2017 WATER DISTRIBUTION MASTER PLAN

CITY OF COPPERAS COVE

City of Copperas Cove

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EXECUTIVE SUMMMARY

Existing System and Facilities

- A review of water system facilities was completed to identify existing system capacity and compliance with the Texas Commission on Environmental Quality (TCEQ) minimum requirements. A summary of all facilities is included in Exhibit A-1.
- The following facilities have been constructed since the previous 2012 Water System Study or are currently in construction:
    - Eastside Water Transmission Main
    - Seven Mile Ground Storage Tank Replacement
    - Mountain Top North Water Improvements
        - Offsite Water Line
        - Ground Storage Tank and Pump Station
        - 300,000 Gallon Elevated Storage Tank
    - Southwest Water Improvements Phase 1 (16-Inch Water Line along Highway 190 South)
    - Various Water Distribution Main Replacements

Water Usage and System Demand

- A review of 10-years of historical water usage was completed. A summary of compiled water usage date is included in Exhibit B.
- The Average Daily Demand was found to be 321-gallons per day per connection (0.22-gpm per connection).
- The Maximum Daily Demand was found to be 713-gallons per day per connection (0.50-gpm per connection) and occurred in August 2009.
- Historical water usage trends do not indicate a strong increase or decrease in per connection water usage.

Recommended Design Criteria

- Previous Water System Studies recommended the following criteria:
    - Total Storage – 400 gallons per connection
    - Elevated Storage – 200 gallons per connection
    - Average Daily Demand – 400 gallons per day (0.3-gpm) per connection
    - Maximum Daily Demand – 1,000 gallons per day (0.7-gpm) per connection
    - Service Pump Capacity – 0.8-gpm per connection
    - Supply Pump Capacity – 0.6-gpm per connection
- The following change in recommended design criteria is proposed:
    - Maximum Daily Demand to 820 gallons per day (0.6-gpm) per connection

Water Model Update

- The existing conditions water model was updated as follows:
  - GIS data provided by the city was used to construct the water model pipe network.
  - Information for tanks, pumps and pipe characteristics used to develop previous models was applied to the GIS based model.
  - A review of recent aerial imagery and street view imagery was used to estimate existing water connections for residential (single-family, multi-family and duplex), institutional and commercial connections. A summary of estimated connections is provided in Table 4.1.
    - Total Connections Allocated to Model – 14,373
      - City Retail Connections – 13,878
      - Water Supply Contracts
        - Topsey WSC – 290
        - Cedar Grove MHP – 205
- Operational controls for the water model were updated to reflect current operational practices as provided by city staff.
- Forecasted growth was used to develop future conditions water models for the following:
  - Near Term, 10-Year Planning Period Water Model
    - 2.0% annual growth rate results in 16,907 connections forecasted for the Year 2025
    - The allocation of the additional connections to the model was based primarily on the location of anticipated developments including:
      - Creekside Hills
      - Mashburn Tract
      - Valley at Great Hills
  - Long Term, 20-Year Planning Period Water Model
    - 2.0% annual growth rate results in 20,610 connections forecasted for the Year 2035
    - The allocation of the additional connections to the model was based on continued growth in the areas identified on the Anticipated Development Areas Exhibit.

Recommended Improvement Projects

- Category 1 Water System Improvements
  - The purpose of these improvements is to address immediate deficiencies and to maintain or improve water service within the existing system based on existing facilities and current demands.
- Category 2 Water System Improvements
  - The purpose of these improvements is to accommodate reasonably anticipated growth within a 10-year planning period and also includes system maintenance/rehabilitation type projects.
- Category 3 Water System Improvements
  - The purpose of these improvements is to accommodate reasonably anticipated growth within a 20-year planning period.

1.0 INTRODUCTION

1.1 PROJECT AUTHORIZATION

On August 11, 2016, Ms. Andrea Gardner, City Manager of the City of Copperas Cove, authorized Trihydro Corporation (Trihydro) to prepare an updated water system study and submit a report summarizing Trihydro's findings and recommendations. This study will evaluate the existing water distribution system and will investigate the improvements needed to meet the future water demands of the City of Copperas Cove.

1.2 PROJECT SCOPE

The purpose of this study is to evaluate current and future pumping, storage, transmission, and distribution capacity of the city's water system. The study does not address water supply and treatment as the city purchases an already treated water supply. This study is an update to the Water System Study that was originally completed in 2004 and subsequently updated in 2012.

Coordination with City staff assisted in identifying internal water distribution system improvements completed, new subdivisions constructed and changes in system operation incorporated into the system since the previous water system update. City staff also provided updated geographic information system (GIS) water system maps and historical water usage data. The updated information has been incorporated into the existing system portion of the model and the study. This report will outline and describe the results of the water system evaluation, determine the most efficient solutions to the problems encountered, and prioritize these solutions by their level of importance and effect on the overall operation of the system.

1.3 PROJECT DESCRIPTION

The first step of the water system study was to evaluate the existing water system facilities and its current operation. Information pertaining to pumps, storage tanks, water lines, meter connections, and water usage was collected and used to evaluate individual pressure planes or service areas, as well as the water distribution system as a whole. Field tests were performed where possible to verify record information. Pumping and water storage capacities available in the existing system were then compared to TCEQ's requirements and to design requirements developed from City of Copperas Cove historical water use data. The existing water system was then modeled using the WaterGEMS software and any deficiencies were noted.

Forecasted growth was used to develop future conditions water models for various planning horizons. For the near-term planning horizon, a 10-year planning period was used. For the long-term planning horizon, a 20-year planning period was used. The additional system demand expected from future growth was allocated to the water model accordingly and the system was again evaluated using WaterGEMS and the developed design requirements. From the future conditions water models, a list of recommended improvements was developed that would ensure that the water system would be able to provide an adequate level of service for up to 20-years of projected growth.

2.0 WATER SYSTEM OVERVIEW

2.1 JURISDICTION

The City of Copperas Cove is authorized by TCEQ to provide water service to areas generally within its city limits by Certificate of Convenience and Necessity (CCN) # 10449. The City's CCN boundary is shown on Figure 2.1. This map indicates that the Kempner WSC and Topsey WSC hold CCN rights to areas adjacent to Copperas Cove's CCN. Kempner WSC, CCN # 10456, holds CCN rights to areas to the south, west, and north of the city while Topsey WSC, CCN # 10454, holds CCN rights to areas to the north and west of the city. The Fort Hood Military Reservation occupies areas to the east of the City of Copperas Cove.

2.2 WATER SOURCE

The City of Copperas Cove is a purchased water supply system. All water is purchased from the Bell County Water Control and Improvement District Number 1 (WCID No. 1) in accordance with the Water Supply Contract dated September 23, 1997. This contract provides for a maximum delivery rate of 13.5-million gallons per day (MGD) at a maximum instantaneous rate not to exceed 9,375-gpm (13.5 MGD). As discussed further in Section 3.2, the city experienced a peak daily delivery from WCID No. 1 of 8.45 MGD in August 2009. The Bell County WCID No. 1 water treatment plant is located near Belton, Texas. It supplies treated water to Fort Hood, the cities of Killeen, Harker Heights, Belton, and Copperas Cove, Bell County WCID No. 3 and the 439 Water Supply Corporation. Bell County WCID No. 1 takes raw water from Lake Belton under the Brazos River Authority Certificate of Adjudication No. 12-5160.

