GCWA at Lateral 10 or using the site as a recreational facility.

## Wastewater Reuse

The City has considered using effluent from its wastewater treatment plant to supplement its potable water supplies. While examination of alternatives for effluent use was not part of the scope of this master plan effort, HDR is fortunate in that we have performed numerous water reuse projects and have staff that are considered leaders in the field of water reuse and have included information in this section which may be helpful to the City. Having performed Type I and Type II Reuse projects and currently working on indirect potable water reuse projects in Lubbock and Abilene, Texas we drew upon our staff to provide insight for Manvel's benefit.

It should be understood that typically direct and indirect reuse of effluent for potable water is not cost effective if more traditional surface water or groundwater supplies are available. However, as populations grows, the demand for reliable water supplies increases the use of reclaimed wastewater becomes more economically viable. As available supplies become strained, municipalities begin looking at alternative sources once considered to be too expensive or undesirable to fulfill their water supply needs. Often overlooked because of public perception, the use of treated wastewater to supplement potable water supply sources has not been widespread until recently except in areas with low annual rainfall or exhausted conventional supplies. With the improvements in treatment technology and the increasing costs of alternative water supplies, reuse of treated wastewater effluent is becoming more viable for all types of reuse economically for these areas. As the cost of water supplies increase, and with an effective community outreach program, reusing wastewater to supplement drinking water supplies is becoming more acceptable to the general public as well.

There are four general wastewater reuse options available, which are discussed below in the order of increasing and more stringent finished water quality requirements.

- Type II Reuse. Treated wastewater effluent is used for purposes where human contact is limited. Potentially Type II Reuse applications include irrigation water that is not likely to contact edible portions of a crop, animal feed-crop irrigation that does not involve milking operations, supply to non-recreational water bodies, soil compaction, dust control, cooling tower makeup water, and certain industrial applications such as well fracking.
- Type I Reuse. Treated wastewater is used for purposes where human contact is possible or likely. Because of the likelihood of human contact or consumption, disinfection requirements and treatment standards are more stringent for Type I Reuse water than for Type II Reuse water. Type I Reuse applications include irrigation of public spaces including parks, residential lawns, and athletic fields; fire protection; and irrigation of food crops and pastures grazed by milking animals. Many new residential and commercial developments and some cities are implementing Type I Reuse distribution networks to reduce reliance on the more expensive potable water supplies.
- Indirect Potable Reuse (IPR). IPR is the incorporation of treated wastewater into a raw water supply specifically to supplement drinking water supplies. In an IPR application, wastewater effluent is placed into an environmental buffer between the wastewater and water plants and may or may not be blended with other raw water supplies. Environmental buffers may include water storage reservoirs, rivers, aquifers, and canals or other similar infrastructure. Much of today's surface water supplies can be considered to be indirect reuse due to wastewater discharges located upstream of many surface water intakes.
- Direct Potable Reuse (DPR). DPR is the introduction of highly treated wastewater effluent either directly into a potable water treatment plant supply, or directly into a potable water distribution system. DPR has been implemented by the Colorado River Municipal Water District in Big Spring, and by the City of Wichita Falls in response to ongoing drought conditions.

Type I and Type II Reuse systems are common and are fairly straightforward in application. They have received general acceptance by the public. DPR systems are less common and require careful planning to reliably meet drinking water requirements.

The main issues with developing a potable reuse system are public perception, health risks, applied treatment technology, and costs. With today's advances in water quality monitoring and treatment capabilities, there are no technological barriers for treating wastewater to drinking water standards except as they relate to cost and reliability. Overcoming public perception has always been difficult, but rising utility rates and water shortages are reasons for cities to consider a water reuse program. If such a program becomes desirable for the City of Manvel, a comprehensive community outreach program will be necessary to help overcome the concerns of the public.

The City has also expressed desire to potentially discharge wastewater effluent to GCWA's American Canal to offset the potential cost of purchasing raw surface water as the drinking water source of supply. Currently, GCWA does not have any water quality standards published for this application or actively pursuing or accepting effluent from adjacent communities. It would be necessary to coordinate and reach an agreement with GCWA in order to accomplish such a goal. It would be expected that GCWA would be facing the same public concerns issued noted in the previous paragraph.