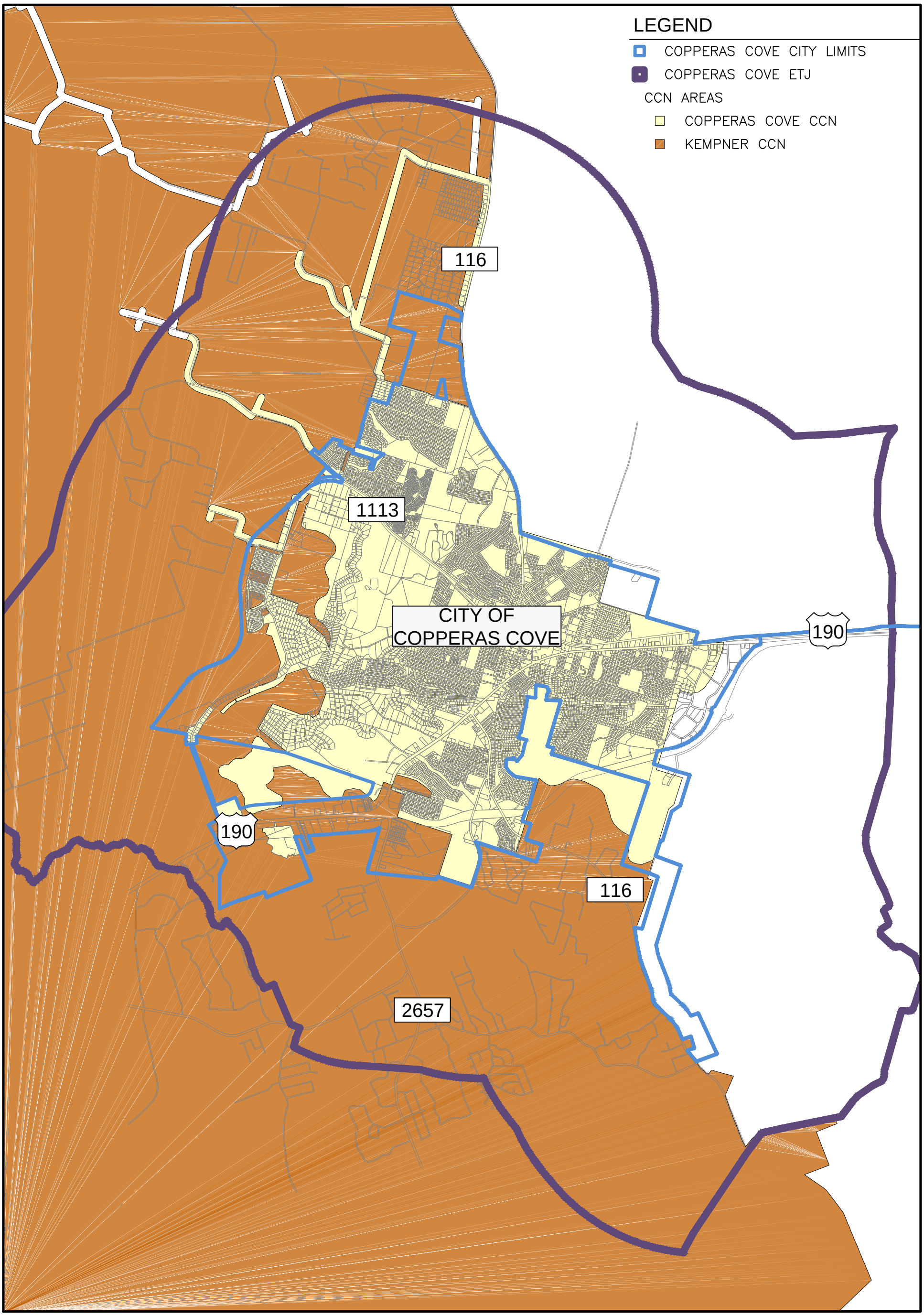

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FIGURE 2.1

WATER SERVICE BOUNDARY MAP

CITY OF COPPERAS COVE
2017 WATER DISTRIBUTION MASTER PLAN

Drawn By: GDP	Checked By: JM	Scale: AS NOTED	Date: JULY 2017

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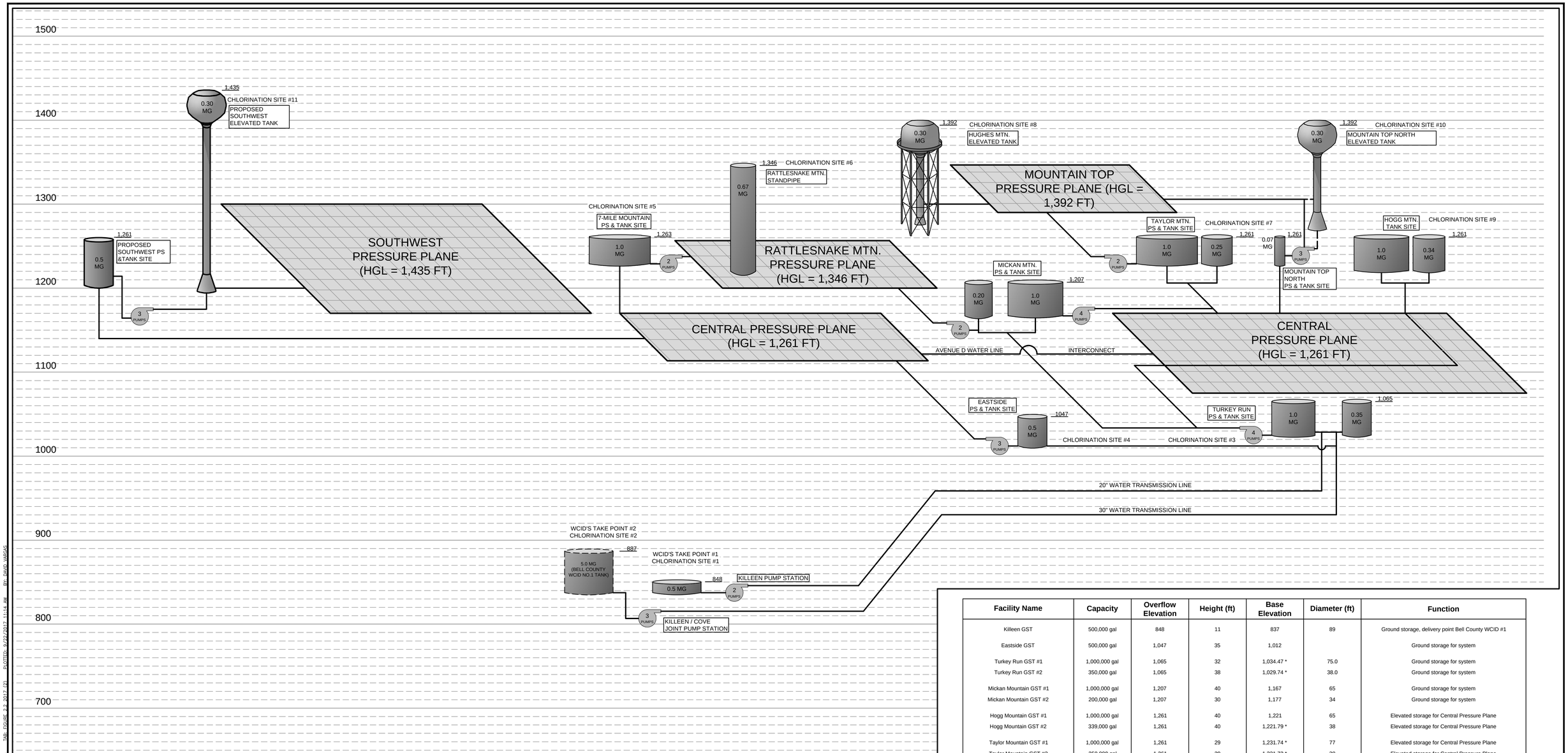
2.3 WATER SYSTEM FACILITIES

The City's water distribution system starts at a 500,000-gallon ground storage tank in Killeen. From there, two supply pump stations convey water through parallel 20-inch and 30-inch transmission lines. The water is then distributed to thirteen (13) storage tanks for a combined storage of 7.919 Million Gallons. The City also supplies water to Topsey Water Corporation, Cedar Grove Mobile Home Park, and Central Texas College.

The Copperas Cove water distribution system is divided into three primary service areas or pressure planes – the Central, Rattlesnake, and Mountain Top Pressure Planes. Pressure planes are isolated areas of a distribution system that maintain a specified hydraulic grade for a particular service area. The hydraulic grade of a pressure plane is equal to the water surface elevation of the tank servicing the area during static conditions (i.e. no water being pumped through the system). Pressure planes are arranged so that a reasonable range of operating pressures exists in each area. Reasonable operating pressures range from 35 to 80 psi. For areas within a pressure plane where pressures exceed 80-psi, pressure reducing valves on individual service lines may be required. Pressure plane boundaries are usually dependent on topography and the geometric configuration or layout of the system. Refer to Exhibit 'E' for the pressure plane service areas.

Water pumped from Killeen is delivered to the Turkey Run and Eastside sites via the 20-inch and the 30-inch transmission lines. It is pumped at the Turkey Run and Eastside sites into the Central Pressure Plane. Water delivered to the Central Pressure Plane is re-pumped at the Seven-Mile site to service the higher Rattlesnake Pressure Plane and at the Mickan Mountain and Taylor Mountain sites to service the higher Mountain Top Pressure Plane. Refer to Figure 2.2 for a schematic of the pressure planes. A more detailed description of individual water distribution facilities is later in this section and capacities are calculated in Exhibit A-1. These facilities are summarized in Table 2.1. A summary of the existing water storage capacities is shown in Table 2.2.



Facility Name	Capacity	Overflow Elevation	Height (ft)	Base Elevation	Diameter (ft)	Function
Killeen GST	500,000 gal	848	11	837	89	Ground storage, delivery point Bell County WCID #1
Eastside GST	500,000 gal	1,047	35	1,012		Ground storage for system
Turkey Run GST #1	1,000,000 gal	1,065	32	1,034.47 *	75.0	Ground storage for system
Turkey Run GST #2	350,000 gal	1,065	38	1,029.74 *	38.0	Ground storage for system
Mickan Mountain GST #1	1,000,000 gal	1,207	40	1,167	65	Ground storage for system
Mickan Mountain GST #2	200,000 gal	1,207	30	1,177	34	Ground storage for system
Hogg Mountain GST #1	1,000,000 gal	1,261	40	1,221	65	Elevated storage for Central Pressure Plane
Hogg Mountain GST #2	339,000 gal	1,261	40	1,221.79 *	38	Elevated storage for Central Pressure Plane
Taylor Mountain GST #1	1,000,000 gal	1,261	29	1,231.74 *	77	Elevated storage for Central Pressure Plane
Taylor Mountain GST #2	250,000 gal	1,261	29	1,231.73 *	38	Elevated storage for Central Pressure Plane
Seven Mile GST	1,000,000 gal	1,263	55	1,208	56	Elevated storage for Central Pressure Plane
Rattlesnake Mountain Standpipe	670,000 gal	1,346	126	1,220	30	Elevated storage for Rattlesnake Mtn Pressure Plane
Hughes Mountain EST	300,000 gal	1,392	124	1,268.15 *	41	Elevated storage for Mountain Top Pressure Plane
Mountain Top North EST	300,000 gal	1,392	139	1,253	48	Elevated storage for Mountain Top Pressure Plane
Mountain Top North GST	68,000 gal	1,261	29	1,232	20	Ground storage for Central Pressure Plane to pump up to Mountain Top North EST
Proposed Southwest GST	500,000 gal	1,261	60	1,201	50	Ground storage for Central Pressure Plane to pump up to Southwest EST
Proposed Southwest EST	300,000 gal	1,435	240	1,195	48	Elevated storage for Southwest Pressure Plane

* NAVD 88 vertical datum verified with on-ground survey.