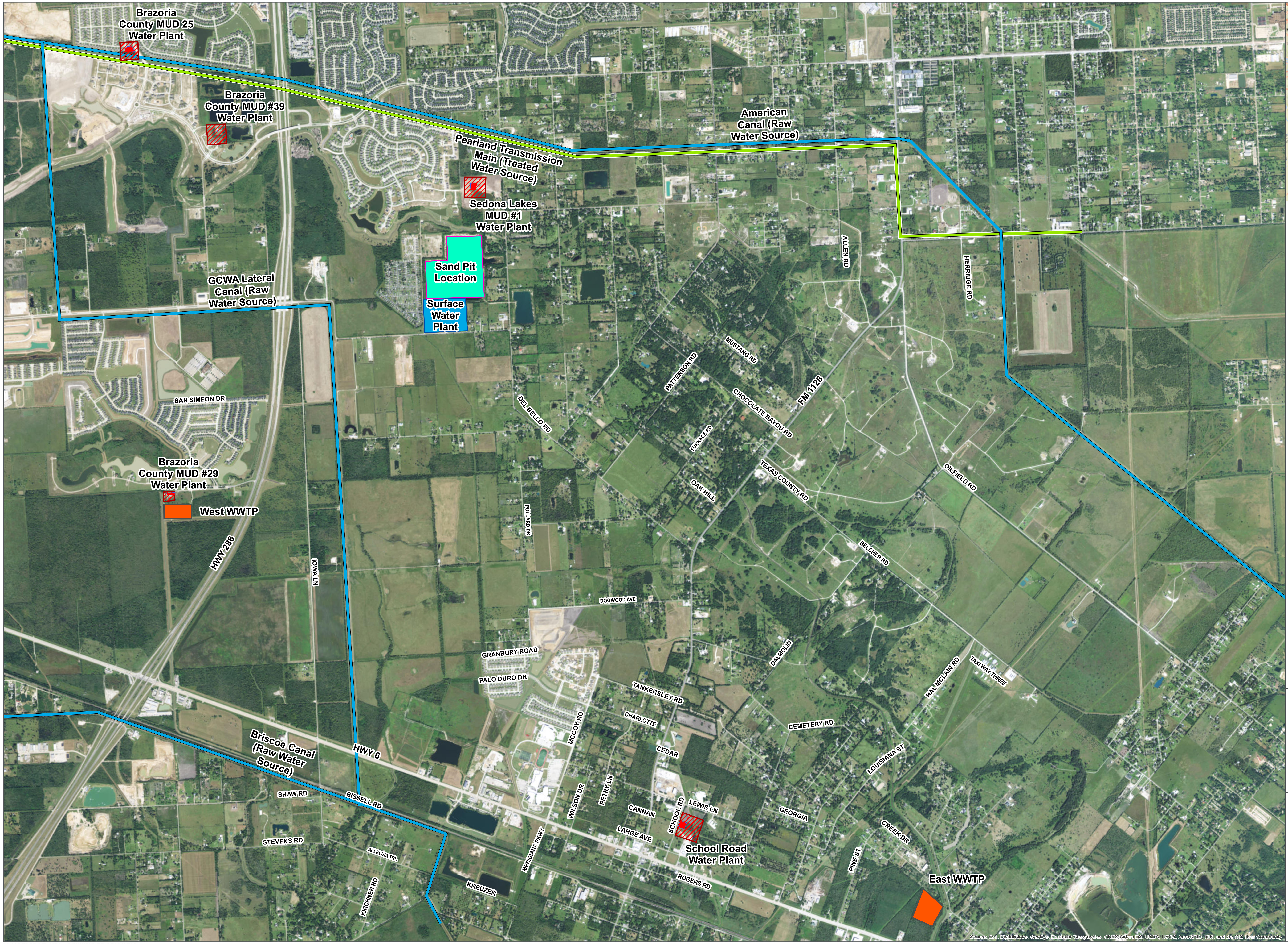
If the City would like to pursue the potential for direct or indirect reuse of its wastewater effluent either for its own use or through sale to other entities (i.e., GCWA), HDR recommends that the City perform a feasibility study to evaluate in more depth the various options available. The feasibility study should evaluate anticipated water quality from both the wastewater plants and other potential raw water sources, treatability of supplies, and blending opportunities to determine the potential treatment processes necessary for both the water and wastewater sources.

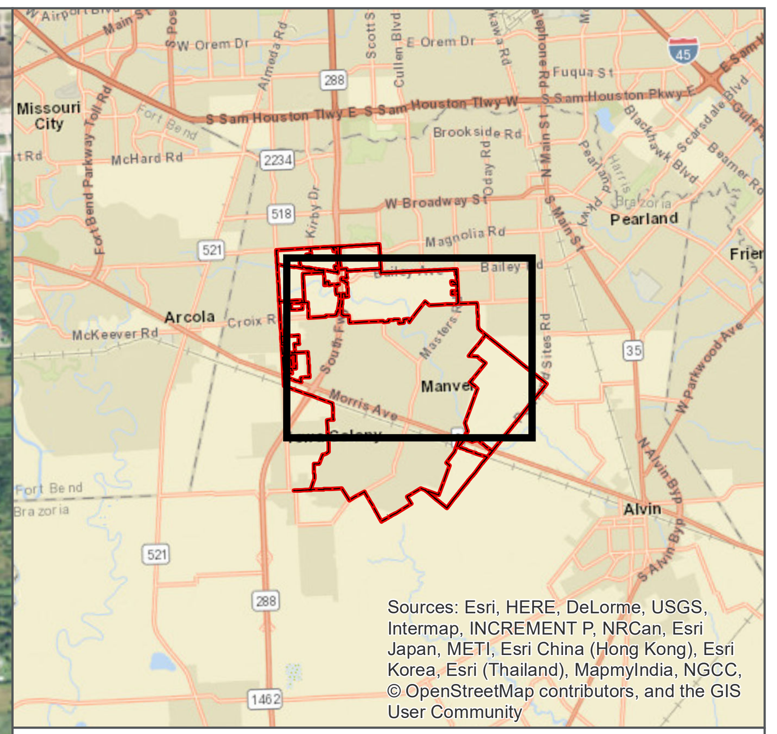
**Table 8** below shows the expected volumes of wastewater effluent that might be available for reuse from the existing and future wastewater treatment plants.

**Table 8 - Wastewater Average Daily Flow**

| Year | Existing WWTP, mgd | East Regional WWTP, mgd | West Regional WWTP, mgd | Total Available Effluent, mgd |
|---|---|---|---|---|
| 2022 | 0.4 | 0.26 | 0.83 | 1.49 |
| 2027 | 0.4 | 1.53 | 1.15 | 3.08 |
| 2037 | - - | 4.48 | 3.16 | 7.64 |

Source: Freese Nichols Inc. 2017 Wastewater Master Plan




## Legend

- Existing Water Plants
- Surface Water Treatment Plant

**Other Water Supply Options**

- Pearland 30" Main
- GCWA Canal
- Sand Pit Location
- Wastewater Treatment Plant

DATA SOURCES: ESRI, HERE, DELORME, USGS, INTERMAP, INCREMENT P CORP., NRCAN, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), ESRI (THAILAND), TOMTOM, MAPMYINDIA, (c) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