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FIGURE 2.2

PRESSURE PLANE SCHEMATIC

CITY OF COPPERAS COVE
2017 WATER DISTRIBUTION MASTER PLAN

Drawn By:JM | Checked By:JM | Scale:AS SHOWN | Date:JULY 2017

FILE: P:\Projects\5019 (Copperas Cove)\119-2016 Water Model Update\CAD\Exhibits\PRESSURE PLANE SCHEMATIC.dwg TAB: FIGURE 2.2 (2) PLOTTED: 9/22/2017 11:14 AM BY: DAVID VARGAS

TABLE 2.1 – SUMMARY OF EXISTING FACILITIES

Facility	Supply Source	Supply/Service Pumps			Service Area	Capacity (gal)	Diameter (ft)	Height (ft)	Overflow (MSL)
		Individual		Firm Capacity					
Killeen/Cove Joint Pump Station	Bell Co. WCID #1	3500 GPM 3500 GPM 3500 GPM	300 HP 300 HP 300 HP	7000 GPM	Central Plane	5,000,000	130	50	887
Killeen 20-in	Bell Co. WCID #1	2118 GPM 2118 GPM	450 HP 450 HP	2118 GPM	Central Plane	500,000	89	11	848
Eastside	Killeen/Cove Joint Pump Station	1500 GPM 1500 GPM 1500 GPM	125 HP 125 HP 125 HP	3000 GPM	Central Plane	500,000	50	35	1,047
Turkey Run	Killeen 20-in Killeen/Cove Joint	2118 GPM 2118 GPM 2118 GPM 3000 GPM	200 HP 200 HP 200 HP 250 HP	6354 GPM	Central Plane	1,000,000 350,000	73 39	32 40	1,065 1,065
Hogg Mountain	Turkey Run	-	-	-	Central Plane	1,000,000 339,000	65 38	40 40	1,261 1,261
7-Mile Mountain	Eastside	1000 GPM 1000 GPM	40 HP 40 HP	1000 GPM	Central Plane	1,010,000	56	55	1,263
Rattlesnake Mountain	7-Mile	-	-	-	Rattlesnake Plane	670,000	30	126	1,346
Mickan Mountain	Turkey Run	575 GPM 300 GPM 1000 GPM 2200 GPM	40 HP 15 HP 60 HP 100 HP	1875 GPM	Central Plane	1,000,000 200,000	65 33	40 32	1,207 1,207
Long Mountain	Mickan Mountain	1000 GPM 1000 GPM	75 HP 75 HP	1000 GPM	Rattlesnake Plane	-	-	-	-
Taylor Mountain	Turkey Run/ Mickan Mountain	1,180 GPM 1,180 GPM	100 HP 100 HP	1,180 GPM	Central & Mountain Top Plane	1,000,000 250,000	77 38	29 29	1,261 1,261
Hughes Mountain	Taylor Mountain	-	-	-	Mountain Top Plane	300,000	43	124	1,392
Mountain Top North EST	Taylor Mountain	-	-	-	Mountain Top Plane	300,000	43	138	1,392
Mountain Top North GST	Turkey Run/ Mickan Mountain	700 GPM 700 GPM 700 GPM	50 HP 50 HP 50 HP	1,400 GPM	Central & Mountain Top Plane	68,000	20	29	1261

TABLE 2.2 – SUMMARY OF EXISTING WATER STORAGE CAPACITY

				Central Pressure Plane[1]		Rattlesnake Pressure Plane[2]		Mountain Top Pressure Plane[3]	
Tank	Capacity (MG)	Ht (Ft)	Overflow Elev.	Grnd	Elev	Grnd	Elev	Grnd	Elev
Turkey Run 1	1.00	32	1065	1.00	-	-	-	-	-
Turkey Run 2	0.35	40	1065	0.35	-	-	-	-	-
Eastside	0.50	35	1047	0.50	-	-	-	-	-
Mickan Mtn 1	1.00	40	1207	1.00	-	-	-	-	-
Mickan Mtn 2	0.20	32	1207	0.20	-	-	-	-	-
Hogg Mtn 1	1.00	40	1261	0.724	0.276	-	-	-	-
Hogg Mtn 2	0.339	40	1261	0.246	0.093	-	-	-	-
Taylor Mtn 1	1.00	29	1261	0.621	0.379	-	-	-	-
Taylor Mtn 2	0.25	29	1261	0.155	0.095	-	-	-	-
7-Mile	1.01	55	1263	0.770	0.240	-	-	-	-
Hughes Mtn Elev	0.30	124	1392	-	-	-	-	0.061	0.239
Mtn Top N Elev	0.30	138	1392	-	-	-	-	0.061	0.239
Rattlesnake Mtn	0.67	126	1346	-	-	0.427	0.243	-	-
Total	7.919			5.566	1.083	0.427	0.243	0.122	0.748
			Total Storage:	6.649		0.670		0.600	

[1] Central Pressure Plane serves a max elevation of 1170. Elevated storage is WSEL 1250 and above.
[2] Rattlesnake Pressure Plane serves a max elevation of 1220. Elevated storage is WSEL 1300 and above.
[3] Mountain Top Pressure Plane serves a max elevation of 1290. Elevated storage is WSEL 1370 and above.

2.3.1 KILLEEN 20-IN PUMP STATION SITE

The Killeen 20-In Pump Station supplies water to the city via the 20-inch transmission line. Suction is taken from the 500,000-gallon ground storage tank and delivered to the Turkey Run Ground Storage Tanks (GSTs). The Killeen 20-In Pump Station contains two 450 HP pumps each rated at 2,118-gpm at 329-feet total dynamic head (TDH) as indicated by City of Copperas Cove pump records.

2.3.2 KILLEEN / COVE JOINT PUMP STATION SITE

The Killeen / Cove Joint Pump Station supplies water to the Eastside GST & the Turkey Run GSTs through the 30-inch transmission line from the 5.0 million-gallon ground storage tank. The Killeen / Cove Joint Pump Station contains three 300 HP pumps with each pump having a design point of 3,500-gpm at 270-feet TDH. Firm pumping capacity of the Killeen / Cove Joint Pump Station is 7,000-gpm.

2.3.3 EASTSIDE GST AND PUMP STATION

The Eastside facility is located on U.S. Business Highway 190 East in the northeast part of the city adjacent to Fort Hood. The site contains a 500,000-gallon GST with an overflow elevation of 1,047-feet. The tank has a diameter of 50-feet. The base elevation of the tank is 1,012-feet resulting in a tank height of 35-feet. Water supplied by the Killeen / Cove Joint Pump Stations is delivered to the Eastside GST via the 30-inch transmission line. Because of the low overflow elevation, the Eastside GST contributes only towards the total storage required for the Central Pressure Plane and does not provide any elevated storage.

The site also contains three 125 HP, 1,500-gpm horizontal split case pumps which pump water to the Seven-Mile Mountain site.

2.3.4 SEVEN-MILE MOUNTAIN GST AND PUMP STATION

The Seven-Mile Mountain facility site is located on Bowen Avenue in the southeast part of the city. The site contains a 1.01 million-gallon ground storage tank with an overflow elevation of 1,263-feet. The tank has a diameter of 56-feet. The base elevation of the tank is 1,208-feet resulting in a tank height of 55-feet. The Seven-Mile Mountain tank provides elevated storage for the Central Pressure Plane and ground storage for the Rattlesnake Pressure Plane. Elevated storage for the Central Pressure Plane is based on a maximum service elevation of 1,170-feet. The Seven-Mile Mountain ground storage tank therefore provides an elevated storage capacity of 240,000-gallons for the Central Pressure Plane.

The Seven-Mile Mountain ground storage tank also provides 770,000-gallons of ground storage for the Rattlesnake Mountain Pressure Plane. Two 40 HP centrifugal pumps located at the site take suction from the 1.0 million-gallon ground storage tank and pump to the Rattlesnake Mountain Standpipe. Pump records indicate that the pumps are rated at 1,000-gpm each at 110-feet TDH.

2.3.5 RATTLESNAKE MOUNTAIN STANDPIPE

Elevated storage for the Rattlesnake Mountain Pressure Plane is provided by the Rattlesnake Mountain Standpipe. The standpipe has a total capacity of 670,000-gallons and an overflow elevation of 1,346-feet. The base elevation of the tank is 1,220-feet and the tank diameter is 30-feet. The Rattlesnake Mountain Pressure Plane currently serves areas up to the 1,220-foot elevation. Undeveloped areas in the Rattlesnake Pressure Plane have elevations of up to 1,240-feet. The existing conditions evaluation considers a maximum service elevation of 1,220-feet for the Rattlesnake Pressure Plan resulting in 243,000-gallons of available elevated storage in the Rattlesnake Mountain Standpipe.

The Rattlesnake Mountain Standpipe receives water from the Seven-Mile Pump Station. Additional supply is provided by the Long Mountain Pump Station located at the Mickan Mountain GST and Pump Station Site.

2.3.6 TURKEY RUN GSTs AND PUMP STATION

The Turkey Run facility is located in the northeast portion of the city on Golf Course Road. The site contains a 1.0 million-gallon ground storage tank with a base elevation of 1,033-feet and a diameter of 73-feet, and a 350,000-gallon ground storage tank with a base elevation of 1,025-feet and a diameter of 39-feet. Both tanks have an overflow elevation of 1,065-feet. Water supplied by the Killeen 20-in and Killeen / Cove Joint Pump Stations is delivered to the Turkey Run GSTs via the 20-inch transmission line and the 30-inch transmission line. Because of their low overflow elevations, the Turkey Run GSTs contribute only towards the total storage required for the Central Pressure Plane.