**WATER SUPPLY**

MASTER WATER PLAN
CITY OF MANVEL

N
0.25 0.125 0 0.25 Miles

MANVEL CITY ON THE RISE

HDR

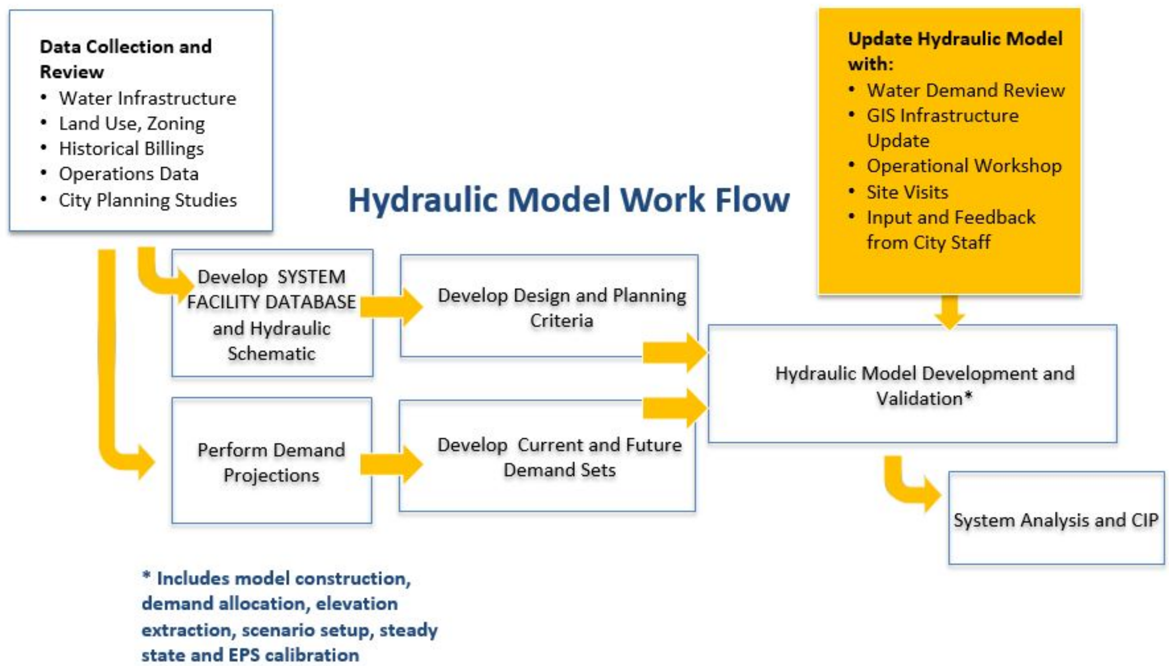
FIGURE 3

# 4 Hydraulic Model and System Analysis

## 4.1 Hydraulic Model

**Figure 4** below shows the standard workflow for the hydraulic model development and analysis process. Note that the process shown is a typical workflow used for model development and not all the steps were required for this master plan.

**Figure 4 - Typical Hydraulic Model Development Workflow**




In agreement with the City, HDR's modeling team utilized the EPANET Version V2.00.12 modeling software by United States Environmental Protection Agency (U.S. EPA). The model includes all water facilities in the distribution system including water pipelines 2-inch in diameter and greater, groundwater wells, water tanks, and booster stations as represented by the data provided by the City. Water pipelines and their associated parameters (e.g. diameter, lengths, and connectivity) were imported from the City's GIS into the model. Ground elevations (based on DEM data) were also used as model input data. Water demands and other necessary data such as operating conditions, control sets, and system curves were incorporated into the model from other information provided by the City.

### 4.1.1 Infrastructure Elevation Extraction

The elevations of all nodes in the model are established from the DEM data obtained in the form of 2-ft contours. The elevations for the model nodes are interpolated from the contours and spot checked using Google Earth. Ground elevation was used as the representation of infrastructure elevation. Pressure results predicted by the model will represent to system pressures measured at ground level.

### 4.1.2 Average Water Demands and Demand Peaking Factors

In order to establish average demands and maximum day peaking factors, the City provided daily production data, demand data and monthly consumption data. Average day demand (ADD) was calculated for each of the records and used as the baseline for the hydraulic model. The historical datasets of daily production data were used to determine a maximum day demand (MDD) peaking factor, which represents the ratio between the demand that occurs on the day with the highest water use during the year and the average day demand. Historical analysis of the demand data provided by City estimated that the maximum day demand peaking factor is 1.8. This peaking factor was used to develop MDD scenarios for this effort, by multiplying the average day demands by the City's MDD peaking factor. All demands in the system are scaled proportionally using the MDD peaking factor to develop the maximum day scenario.

Peak-hour demands can also be an important factor in sizing distribution and storage facilities. These typically are incorporated into an extended period simulation to evaluate operation of a water system throughout a 24-hour to 48-hour maximum demand period. The scenarios developed for this analysis utilized only a steady state model, and no extended period simulation was performed, and peak-hour demands were not evaluated. However, the scenarios included in this analysis can be modified to incorporate extended period simulation with diurnal demand patterns if required in the future.

## 4.2 Hydraulic Planning Criteria

Hydraulic planning criteria were established to evaluate the existing system, identify deficiencies, and to determine the size of the new transmission facilities such as water pipelines, and storage tanks. **Table 9** summarizes these criteria, which are planning level criteria and should not be considered Level of Service (LOS) criteria for the City.

**Table 9 - Summary of System Performance Criteria**

| Element | Description |
|---|---|
| Distribution System | **Minimum Pressure**<br>- 35 psi during maximum day<br>- 20 psi during maximum day plus fire flow |
| | **Maximum Pressure**<br>- 120 psi |
| | **Maximum Allowable Velocity for distribution lines**<br>- 12 ft/sec for existing pipes under Max Day conditions<br>- 6 ft/sec for new pipes under Max Day conditions<br>- 15 ft/sec under Max Day and Fire Flow conditions<br>- 8ft/sec for transmission lines |
| | **Maximum Allowable Head-Loss Rates for distribution lines**<br>- 5 ft/1000ft under any conditions other than Fire Flow<br>- 8ft/1000ft for transmission lines |

| Element | Description |
| --- | --- |
| | **Existing System Fire Flow Requirements**<br>- These requirements are for water system master planning purposes. The Fire Department sets the specific requirements for individual subdivisions<br>- One fire at a time in zone (no simultaneous fires in the same pressure zone). |
| | **Flow Rates and Durations**<br>- Required fire flow used- 1,200 gpm for 2 hours |
| Elevated Storage Capacity | **Storage Capacity:**<br>**-** Provide for 100 gallons of storage per connection for scenario conditions. |

The distribution system evaluation criteria are used to identify system capacity constraints. They specify how the pipes that make up the distribution system should perform. System pressures, velocities and head–loss rates are the major pieces which impact system performance. Acceptable system performance is indicated by each of the elements of the distribution system evaluation meeting the required criteria.

System pressures are generally desired to be above 35 psi under normal and maximum day operation to allow for all users in the system to have adequate working pressures at their connections. Under maximum day with fire flow conditions pressures as low as 20 psi are allowable to avoid oversizing the system. The maximum system pressure used for the model was 120 psi but the maximum modeled pressures in the model did not exceed 90 psi. Excessive pipe velocities and pipe head-loss rates are indicators of undersized pipelines and might lead to inefficient operations. High velocities can damage pipelines and system valves, and cause low system pressure. Large head-loss rate values can cause low system pressure and require excessive pumping. System velocities and head-loss rates are criteria are used for sizing new pipes and are designed to identify elements within the system which cause unnecessary energy expenditures and low pressures. High velocity and head-loss rates conditions can also cause a number of other problems such as rapidly scouring or deteriorating pipes and high surge pressures, both of which can shorten the lifespan of distribution system elements.