The site also contains three 200 HP, 2118-gpm and one 250 HP, 3000-gpm vertical turbine pumps. Depending on pump operation, water is either pumped to the Mickan Mountain GSTs or to both the Mickan Mountain GSTs and the Hogg Mountain GSTs.

2.3.7 MICKAN MOUNTAIN GSTs AND PUMP STATION

The Mickan Mountain facility is located in the center of the city on Robertson Avenue between Elm Street and Highway 190. The Mickan Mountain facility functions as an intermediate storage and pumping facility. The site contains a 1.0 million-gallon ground storage tank with a base elevation of 1,167-feet and a diameter of 65-feet and a 200,000-gallon ground storage tank with a base elevation of 1,175-feet and a diameter of 33-feet. Both tanks have an overflow elevation of 1,207-feet. Like the Turkey Run tanks, the Mickan Mountain tanks only contribute towards the total storage required for the Central Pressure Plane.

The Mickan Mountain Pump Station consists of four vertical turbine pumps ranging in size from 15 HP to 100 HP. Table 2.3 summarizes pump capacities based on pump records provided by the City of Copperas Cove Water Department. Firm pumping capacity of the Mickan Mountain Pump Station is 1,875-gpm.

TABLE 2.3 – MICKAN MOUNTAIN PUMP CAPACITIES

Mickan Pumps	Rated Flow (GPM)	Rated TDH (FT)	Motor (HP)
Pump 1	575	165	40
Pump 2	300	130	15
Pump 3	1000	192	60
Pump 4	2000	162	100

The four Mickan Mountain pumps draw from the 1.0 million-gallon and 200,000-gallon ground storage tanks and pump to the Central Pressure Plane. Primary delivery is to the Taylor Mountain GSTs.

The Mickan Mountain site also contains two 75 HP centrifugal pumps referred to as the Long Mountain Pump Station. Based on pump records provided by the City of Copperas Cove Water Department, the pump capacity is 1,000-gpm per pump for single pump operation. The Long Mountain pumps draw from the Mickan Mountain 200,000-gallon ground storage tank and provide an additional supply source to the Rattlesnake Mountain Pressure Plane.

2.3.8 TAYLOR MOUNTAIN GSTs AND PUMP STATION

Elevated storage for the Central Pressure Plane is provided by the Hogg Mountain ground storage tanks and the Taylor Mountain ground storage tanks. The Taylor Mountain facility is located on Tank Street in the northwest portion of the city. The site contains a 1.0 million-gallon ground storage tank and a 250,000-gallon ground storage tank. The 1.0 million-gallon tank has a base elevation of 1,232-feet and a diameter of 77-feet. The 250,000-gallon tank has a base elevation of 1,232-feet and a diameter of 38-feet. The overflow elevation of the Taylor Mountain tanks is 1,261-feet. Elevated storage for the Central Pressure Plane is based on a maximum service elevation of 1,170-feet. The Taylor Mountain facility therefore provides a combined elevated storage capacity of 474,000-gallons for the Central Pressure Plane.

The Taylor Mountain facility also provides ground storage for the Mountain Top Pressure Plane. Two 100 HP centrifugal pumps take suction from the Taylor Mountain GSTs and deliver water to the Hughes elevated storage tank. Pump records indicate that the rated capacity of each pump is 1,180-gpm.

2.3.9 HOGG MOUNTAIN GSTs

The Hogg Mountain facility is located in the north-central portion of the city and provides elevated storage for the Central Pressure Plane. The site contains a 1.0 million-gallon ground storage tank that has a diameter of 65-feet and a 339,000-gallon ground storage tank that has a diameter of 38-feet. Water is supplied to the tanks from the Turkey Run Pump Station. The base elevation of the Hogg Mountain tanks is 1,221-feet and the overflow elevation of the Hogg Mountain tanks is 1,261-feet. A total of 369,000-gallons of elevated storage is provided by the Hogg Mountain GSTs for the Central Pressure Plane.

2.3.10 HUGHES MOUNTAIN EST

The Hughes Mountain facility is located in the south-west portion of the city off of Freedom Lane and provides elevated storage for the Mountain Top Pressure Plane. The site contains a 300,000-gallon multi-column elevated storage tank (EST) that has a base elevation of 1,268-feet and a diameter of 43-feet. The overflow elevation of the Hughes Mountain tank is 1,392-feet. Water is supplied to the EST from the Taylor Mountain Pump Station. Since the elevated storage for the Mountain Top Pressure Plane is based on a maximum service elevation of 1,290-feet, the Hughes Mountain facility provides 239,000-gallons of elevated storage for this pressure plane.

2.3.11 MOUNTAIN TOP NORTH EST, GST, AND PUMP STATION

The Mountain Top North facility is located in the north-west portion of the city off of Skyline Drive. The site contains a 300,000-gallon pedesphere EST with a base elevation of 1,254-feet, a diameter of 43-feet, and an overflow elevation of 1,392-feet. The site also includes a 68,000-gallon ground storage tank with a base elevation of 1,232-feet, a diameter of 20-feet, and an overflow elevation of 1,261-feet. Water flows uphill through a 16” pipeline branching off W. Avenue B and into the GST. Since the GST does not contribute storage towards the Mountain Top Pressure Plane, it functions as ground storage for the Central Pressure Plane to pump up to the on-site EST. A total of 239,000-gallons of elevated storage is provided by the elevated storage tank for the Mountain Top Pressure Plane.

The Mountain Top North Pump Station consists of three 50 HP vertical turbine pumps that take suction from the on-site GST and conveys water to the on-site EST. Each of these pumps have a design point of 700-gpm at 200-feet TDH and the firm pumping capacity of the pump station is 1,400-gpm.

3.0 DESIGN CRITERIA

3.1 PURPOSE

In order to appropriately evaluate the Copperas Cove water system, certain design requirements have to be established. TCEQ outlines minimum design requirements and operating practices in Chapter 290 of the Texas Administrative Code (TAC). While TCEQ requirements provide general guidelines applicable to a broad array of systems, actual design and evaluation criteria for a specific system should be developed based on historical data when possible. For the purpose of this study, the Copperas Cove water system was evaluated using both TCEQ requirements and design criteria developed from historical data provided by the City of Copperas Cove. The historical water usage data provided is the amount of water purchased from Bell County WCID No. 1. The amount of water billed versus unbilled, or water loss in the system, was not evaluated.

3.2 TCEQ DESIGN REQUIREMENTS

Minimum water system requirements as enforced by the TCEQ can be found in Chapter 290 Section 290.45. The requirements contained in this section can be used in evaluating both the total capacities for public water systems and the capacities at individual pump stations and pressure planes. The capacities specified in Chapter 290 are regulatory minimum requirements only.

For a community water system, a total storage capacity of 200-gallons per connections and an elevated storage capacity of 100-gallons per connection must be provided. Elevated storage capacity is defined as that portion of water that can be stored at least 80-feet above the highest service connection in the pressure plane served by the storage tank (TCEQ Section 290.38 (18)).

Service pump capacity should provide each pump station or pressure plane with two or more pumps that have a total capacity of 2.0-gpm per connection or that have a total capacity of at least 1,000-gpm and the ability to meet peak hourly demands with the largest pump out of service, whichever is less. For systems, which provide an elevated storage capacity of 200-gallons per connection, two service pumps with a minimum combined capacity of 0.6-gpm per connection are required at each pump station or pressure plane (TCEQ Section 290.45 (b)).

Minimum system pressure requirements are presented in Section 290.44 (d). TCEQ requires that the system must be designed to maintain a minimum pressure of 35-psi at all points within the distribution network at a flow rate of at least 1.5-gallons per minute per connection. Additionally, when the system is intended to provide fire-fighting capability, it must also be designed to maintain a minimum pressure of 20-psi under combined fire and drinking water flow conditions.

3.3 DESIGN CRITERIA BASED ON HISTORICAL DATA

Historical water usage, billing data, and connection records were provided to Trihydro by the City of Copperas Cove. This data was used to determine average daily demand, maximum daily demand, and peak hour demand. In the absence of verified historical data, TCEQ defines maximum daily demand as 2.4 times the average daily demand. The maximum daily demand represents the highest anticipated water usage for a 24-hour period during any given year. Peak hourly demand is defined as 1.25 times the maximum daily demand (prorated to an hourly rate) if a public water supply meets TCEQ minimum requirements for elevated storage. Peak hourly demand represents the highest anticipated water usage for any given instant in the water system. (TCEQ Section 290.38 (28) & (38))

Data for the past 10-years of water usage and number of connections is presented in Exhibit B. Water usage is based on metered water pumped from the Killeen pump stations. An annual water usage summary is presented below in Table 3.1, as well as Figure 3.1.