The required elevated storage for a water system is equal to 100 gal per connection for the City's service areas based on the TCEQ criteria. Usually the storage takes into account three key elements: operational, fire protection and emergency storage. These components can be calculated individually for each pressure zone and are then combined to determine the total required storage for that zone. These components are analyzed on a system wide basis based on the TCEQ per connection basis criteria to determine how well the system meets storage criteria as a whole in this report.

## 4.3 Water Distribution System Analysis

This section discusses the findings of the hydraulic analysis of the water distribution system which was carried out using the hydraulic model of the City's system. These include system evaluations for both the existing conditions (2016) and future (Buildout and City Integrated scenarios) conditions. The system evaluations were performed using the City's hydraulic model to analyze system performance and identify deficiencies.

### 4.3.1 Project Planning Scenarios

Manvel's existing model provided by the City was expanded to evaluate three scenarios to aid in short- and long-term planning by the City.

#### Existing Condition Scenario: Baseline

This version of the model expanded the existing model to include projects identified in the City's 5-Year CIP. The water demands on this model were developed using the same methodology as described in Section 3 as it applies to the areas served by the proposed projects. HDR compared these results with the planned pipe sizes. This analysis will provide Manvel with the information needed to decide whether to modify the planned pipe size or length of the CIP project or defer building that capacity until required by actual development.

#### City Limits Buildout

This model scenario evaluates incorporating an additional water supply (i.e. the New Surface Water Treatment Plant) and the transmission network components required to satisfy the water demands under full development of all land inside the City Limits. Because the locations and timing of actual developments are not known at this time, this analysis is intended to create a base case for general planning and budgeting purposes. The system components identified under this scenario will need to be re-evaluated once the timing, location and extent of specific development projects become better defined.

#### Integrated City Limits and MUD Infrastructure

This model scenario connects the City Limits Buildout Scenario, with the existing MUD infrastructure to identify the location and sizes of interconnects needed to supply water to MUDs within the ETJ. This model scenario is intended to identify potential system improvements needed to interconnect and serve the isolated MUD developments within the ETJ.

## 4.4 Hydraulic Analysis/Model Assumptions

The analyses described herein were performed under the following assumptions, as directed by City staff:

- HDR will use the water model provided by the City del "As-Is" for the existing conditions hydraulic analysis. It is assumed that the current City model reflects the City's water infrastructure and operation conditions accurately and no additional model refinement or calibration was completed.
- No modeling of service to wholesale water purchasers outside of the City Limits or ETJ.
- The Buildout model network will be based on a single surface water treatment plant and transmission system originating at that location. All other sources of water would be assumed to be delivered to this site for distribution through the system.

- Cost estimates for infrastructure beyond 2020 will be for the specific water system asset only. These do not include ancillary costs of roads, drainage, utility relocations, property acquisition or other ancillary costs of implementing the project.
- HDR's assumption is that Manvel will, for some time frame, continue to develop water infrastructure through developer-led construction. The intent of the various model versions is to provide Manvel with a water modeling tool to evaluate how each of those developments will fit into the long-term plan.
- No water quality analysis, evaluation of water source blending, or assessment of water age will be performed in these model runs. Those evaluations require detailed data on the quality, stability, age and proposed blending ratios to develop actionable data. Those evaluations will be needed at the point in time when Manvel begins to utilize additional sources of water.
- Steady state model runs will be for Average Day Flows and Maximum Day Flows only. Since the future scenarios will include only larger transmission facilities, fire flow analysis will not be performed since fire-flow analyses are typically performed on distribution system level piping s.
- Due to the rapid growth expected by the City, the MWP should be updated every five years and the model re-evaluated to match new infrastructure and new water demands.

## 4.5 Hydraulic System Analysis

This sub-section discusses the findings of the hydraulic modeling analysis using the City's model. The analysis was based on the performance of the system in comparison to the hydraulic planning criteria developed for the City. The hydraulic system analysis performed included storage evaluations as well as distribution/transmission system pipeline analyses.

### 4.5.1 Existing System Evaluation Approach and Results

Model runs were simulated using the Existing System Scenario under ADD and MDD conditions. System performance was evaluated under the specified demand conditions. Future demands were incorporated to evaluate whether the projects in the existing five-year CIP would need to be replaced or upgraded to support water demands at Buildout.

#### Existing Storage Evaluation

As described in Section 2.1 of the report, the City is currently meeting the TCEQ requirements for total and pressurized storage, however the City will soon not meet the criteria for booster pump capacity, requiring the addition of either additional pumping capacity or elevated storage.

HDR evaluated the proposed location of an elevated tank to serve the current city and the adjacent developments. In addition to meeting TCEQ requirements, the elevated tank would be able to supply water during a high demand situation such as during a fire.

These tanks typically empty during the day and refill each night when other demands on the system are small.

Based on conversations with the City and information from local developers, the following projected ESFC in **Table 10** were used for the sizing of the proposed elevated tank.

**Table 10 - Elevated Storage Connection Projections**

| Developer | ESFC |
|---|---|
| City | 800 |
| Lakeland | 818 |
| Southpointe Crossing | 800 |
| Blue Water Lakes | 508 |
| Sowell Properties | 2,000 |
| Presidio | 2,146 |
| **Total** | **7,072** |

Using the TCEQ standard of 100 gallons per connection, the required elevated storage would be 677,200 gallons. With the assumption that the existing hydropneumatic tanks would remain in the system, the required elevated storage can be reduced by 250,000 gallons (based on 2,500 connections allowed capacity); therefore the required elevated storage is 457,200 gallons. The tank would be sized at a nominal capacity of 500,000 gallons.

Three options for locating the tank were reviewed with City staff and are shown on **Figure 5**.

Option 1 is located off Highway 6 near Corporate Drive near an existing 16-inch water main. The site is owned by the City of Manvel. The site is close to the existing wastewater plant, but does have the 500-ft buffer required for any elevated tank site. Even though the main feed would come from the 16-inch main, an additional connection to the system near Lakeland is recommended for redundancy.

Option 2 is located just west of the Lakeland development. This option was evaluated due its more centralized location. As in Option 1, a redundant connection would be installed to an existing 12-inch line on Highway 6.

Option 3 is located towards Highway 288 in the proposed Southpointe Crossing development. Based on the development layout, a water plant site has been planned. This location provides the furthest location from the existing service area but would be located closer to the future commercial areas. At this time, there is no nearby connection point for the tank. It would require the installation of a 12-inch water main along Iowa Lane from the 12-inch water main at Highway 6.

All sites produced acceptable pressure support for this system, and all can be considered hydraulically equivalent. Therefore, Option 1 is recommended since it appears to be the most cost effective and does not require land acquisition for the site. An easement may be necessary from Lakeland to make the connection to the Lakeland subdivision. It appears that the 8-inch redundant water main to Lakeland would be primarily within existing City-owned rights of way.

The tank elevation would be approximately 140-ft. This will be confirmed and refined during the preliminary design of the project. The 500,000 gallon elevated storage and other necessary improvements are estimated to cost approximately $2.85 million, including engineering services. The City only has $1.4 million budgeted for this project as part of their bond issue. During a meeting held with the City on May 31st, the City requested that the tank size be reduced to 250,000 gallons based on the budgetary constraints. City staff has noted that developments at Southpointe Crossing and Presidio will only be partially installed in the next 5 to 10-year time period, and the schedule for development of the Sowell Property is not known. Considering the expected delay in development and anticipating that the needs are reduced then a reducing the initial size of the elevated tank is acceptable.

As described previously, the City's hydropneumatic capacity allows for up 2,500 connections. After that point the City must install elevated storage tank. Installation of the proposed elevated storage tank (at the reduced 250,000 gallons) will allow the City up to 5,000 connections. However, by initially installing a smaller tank, the City understands that an additional elevated storage tank may be required based on the rate of growth of development in the City system.

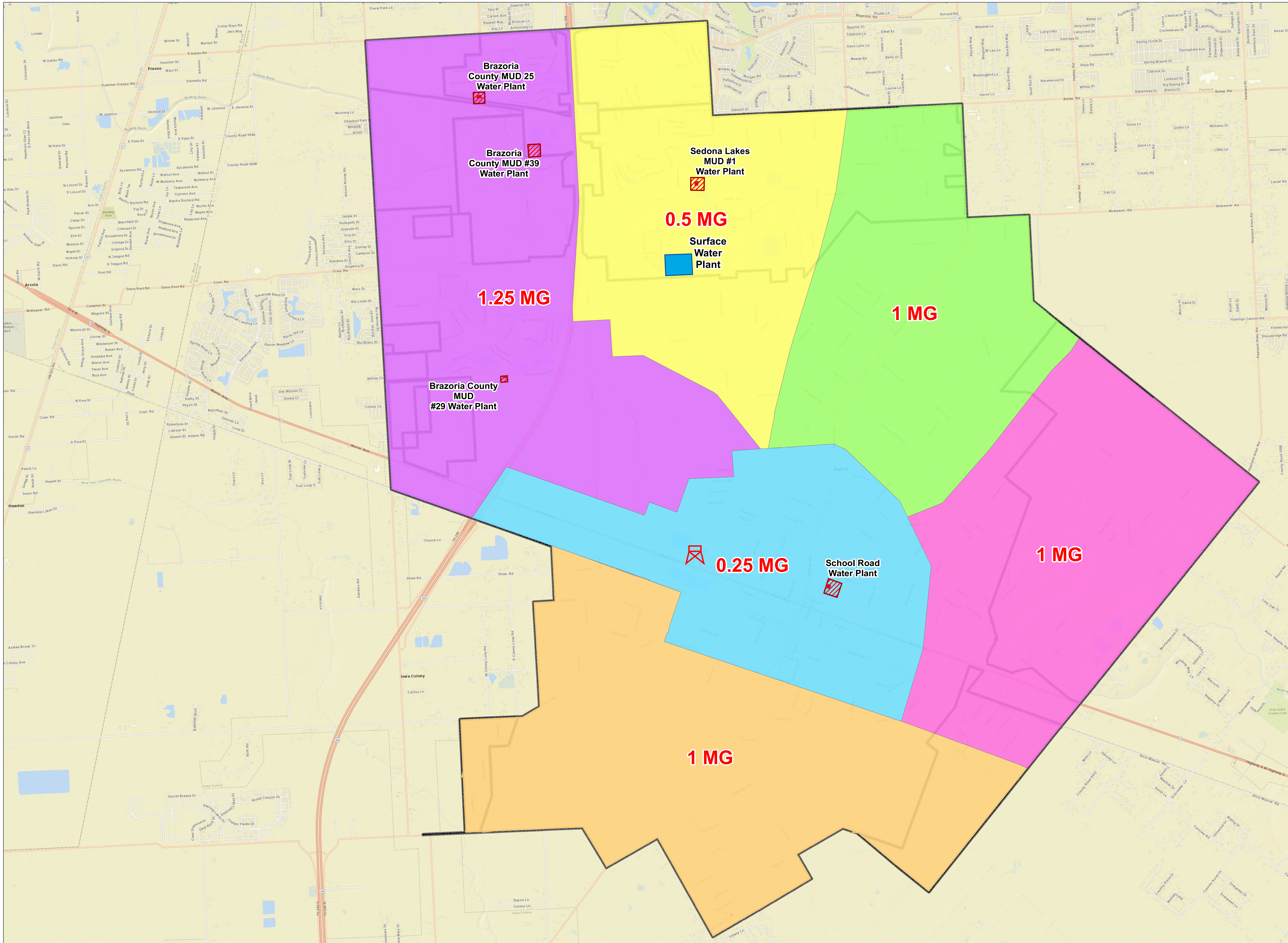
### 4.5.2 Buildout and Integrated Scenario Analysis

Evaluations for the transmission network required for City's buildout and integrated scenario were carried out using the hydraulic model. The existing model was expanded based on the City's recently developed thoroughfare plan. This analysis included model expansion to include the various future developments and their anticipated demands listed in Section 3.