TABLE 3.1 – ANNUAL WATER USAGE SUMMARY

Year	Average Daily Usage (GPD/Connection)	Maximum Daily Usage (GPD/Connection)
2006	324	576
2007	316	612
2008	368	698
2009	352	**713**
2010	310	621
2011	341	686
2012	319	634
2013	297	628
2014	283	585
2015	299	619
Average	**321**	-

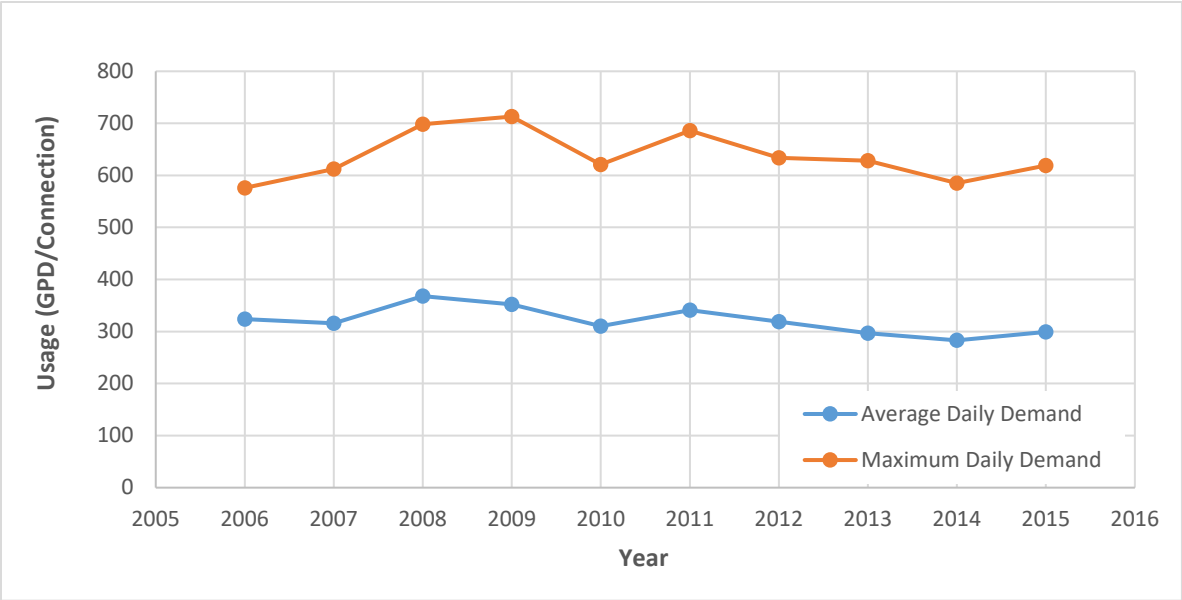


FIGURE 3.1 – HISTORICAL WATER USAGE TREND

The 10-year period from January 2006 through January 2016 was used to establish the system's Average Daily, Maximum Daily, and Peak Hourly Demands. The Average Daily Demand over this period was 321-gpd/connection. The maximum daily flow occurred in August 2009 and was 8.449 MGD with 11,844 connections. This equates to a maximum daily flow of 713-gpd/connection. TCEQ rules require that a 15% safety factor be added, resulting in a Maximum Daily Demand value of 820-gpd/connection, or 0.57-gpm/connection. The TCEQ peaking factor from Section 290.38 of 1.25 times Maximum Daily Demand was used to establish a Peak Hourly Demand of 1,025-gpd/connection, or 0.71-gpm/connection. These results are summarized below in Table 3.2.

TABLE 3.2 – HISTORICAL WATER USAGE SUMMARY

Average Daily Demand	321 GPD / Connection	0.22 GPM / Connection
Maximum Daily Demand (1)	820 GPD / Connection	0.57 GPM / Connection
Peak Hourly Demand (2)	1,025 GPD / Connection	0.71 GPM / Connection

(1) Calculated using the historic maximum day demand plus 15% TCEQ required safety factor.
(2) Calculated using a maximum day to peak hour demand peaking factor of 1.25. Section 290.38 (38).

Based on the average daily demand developed from historical data, the following design criteria were developed. Several of the values were rounded up to account for fluctuations in usage and to provide a factor of safety. Total storage capacity was based on the ability of the system to store enough water for an average day's demand. This results in a value of 400-gallons per connection of total storage. Fifty-percent of a system's total storage should be elevated

resulting in an elevated storage capacity of 200-gallons per connection. Service pump capacity was based on the ability to meet the peak hourly demand of 0.8-gpm per connection with the largest pump out of service or a total minimum pumping capacity of 1,000-gpm, whichever is greater.

The design criteria developed from historical records is more stringent, in most cases, than that given by TCEQ. Therefore, the design criteria based on historical records will be used to evaluate the water system. The recommended design criteria are summarized below in Table 3.3.

TABLE 3.3 – RECOMMENDED DESIGN CRITERIA

Criteria	TCEQ		Historical Water Usage	Recommended Design Criteria
	Requirement	Reference		
Total Storage	200 Gal. / Connection	290.45(b)(2)(E)	-	**400 Gal. / Connection**
Elevated Storage	100 Gal. / Connection	290.45(b)(2)(G)	-	**200 Gal. / Connection**
Average Daily Demand	-	-	321 GPD / Connection	**400 GPD or 0.3 GPM Per Connection**
Maximum Daily Demand	-	-	713 GPD / Connection	**820 GPD or 0.6 GPM Per Connection**
Peak Hourly Demand	1.5 GPM / Connection	290.44(d)	-	**1.5 GPM Per Connection**
Service Pump Capacity	0.6 GPM / Connection [(1)]	290.45(b)(2)(F)	-	**0.8 GPM Per Connection**
Supply Pump Capacity	0.6 GPM / Connection [(1)]	290.45(b)(2)(F)	-	**0.6 GPM Per Connection**

[(1)] A service pump capacity is required that provides each pump station or pressure plane with two or more pumps that have a total capacity of 2.0-gpm per connection or that have a total capacity of at least 1,000-gpm and the ability to meet peak hourly demand with the largest pump out of service, whichever is less. Section 290.45 (b) (2) (F). For systems that provide an elevated storage capacity of 200-gallons per connection, two service pumps with a minimum combined capacity of 0.6-gpm per connection are required at each pump station or pressure plane. [Section 290.45 (b) (2) (F)]

3.4 FIRE PROTECTION REQUIREMENTS

When a fire occurs in a water distribution system, fire flow demands can represent a large fraction of the total demand for the system. The effects of fire demands are difficult to derive precisely since fires occur with random frequency in different areas, with each area having unique fire protection requirements. Generally, the amount of water needed to adequately fight a fire depends on the size of the burning structure, its construction materials, the combustibility of its contents, and the proximity of adjacent buildings.

One of the benefits of providing water for fire protection is a reduction in the insurance rates of residents and businesses in the community. In the United States, the fire-fighting capabilities of a community's fire department and the capacity of the water distribution network is audited and rated by the Insurance Services Office (ISO) using the *Fire Protection Rating System* (ISO, 1998). The ISO evaluation process is summarized in the American Water Works Association (AWWA) M-31 (1998).

Since systems will be evaluated using ISO methods, it is recommended that the design of the fire protection systems be based on the ISO rating system, which includes determining fire flow demands according to the ISO approach. Although the actual water needed to fight a fire depends on the structure and the fire itself, the ISO method yields a Needed Fire Flow (NFF) that can be used for design and evaluation of the system. Different calculation methods are used for different building types, such as residential, commercial, or industrial.

For one- and two-family residences, the needed fire flow is determined based on the distance between structures, as shown in Table 3.4.

TABLE 3.4 – REQUIRED RESIDENTIAL FIRE FLOW

Distance Between Buildings (ft)	Fire Flow (gpm)
More than 100	500
31 – 100	750
11 – 31	1,000
Less than 11	1,500

For commercial and industrial structures, the needed fire flow is based on building area, construction class (frame or masonry construction), occupancy (such as a department store or chemical manufacturing plant), exposure (distance to and type of nearest building), and communication (types and locations of doors and walls). The formula for determining needed fire flow can be summarized as:

$$NFF = 18 F A^{0.5} O (X + P)$$

Where:

NFF	=	Needed Fire Flow (gpm)
F	=	Class of Construction Coefficient
A	=	Effective Area (ft²)
O	=	Occupancy Factor
X	=	Exposure Factor
P	=	Communication Factor

The procedure for determining NFF is documented in the Fire Protection Rating System (1998) and AWWA M-31 (1998). The minimum needed fire flow should not be less than 500-gpm, and the maximum should not exceed 12,000-gpm. Most frequently, the procedure produces values less than 3,500-gpm. Values are also adjusted if a building is equipped with sprinklers.

In addition to a flow rate requirement, a requirement exists for the duration over which the flow can be supplied. According to ISO (1998), fires requiring 3,500-gpm or less are referred to as receiving "Public Fire Suppression," and those requiring greater than 3,500-gpm are classified as receiving "Individual Property Fire Suppression." For fires requiring 2,500-gpm or less, a two-hour duration is sufficient; for fires needing 3,000 to 3,500-gpm, a three-hour duration is used; and for fires needing more than 3,500-gpm, a four-hour duration is used along with slightly different rules for evaluation.

For the purpose of this study, a minimum required fire flow rate of 1,000-gpm was used to evaluate the water system. This value was chosen since the Copperas Cove water system is comprised primarily of residential connections with building separation typically falling in the 11 to 31-feet range. Required fire flow for commercial and industrial connections should be determined using ISO requirements.

3.5 EXISTING WATER SYSTEM DESIGN CRITERIA REVIEW

Water system storage and pumping requirements using both the recommended design criteria and TCEQ criteria is summarized in Table 3.5. Initial review of the existing Copperas Cove water system facilities shows that the overall system meets the minimum TCEQ requirements with respect to storage and pumping capacities. A water model simulation was used to evaluate the system’s ability to maintain adequate pressure. These results are presented in subsequent sections of this report.

Evaluation of the City's water system utilizing TCEQ requirements indicates that the overall total system storage, elevated storage and service pump capacity meets minimum requirements. However, when evaluating individual pressure planes and applying the recommended design criteria, the evaluation shows that elevated storage in the Central Pressure Plane is inadequate. Additionally, in consideration that the Mickan Mountain facility functions primarily as an intermediate storage and pumping facility, service pump capacity in the Central Pressure Plane is a concern (meets minimum requirement but not recommended design criteria).

Evaluation of the Copperas Cove water system indicates that the system does not fully satisfy the design criteria developed. While there is adequate total storage in the system, available elevated storage is deficient. Computer modeling of the system also indicates pressure problems exist in the system. Computer modeling of the water system is described in subsequent sections.