The model was developed only to include the larger-sized pipes of the transmission pipeline network and not the smaller distribution network pipes. For the purpose of this analysis, transmission infrastructure are those pipes needed to move water from points of supply to points of connection to the distribution piping which then connects directly to customer services. This approach was adopted to account for the uncertainty in timing and internal lay-out of the developments subject to changes over time. These developments were included as point demand nodes in the model and connected with 12" or larger mains to build the transmission-trunk network for the future scenario. Note that the transmission pipes were limited to a maximum diameter of 24" as requested by the City. **Figure 7** shows the pipe sizes and general layout of the transmission network for City's buildout.

## Buildout Elevated Storage Evaluation

Based upon the projected number of connections at buildout, several additional elevated storage tanks would be required. The City was divided into several zones of likely contiguous development, and elevated storage tanks were identified whose sphere of influence would be within or near each zone. The general sphere of influence for each the storage tank is shown in **Figure 5**. Note that as the developments occur, detailed studies should be carried out to determine the optimal spatial location of the EST. It is also recommended that there be a hydraulic operational study carried out to see what the best strategy will be for the City areas to be divided into pressure planes or subareas, depending upon the locations of these ESTs to ensure proper tank cycling/fill-drain operations. The number and size of the future elevated tanks can change based on the development growth and timing of development within the ETJ.




**ULTIMATE BUILDOUT**
ELEVATED STORAGE AREAS

MASTER WATER PLAN
CITY OF MANVEL

FIGURE 5

# 5 Capital Improvement Program

This section summarizes the proposed capital improvements for the 5-Year and Buildout scenarios. The budgeted project costs are based on today's costs and must be updated at the time of the project implementation.

## 5.1 5-Year CIP Recommendations

HDR confirmed the projects in the City's current CIP. These projects include system improvements and extension of the existing system for future development. The proposed 5-Year CIP is shown in **Figure 6** and summarized in **Table 11**. There were no addition projects added but modifications are recommended to the Elevated Storage Tank, Tankersley Water Line Loop, and the FM 1128 Water Line Extension. The projects are shown based on the priority determined by the City.

**Table 11 - 5-Year CIP Recommendations**

| Existing 2016-2021 CIP | Project Cost | Trigger |
|---|---|---|
| 250,000 Gallon Elevated Storage Tank | $1,915,000 | 2,500 Connections |
| Purchase Surface Water Rights | $5,000,000 | In progress |
| Rogers Road West Water Line Loop | - | In construction |
| Rogers Road East Water Line Loop | $159,100 | FY2017 |
| Charlotte Water Line Loop | $248,400 | FY2017 |
| Cemetery Water Line Loop | $218,700 | FY2017 |
| Tankersley Water Line Loop | $479,600 | FY2018 |
| SH6 East Water Line Extension | $894,300 | FY2019 |
| FM 1128 Water Line Extension | $1,788,500 | Developer Driven |
| Del Bello Water Line Extension | $1,341,400 | Developer Driven |

- Elevated Storage Tank:

  As noted in Section 4.5.1, the recommendation of the tank size is based on discussion with the City. The project has been revised to include the additional 8-inch water main to the Lakeland subdivision. Due to the project still projected to be over the budget set in the bond by over $400,000, the City can elect to construct the 8-inch water main at a later time (savings of approximately $180,000) or include it as an add alternative bid item.

- Rogers Road East Water Line Loop

  This project includes extending an 8-inch water line approximately 1,600 linear feet from the C1 ditch to Cemetery Road, and then to the 12-inch water line at Large Road.

- Tankersley Water Line Loop:

  The original CIP recommended that the Tankersley Water Line Loop Project would extend a 12-inch water line along FM 1128 from Charlotte to Tankersley, down Tankersley to McCoy. Base on the ultimate buildout and recommended transmission main layout, HDR recommends that the section of pipe on FM 1128 be enlarged to 16-inch. This project now consists of approximately 2,500 linear feet of 12-inch water line and 900 linear feet of 16-inch water line.

- Rodgers Road West Water Line Loop:

  This project is currently under construction. It replaces an existing 4-inch water line with approximately 3,400 linear feet of 8-inch water line, fire hydrants, and shut off valves. Extending from Masters (west to McCoy) this line would loop back into the 16" water line at State Highway 6 and McCoy.

- Cemetery Water Line Loop :

  The Cemetery Water Line Loop connects the existing 12-inch water line on Cemetery Road to the existing 8-inch water line on Lewis Lane. This project consists of approximately 2,200 linear feet of 8-inch water line.

- FM1128 Water Line Extension Phase 2

  FM 1128 is recommended to be a major corridor for the transmission main network for buildout. HDR recommends changing the pipe to 16-inch. The project consists of approximately 9,000 linear feet of 16-inch water line along FM 1128 from Tankersley to Chocolate Bayou. This project is primarily driven by development growth in the area.

- SH6 East Water Line Extension

  In order improve fire protection and promote economic development along SH6 to the eastern City Limits, this project identifies a new water main to extend from the current termination point (near ProBuild Lumber) to the eastern City Limits. It is anticipated that a 12-inch water line extended approximately 6,000 linear feet will be the ultimate design for this project. There is currently no City water in this general vicinity, this project will allow for future development in the area.

- Charlotte Water Line Loop

  The Charlotte Water Line Loop Project would connect McCoy with FM 1128 with approximately 2,500 linear feet of 8-inch water line.

- Del Bello Water Line Extension

This project consists of approximately 9,000 linear feet of 12-inch water line. Tankersley Water Line Loop and FM1128 Water Line Extension need to be completed prior to this project. The connection point for the water main will be to the anticipated 20-inch water main from the proposed surface water plant. The original footage was 12,000 linear feet.

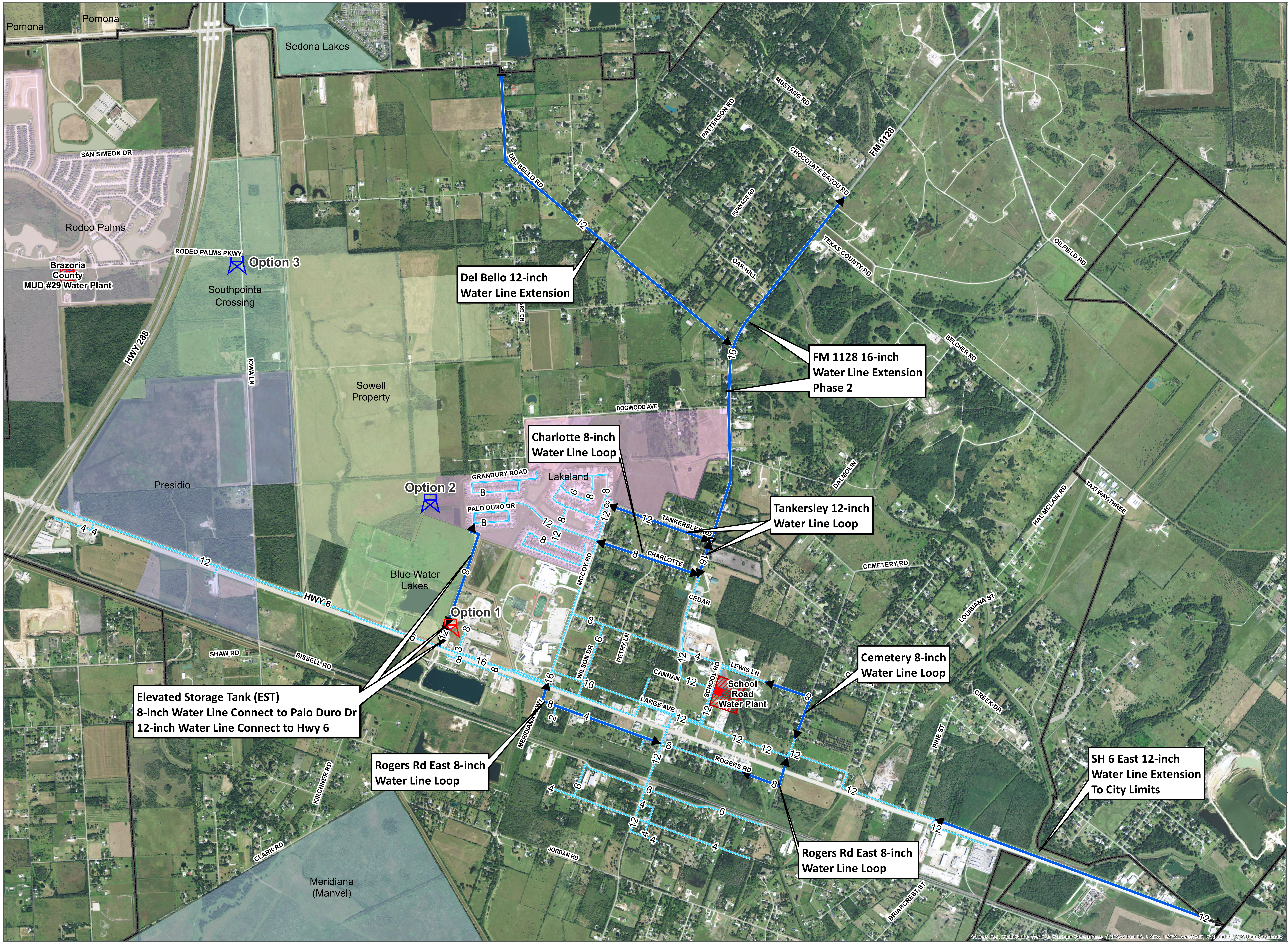
## 5.2 Ultimate Buildout CIP

As described in Section 4, HDR has provided a proposed water transmission network based on the planned land use for the City under ultimate buildout conditions. Timing is not provided for the buildout recommendations since it is dependent on the actual timing of development. **Table 12** and **Figure 7** show the recommend improvements for buildout. The locations of possible system interconnects with existing developments are also shown in **Figure 7**. The system interconnects are recommended as emergency water supply sources. Please note that additional improvements such as water plants (including wells, storage tanks, booster pumps) and distribution networks by developers (or the City) are not included.

As development occurs, these projects should be re-evaluated and the basis for design refined to more closely match actual future conditions. The improvements identified here are intended to provide only a rough basis for planning and budgeting future water system improvements so that the City has a strategic framework for accommodating future development and a strong understanding of the potential costs for expanding its water system to meet future demands.

**Table 12 - Ultimate Buildout Recommendations**

| Item No. | Qty. | Units | Description | Unit Price | Total |
|---|---|---|---|---|---|
| 1 | 4,220 | L.F. | 8" Water Main | $72 | $303,800 |
| 2 | 181,300 | L.F. | 12" Water Main | $108 | $19,580,400 |
| 3 | 60,450 | L.F. | 16" Water Main | $144 | $8,733,600 |
| 4 | 10,240 | L.F. | 20" Water Main | $180 | $1,843,200 |
| 5 | 15,230 | L.F. | 24" Water Main | $216 | $3,289,700 |
| 6 | 1 | EA. | 0.5 Million Gallon Elevated Storage Tank | $2,200,000 | $2,200,000 |
| 7 | 3 | EA. | 1 Million Gallon Elevated Storage Tank | $4,500,000 | $13,500,000 |
| 8 | 1 | EA. | 1.25 Million Gallon Elevated Storage Tank | $5,312,500 | $5,312,500 |
| 9 | 1 | L.S. | 14 Million Gallon Surface Water Treatment Plant | $126,000,000 | $126,000,000 |
| | | | | **Subtotal:** | **$180,763,200** |
| | | | | **20% Construction Contingency:** | **$45,191,000** |
| | | | | **Professional Services** | **$33,894,000** |
| | | | | **Total:** | **$225,954,200** |




## Legend

- ETJ and City Limits
- Existing Water Plants
- Existing Water Lines
- 5-Year CIP Water Lines
- Option 1 - Recommended
- Option 2
- Option 3

DATA SOURCES: ESRI, HERE, DELORME, USGS, INTERMAP, INCREMENT P CORP., NRCAN, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), ESRI (THAILAND), TOMTOM, MAPMYINDIA, (c) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