As the City of Copperas Cove continues to grow and areas to south, west and northwest continue to develop, the need to efficiently transfer water to these hydraulically remote areas of the system remains an increasing concern.

TABLE 3.5 – MAXIMUM EXISTING SYSTEM CAPACITY REQUIREMENTS

	Total Storage Capacity	Elevated Storage Capacity	Service Pump Capacity
Design Criteria *(per connection)* Recommended:	400 gal.	200 gal.	0.8 gpm
TCEQ Minimum:	200 gal.	100 gal.	0.6 gpm
Central Pressure Plane			
Connections: 12,457			
Capacity Required (Recommended)	4,982,800	2,491,400	9,966
Capacity Required (TCEQ)	2,491,400	1,245,700	7,474
Existing Capacity	6,649,000	1,083,000	9,354 *
Rattlesnake Pressure Plane			
Connections: 913			
Capacity Required (Recommended)	365,200	182,600	730
Capacity Required (TCEQ)	182,600	91,300	548
Existing Capacity	670,000	243,000	2,000
Mountain Top Pressure Plane			
Connections: 1,003			
Capacity Required (Recommended)	401,200	200,600	802
Capacity Required (TCEQ)	200,600	100,300	602
Existing Capacity	600,000	478,000	2,580
System Total			
Connections: 14,373			
Capacity Required (Recommended)	5,749,200	2,874,600	11,498
Capacity Required (TCEQ)	2,874,600	1,437,300	8,624
Existing Capacity	7,919,000	1,804,000	13,934

** Considers Mickan Mountain pump station as an intermediate/booster pumping facility, that is, its pumping capacity relies solely on water provided by the Turkey Run Pump Station or the Eastside Pump Station.*

4.0 WATER MODEL DEVELOPMENT

4.1 APPROACH

Hydraulic analysis of the distribution system was performed with the use of Bentley WaterGEMS V8i water modeling software version. The program is a Windows application, which provides a graphical interface that enhances construction and analysis of the water model and permits presentation of results graphically in addition to tabular format. The water system was analyzed with 24-hour extended period simulations and steady state simulations for existing conditions and with projected future development. These simulations were performed in order to identify system deficiencies and analyze proposed water system improvements.

4.2 PHYSICAL DATA

Physical data input for the water model includes water storage facilities, pump characteristics, and pipe networks. The following are sources of data supplied by the City of Copperas Cove Water Department both in 2004 for the original report and for this update that were used for construction of the computer model and analysis of the distribution system:

- Water distribution system maps
- Construction plans and drawings made by Copperas Cove Water Department personnel
- Storage facilities data tables, pump data tables, and pump curves
- Field tests performed by Copperas Cove Water Department personnel to determine actual pump performance, and water transmission and distribution pipe characteristics
- Aerial maps containing images and topographic data at 2-foot contour intervals
- Historical operational data obtained from SCADA system
- Geographic Information System (GIS) files for water system facilities

Due to the variety and nature of the information sources available, vague and/or conflicting data was often encountered. Trihydro Corporation consulted with Copperas Cove Water Department personnel whenever possible to determine the most reliable data sources and resolve any conflicting information. A series of field tests was also performed in order to determine actual pump and distribution system performance. Pump curves and pipe friction coefficients (C-values) were extrapolated from these field tests.

Pipes entered in the model were limited to water distribution lines with diameters of six inches and larger. In certain instances, pipes smaller than 6-inches may have been included in the model to preserve system connectivity. Pipe diameters were obtained from GIS shapefiles, distribution system maps and meetings with Copperas Cove Water Department personnel.

Aerial and topographic maps provided by the City of Copperas Cove were used as a background map in the water model. This meant that WaterGEMS automatically determined pipe lengths and node elevations as they were added to the model. Typical C-values used for various pipe materials are given below in Table 4.1. When possible, C-values for longer transmission lines were determined using data obtained from field tests.

TABLE 4.1 – TYPICAL C-VALUES

Pipe Material	C-Value
Asbestos Cement (AC)	130
Cast Iron	91
Concrete Cylinder	125
Ductile Iron	130
PVC	140

Pumps, tanks, control valves and pressure-reducing valves were modeled based on information provided by the City of Copperas Cove and on information obtained from field tests. Pump controls were modeled using data obtained from the Copperas Cove SCADA system. Pumps were modeled in WaterGEMS using simple controls; pump ON or pump OFF based on predetermined tank levels. Simple controls do not account for pump timers or delays.

4.3 DEMAND DETERMINATION / ALLOCATION

The general methodology for developing the water demands for the system was to first develop a per connection demand, allocate connections to the modeled system and then to apply the demands to each connection in the system. A connection for the purposes of this study is defined as the equivalent water use of a single-family residential unit. The number of connections allocated to the model will not equal the number of actual water meters in the system. As an example, a typical residential home served by a ¾” meter would equal one connection while the number of connections for a multifamily unit served by a single meter would be equal to the number of individual apartment units (TCEQ Section 290.38 (15)).

Average day and maximum day demands of 0.3-gpm per connection and 0.6-gpm per connection, respectively, were previously developed in Section 3.2. A peak hourly demand of 0.8-gpm per connection was used. The City of Copperas Cove consists primarily of residential connections; therefore, the derived demands were simply applied to all connection types including single family residential, multifamily residential, commercial and institutional.

Aerial maps and street view imagery was utilized to allocate connections to the system. A GIS overlay of the water model nodes and pipes was generated and imposed on the aerial maps. A point shapefile was created in which each point represented a water system connections. The placement of single family residential and commercial connection points was accomplished using primarily aerial imagery. The placement of institutional and multifamily points was accomplished utilizing a combination of aerial imagery, street view imagery and information provided by the City. The placement of wholesale customers, such as Topsey Water Supply Corporation and Cedar Grove Mobile Home Park, was performed on an individual basis based on meter and reporting data available. Demand service areas for nodes in the model were defined in a separate shapefile and the WaterGEMS software was utilized to combine data and allocate demand to the model.

A summary of connection allocation in the water model is presented below in Tables 4.2 and 4.3.

TABLE 4.2 – ESTIMATED CONNECTIONS BY TYPE

Retail Service Connection Type			**Count**
Residential			13,373
Single-Family Residences			10,426
Duplex Units			837
Multi-Family Units			2,110
Commercial / Institutional			505
		Total Estimated Retail Water Connections:	13,878
Water Supply Contracts	Maximum per Month Allowed by Contract (Gal.)	Average Day Demand Design Criteria	**Count**
Topsey Water Supply Corporation	3,500,000	400 GPD Per Connection	290
Cedar Grove Mobile Home Park	2,500,000	400 GPD Per Connection	205
		Estimated Water Supply Contract Connections:	495
Total Existing Water Connections Allocated to Model			**14,373**

TABLE 4.3 – ESTIMATED MULTI-FAMILY CONNECTIONS BY LOCATION

Multi-Family Complex	Location	Units
Five Hills Apartments	2015 E US 190	73
Willow Creek Apartments	307 Judy Ln	201
Copper Commons	1301 Martin Luther King Jr Dr	154
Colonial Plaza	1613 N. Main St	240
Copperas Cove Housing Authority	1216 Phil Ave	46
Copperas Cove Housing Authority	1101 & 1102 Golf Course Rd	50
Clear Creek Meadows	1202 S FM 116	188
Exchange Sunshine Homes	1103 Leonard St	50
Constitution Court Apartments	712 Constitution Court	180
Brookview Village Apartments	1000 Brookview Dr	96
Stoney Brook Assisted Living	1808 Martin Luther King Jr Dr	60
Miscellaneous Multi-Family	Creek Street	96
Miscellaneous Multi-Family	Erby Ave / North Dr	146
Miscellaneous Multi-Family	Northern Dove Ln	72
Miscellaneous Multi-Family	Brown Dr	36
Miscellaneous Multi-Family	various locations	422
Total Multi-Family Connections		**2,110**

4.4 MODEL CALIBRATION

The existing conditions model was calibrated, as part of the 2004 Study, using data from fire hydrant flow tests and by verifying an average 24-hour extended period simulation to a data from the SCADA system for a 24-hour period. The average difference between the results from the water model and the field data was 6.3%. A portion of the discrepancy between the model results and the actual field test results can be attributed to not knowing the exact water storage tank levels and the amount of water being used in the system at the time these tests were performed. A certain level of system error always exists in modeling due to the many variables modeled and the precision of information input into the model. The favorable comparison of field tests with model results demonstrates that the water model is accurately able to simulate existing system conditions. Based on these comparisons, we feel that the water model has been calibrated to an acceptable level.

5.0 EXISTING CONDITIONS WATER MODEL

5.1 EXISTING CONDITIONS SIMULATIONS

Performance and adequacy of the Copperas Cove water system was analyzed for four demand scenarios for the existing conditions state of the system. The four demand scenarios include an average day 24-hour simulation, a maximum day 24-hour simulation, a steady state peak hour simulation, and a fire flow analysis. The existing conditions model reflects typical operation of the system as of January 2017. The conditions modeled include tank levels, pump controls, pressure-reducing valve settings, and other general characteristics of the distribution system. The results from the existing conditions simulations are presented in the following Sections. The system deficiencies discovered are discussed in Section 5.2.

The Average Day Simulation is a 24-hour extended period simulation based on an average day demand of 0.3-gpm per connection. A minimum required pressure of 35-psi at any point in the system was used.

The Maximum Day Simulation is a 24-hour extended period simulation based on a maximum day demand of 0.6-gpm per connection. This simulation represents the highest anticipated water usage for a 24-hour period during a given year. A minimum required pressure of 35-psi at any point in the system was used.

The Peak Hour Simulation is a steady-state simulation based on a peak hourly demand of 1.5-gpm per connection. This simulation represents the highest anticipated water usage at any given instant in the water system. A minimum required pressure of 35-psi at any point in the system was used.

A fire flow simulation was performed in WaterGEMS using fire protection requirements previously outlined in Sections 3.1 and 3.3. WaterGEMS calculates the fire flow available at each node in the system through an iterative process for a steady state simulation. Although required fire flow for any node in the system is dependent on an individual structure's use, type of construction, and size, a minimum required fire flow of 1,000-gpm was specified in the water model for each node at a residual pressure of 20-psi.

5.2 EXISTING CONDITIONS DEFICIENCIES AND CONCERNS

Low System Pressure

The updated water model simulations indicate that low system pressures are a concern for certain areas. These results are consistent with previous system modeling efforts and the previous study may be referenced for additional information. The low system pressures are primarily a result of high ground elevations at the upper regions of a pressure plane service area or from services off of relatively long and relatively small diameter water mains. The following primary areas of concern have been identified:

- Oak Hill Drive & Deer Flats
- South 27th Street and Urbantke Avenue
- Martha Street and Alfred Drive
- Highland Drive
- Pecan Cove Drive and Garden Avenue at Hwy 190
- Brown Drive / Connie Avenue

Fire Flow

The updated water model simulations indicate that fire flows less than 1,000-gpm exist in certain areas of the city. This is primarily a result of areas being served by small diameter water mains (6-inch in diameter or less) and/or at a high ground elevation. These results are consistent with previous system modeling efforts and the previous study may be referenced for additional information. The following primary areas of concern have been identified:

- High Chaparral Drive
- Buckboard Trail
- Post Office Road and Alan Arbor Lane
- Manning Drive
- Other areas not modeled served by 6-inch diameter or smaller water mains

Central Pressure Plane Elevated Storage and Pumping Capacity

Section 3.4 provided a review of system capacities in consideration of TCEQ requirements and recommended design criteria. Table 3.5 – Minimum Existing System Capacity Requirements indicates that the overall total system storage, elevated storage and service pump capacity meets minimum requirements. However, when evaluating individual pressure planes and applying the recommended design criteria, the evaluation shows that elevated storage in the Central Pressure Plane is inadequate. Additionally, in consideration that the Mickan Mountain facility functions primarily as an intermediate storage and pumping facility, service pump capacity in the Central Pressure Plane is a concern (meets minimum requirement but not recommended design criteria).

System Optimization

The City's water system operators have long been challenged to maintain a balance of water quality and quantity when providing water service to its residents. Large storage tanks are often needed to provide the necessary storage for fire flow, buffering demand peaks and re-pumping to higher pressure planes. However, increased storage also increases water age in the system. This requires attentive system monitoring and adjustments to chlorination systems to ensure delivery of the highest water quality possible. The following primary areas of concern have been identified:

- Redefine pressure plane boundary between Central Pressure Plane and Mountain Top Pressure Plane in certain areas to maximize storage efficiency in existing tanks
- Replace Mickan Mountain GSTs with an elevated tank of similar capacity to reduce redundant storage and pumping

5.3 RECOMMENDED IMPROVEMENTS – CATEGORY 1

A list of recommended improvements has been developed to address areas of concern and deficiencies within the existing water system under current operating and demand conditions. These improvements are referred to as Category 1 Water System Improvements. The water system was also evaluated using projected growth for a 10-year and a 20-year planning period. Water system improvements necessary for the 10-year planning period and the 20-year planning period are referred to as Category 2 Water System Improvements and Category 3 Water System Improvements, respectively.

Refer to Exhibit C-1 in the Appendix for a detailed description of all Category 1 recommended projects.

Table 5.1 is an update to Table 3.5 – Minimum Existing System Capacity Requirements and summarizes system capacity requirements assuming completion of Category 1 improvements. Table 5.1 demonstrates how significant increases in Central Pressure Plane elevated storage capacity can be achieved without increasing total storage by redefining pressure plane boundaries and replacing the Mickan Mountain GSTs with an EST.

TABLE 5.1 – MINIMUM SYSTEM CAPACITY REQUIREMENTS

	Total Storage Capacity	Elevated Storage Capacity	Service Pump Capacity
Design Criteria *(per connection)* Recommended:	400 gal.	200 gal.	0.8 gpm
TCEQ Minimum:	200 gal.	100 gal.	0.6 gpm
Central Pressure Plane			
Connections: 12,357 **			
Capacity Required (Recommended)	4,942,800	2,471,400	9,886
Capacity Required (TCEQ)	2,471,400	1,235,700	7,414
Existing Capacity	6,649,000	1,083,000	9,354 *
Capacity w/ Category 1 Improvements	**6,949,000**	**4,223,000**	**15,000**
Rattlesnake Pressure Plane			
Connections: 913			
Capacity Required (Recommended)	365,200	182,600	730
Capacity Required (TCEQ)	182,600	91,300	548
Existing Capacity	670,000	243,000	2,000
Capacity w/ Category 1 Improvements	670,000	243,000	2,000
Mountain Top Pressure Plane			
Connections: 1,103 **			
Capacity Required (Recommended)	441,200	220,600	882
Capacity Required (TCEQ)	220,600	110,300	662
Existing Capacity	600,000	478,000	2,580
Capacity w/ Category 1 Improvements	600,000	478,000	2,580
System Total			
Connections: 14,373			
Capacity Required (Recommended)	5,749,200	2,874,600	11,498
Capacity Required (TCEQ)	2,874,600	1,437,300	8,624
Existing Capacity	7,919,000	1,804,000	13,934
Capacity w/ Category 1 Improvements	**8,219,000**	**4,944,000**	**19,580**

** Considers Mickan Mountain pump station as an intermediate/booster pumping facility, that is, its pumping capacity relies solely on water provided by the Turkey Run Pump Station or the Eastside Pump Station.*

*** Assumes 100-connections converted from Central Pressure Plane to Mountain Top Pressure Plane.*

6.0 FUTURE CONDITIONS WATER MODEL

6.1 PROJECTED GROWTH

Previous water system studies reviewed historical growth trends for the city and determined the average annual growth rate for water system connections to be approximately 1.7%. The City currently uses an assumed annual growth rate of 2.0% for planning purposes. Therefore, to be consistent with other city planning studies, this study also assumes a 2.0% annual growth rate. Table 6.1 presents forecasted water system connections based on the current number of connections and assumed growth rate.

TABLE 6.1 – WATER SYSTEM CONNECTIONS FORECAST

Year	Water Connections [1,2]	Estimated Population [3]
2015	13,870	36,756
2016	14,147	37,491
2017	14,430	38,240
2018	14,719	39,005
2019	15,013	39,785
2020	15,314	40,581
2021	15,620	41,393
2022	15,932	42,221
2023	16,251	43,065
2024	16,576	43,926
2025	**16,907**	**44,805**
2026	17,246	45,701
2027	17,591	46,615
2028	17,942	47,547
2029	18,301	48,498
2030	18,667	49,468
2031	19,041	50,457
2032	19,421	51,467
2033	19,810	52,496
2034	20,206	53,546
2035	**20,610**	**54,617**

[1] Assumes 2% annual growth rate.
[2] Year 2015 connection estimate as reported by City in its 2015 TWDB Water Conservation Plan Annual Report.
[3] Assumes 2.65-persons per connection

6.2 NEAR-TERM AND LONG-TERM GROWTH CATEGORIZATION

Development of the future conditions water models was divided into two planning periods. Initially, a near-term or 10-year planning period was identified followed by a longer, 20-year planning period. A split short and longer planning period approach was used to develop the future conditions models because there is a reasonable assumption of where near-term growth will occur based on preliminary plats and site plans already received by the City. Using this approach, the development of capital improvements necessary to serve future growth can be prioritized and focused first on areas where development is likely to occur.

Based on information provided by the City to Trihydro Corporation, a near-term conditions water model was developed. The anticipated growth areas are shown on Exhibit F and summarized in Table 6.2.

Approximately 2,800 potential connections are anticipated to be added in the near-term based on the planning information currently available at the time of model development. Therefore, the number of connections anticipated for near-term planning would be approximately 16,907 to 17,173 connections. For the purposes of this study, the 10-year forecasted amount of 17,173 connections was used for developing the hydraulic model.

For the long-term planning, an additional 5,140 connections may be possible in the areas identified on Exhibit F. This exceeds the amount of connections forecasted for the 20-year planning period, however, a total of 22,713 connections were allocated to the model for the purposes of this study due to the uncertainty of predicting growth trends.

6.3 FUTURE WATER SYSTEM REVIEW

The water system storage and pumping capacity requirements, using the recommended Design Criteria developed in Section 3.0, were calculated for the near-term and long-term planning periods (assumed annual growth rate of 2%). The evaluation assumes that all Category 1 recommended improvements are complete. Results are summarized in Tables 6.3 and 6.4 for a 10-year and 20-year planning, respectively. A number of storage and pumping facilities would need to be expanded to meet the projected future demands. This information, along with the results of the future conditions water model, is used to identify needed improvements to the system. The proposed improvements were sized with ultimate build-out of the system in mind, in an effort to avoid installing improvements such as transmission mains and storage tanks that would be undersized when the system does fully develop.