# 5-YEAR CIP PROJECTS

MASTER WATER PLAN
CITY OF MANVEL

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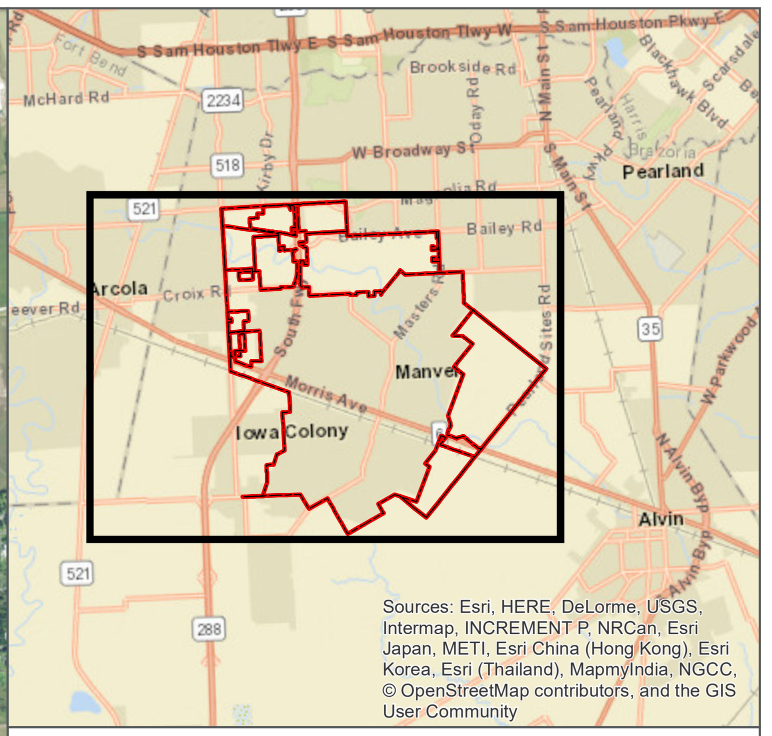
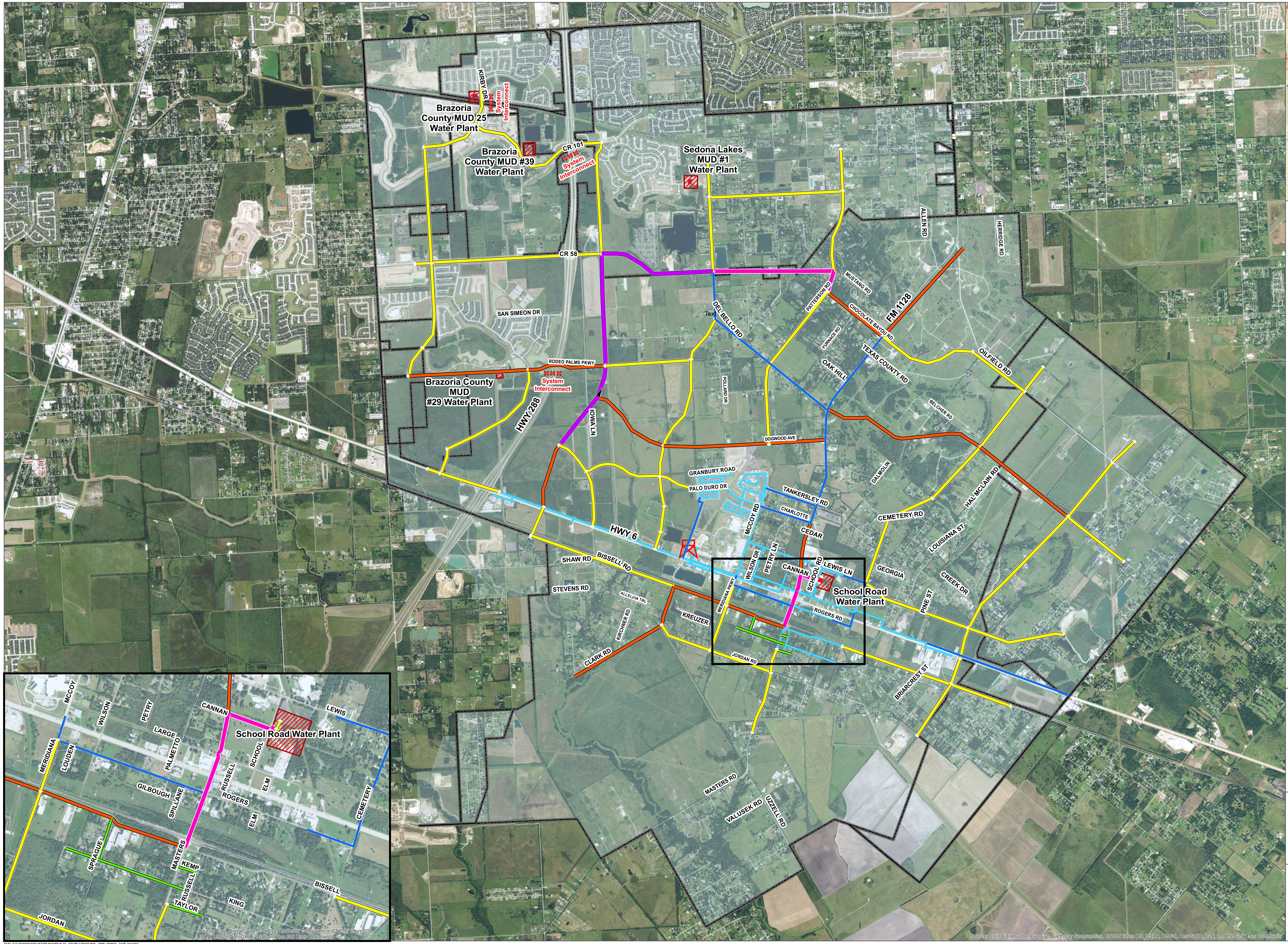
Miles
0.2 0.1 0 0.2

MANVEL CITY ON THE RISE

HDR

FIGURE 6




## Legend

- ETJ and City Limits
- Service Area
- Existing Water Plants
- Existing Water Lines
- 5-Year CIP Water Lines

### Proposed EST

- Option 1 - Recommended

### Ultimate Water Lines

**Diameter**

- 8-inch
- 12-inch
- 16-inch
- 20-inch
- 24-inch

DATA SOURCES: ESRI, HERE, DELORME, USGS, INTERMAP, INCREMENT P CORP., NRCAN, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), ESRI (THAILAND), TOMTOM, MAPMYINDIA, (c) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

# ULTIMATE BUILDOUT

MASTER WATER PLAN
CITY OF MANVEL

N

0.4 0.2 0 0.4 Miles

MANVEL CITY ON THE RISE

HDR

FIGURE 7