TABLE 6.2 – DEMAND ALLOCATION FOR ANTICIPATED DEVELOPMENT AREAS

Anticipated Development Areas – Near-Term (10-Year Planning)					
Development / Area	**Acres**	**Assumed Density (Connections / Acre)**	**Approx. # of Additional Connections**	**Map Designation**	**Assigned Water Model Node**
Creekside Hills	308	3.5	1,100	A-1	J-419 (350) J-1550 (350) J-1556 (400)
Southeast Area	71	3.5	250	A-2	J-1359
Southeast Area - Mashburn Tract	300	2	600	A-3	J-1552
Southwest Area - Valley at Great Hills	375	2	750	A-4	J-1567
Mountain Top (North)	200	2	100	A-5	J-1564
Potential Number of Additional Connections			**2,800**		
Anticipated Development Areas – Long-Term (+10-Year Planning)					
Development / Area	**Acres**	**Density (Connections / Acre)**	**Approx. # of Additional Connections**	**Map Designation**	**Assigned Water Model Node**
Big Divide Road Area	60	2	120	B-1	J-1494
Big Divide / Mountain Top	200	2	400	B-3	J-1494
Big Divide Road Area	400	2	800	B-4	J-1447
Big Divide Road Area	340	2	680	B-5	J-1448
Big Divide Road Area	470	2	940	B-6	J-1475
Mountain Top (South)	440	2	880	B-7	J-1254, J-1039
Highway 190 South	110	2	220	B-8	J-1452
South of Valley at Great Hills	800	2	-	B-9	-
South of Hwy 190 Bypass	550	2	1,100	B-10	J-1455
Remainder Rattlesnake PP	100	2	-	B-11	-
Southeast Area	100	2	-	B-12	-
Potential Number of Additional Connections			**5,140**		

TABLE 6.3 – MINIMUM SYSTEM CAPACITY REQUIREMENTS NEAR-TERM (10-YR PLANNING)

	Total Storage Capacity	Elevated Storage Capacity	Service Pump Capacity
Design Criteria Recommended *(per connection)*	400 gal.	200 gal.	0.8 gpm
Central Pressure Plane Forecasted Connections: 13,390			
Capacity Required	5,356,000	2,678,000	10,710
Capacity Available*	6,949,000	4,223,000	15,000
Rattlesnake Pressure Plane Forecasted Connections: 1,763			
Capacity Required	705,200**	352,600	1,410
Capacity Available*	600,000**	600,000	3,000
Mountain Top Pressure Plane Forecasted Connections: 1,270			
Capacity Required	508,000	254,000	1,020
Capacity Available*	600,000	478,000	2,580
Southwest Pressure Plane Forecasted Connections: 750			
Capacity Required	300,000	150,000	600
Capacity Available*	600,000	300,000	1,200
System Total Forecasted Connections: 17,173			
Capacity Required	6,869,200	3,434,600	13,740
Capacity Available*	8,749,000	5,601,000	21,780

** Assumes completion of Category 1 and Category 2 Recommended Improvements.*
*** Difference in required and available total storage provided by excess Central Pressure Plane elevated storage.*

TABLE 6.4 – MINIMUM SYSTEM CAPACITY REQUIREMENTS LONG-TERM (20-YR PLANNING)

		Total Storage Capacity	Elevated Storage Capacity	Service Pump Capacity
Design Criteria *(per connection)*	Recommended	400 gal.	200 gal.	0.8 gpm
Central Pressure Plane				
Forecasted Connections:	17,103			
Capacity Required		6,841,200	3,420,600	13,680
Capacity Available*		8,149,000	5,423,000	15,000
Rattlesnake Pressure Plane				
Forecasted Connections:	2,470			
Capacity Required		988,000**	494,000	1,980
Capacity Available*		600,000**	600,000	3,000
Mountain Top Pressure Plane				
Forecasted Connections:	2,390			
Capacity Required		956,000**	478,000	1,910
Capacity Available*		600,000**	478,000	2,580
Southwest Pressure Plane				
Forecasted Connections:	750			
Capacity Required		300,000	150,000	600
Capacity Available*		600,000	300,000	1,200
System Total				
Forecasted Connections:	22,713			
Capacity Required		9,085,200	4,542,600	18,170
Capacity Available*		9,949,000	6,801,000	21,780

** Assumes completion of Category 1 and Category 2 Recommended Improvements.*
*** Difference in required and available total storage provided by excess Central Pressure Plane elevated storage.*

6.4 FUTURE CONDITIONS WATER MODEL SIMULATIONS

The future conditions water model was used to develop and evaluate improvements needed to satisfy future system requirements. Extended period simulations for the average day and maximum day demands were used to evaluate service pump and tank performance. A steady-state simulation was performed to evaluate system performance during peak hour demand. A Fire Flow Simulation was also performed for the future conditions. The water model results for the average day, maximum day, and peak hour simulations demonstrate that the addition of the Category 2 and 3 Recommended Improvements will allow the Copperas Cove water system to provide an adequate level of service for up to twenty years of system wide growth at 2%.

6.5 RECOMMENDED IMPROVEMENTS – CATEGORY 2 AND CATEGORY 3

A list of recommended improvements has been developed to address areas of concern and deficiencies within the future water system under projected operating and demand conditions. The improvements identified for the near-term (10-year planning period) are referred to as Category 2 Water System Improvements. The improvements identified for the long-term (20-year planning period) are referred to as Category 3 Water System Improvements.

Refer to Exhibits C-2 and C-3 in the Appendix for a detailed description of all Category 2 and Category 3 recommended projects. A summary list and cost estimates for all Category 1-3 projects is presented in Section 7 of this report.

7.0 CONCLUSION

7.1 SYSTEM EVALUATION AND IMPROVEMENTS

Hydraulic modeling and evaluation of the Copperas Cove water system using design criteria developed from historical water use records shows that there are several deficiencies in the existing system. The existing system concerns and deficiencies are generally summarized as follows:

- Insufficient elevated storage capacity in the Central Pressure Plane
- Limitations of the Mickan Mountain Pump Station (facility age, capacity and general function)
- Water transmission capacity across central portion of city
- Low pressures at the upper elevations of the Central Pressure Plane
- Limited available fire flow in portions of the city served by aging and undersized water mains

Projected growth in the City is expected to increase the number of connections served by the Copperas Cove water system from 14,373 currently to approximately 17,000 in 10-years and over 20,600 within 20-years (using a 2% growth forecast). The existing system deficiencies and future growth in the system will require that extensive improvements be made to the system.

Three categories of recommended improvements have identified to address existing system concerns and plan for future growth.

Category 1

The purpose of these improvements is to address immediate deficiencies and to maintain or improve water service within the existing system based on existing facilities and current demands. The general goal of this category of improvements is to:

1. Redefine the Central Pressure Plane boundary in certain areas to be accomplished by constructing several minor water line and valve improvements projects. The redefined pressure plane boundary will provide the following benefits:

    - Increase service pressure to areas that currently experience low or marginal pressure.
    - Allow for increased control and operational flexibility in areas where the Central and Mountain Top Pressure Planes are hydraulically connected.
    - Allow for better accounting of existing storage capacity in the Central Pressure Plane thereby deferring the need for additional storage capacity.

2. Increase water transmission capacity between the Turkey Run Pump Station and the Mickan Mountain facility.
3. Simplify and optimize system operation by utilizing the existing Mickan Mountain site to increase elevated storage capacity in the Central Pressure Plane.
4. Simplify and optimize system operation by eliminating the Mickan Mountain pump station and installing additional capacity at the Turkey Run site.
5. Increase fire flow with various water line improvement projects.

Category 2

The purpose of these improvements is to accommodate reasonably anticipated growth within a 10-year planning period and to include system maintenance/rehabilitation type projects. The general goal of this category of improvements is to:

1. Increase system capacity by constructing storage and pumping facilities in the southwest portion of the city.
2. Increase system capacity by constructing elevated storage and pumping facilities in the southeast portion of the city. Replacing the existing standpipe with an elevated tank will have the added benefit of optimizing storage capacity.
3. Increase reliability of water transmission supply to the city.

Category 3

The purpose of these improvements is to accommodate reasonably anticipated growth within a 20-year planning period and to include system maintenance/rehabilitation type projects. The general goal of this category of improvements is to:

1. Improve and increase water transmission capacity across the city.
2. Increase storage and pumping capacity of the system.

7.2 WATER QUALITY HYDRAULIC ANALYSIS

The City of Copperas Cove purchases its water supply from Bell County WCID No. 1. The Bell County WCID No. 1 provides treatment of and delivery of water satisfying drinking water standards as regulated by the TCEQ and the Environmental Protection Agency (EPA). The City is responsible for ensuring the water supply continues to meet drinking water standards as it is conveyed through the transmission and distribution system, ultimately to the customers.

As all drinking water may reasonably be expected to contain at least small amounts of some contaminants, the City's challenge is to maintain an adequate level of disinfectant residual in the drinking water system while minimizing the adverse formation of disinfectant byproducts. The most effective means of accomplishing this from a system design perspective is to minimize dead-end water mains, avoid un-mixed zones in storage tanks and efficiently route water through the system.

In consideration of this, an extended period simulation was performed to evaluate water age at various points in the system at various development periods. The results of this analysis are presented in Exhibit H. The results demonstrate that the recommended improvements from Category 1 to Category 3 accomplish the goal of adding additional capacity to the system while also reducing overall water age in the system.

7.3 RECOMMENDED PROJECTS SUMMARY AND COST ESTIMATES

A complete listing of all recommended improvements is presented in Table 7.1. The summary table includes a general prioritization of the projects and also includes a cross reference of recommended projects that may have been identified in previous versions of the Water System Study. Additionally, the table identifies which projects may already be included in the City's FY2016-2020 Capital Improvement Plan.

Cost estimates were developed for all the recommended capital projects. The cost of Category 1, Category 2 and Category 3 projects is presented in Tables 7.2, 7.3 and 7.4, respectively.

Table 7.1 - Recommended Improvements Summary

Water System Study - 2017 Update				Water System Study - 2012 Update			FY 2016-2020 Capital Improvement Plan	
Project ID	**Project Description**	**Priority [1]**	**Estimated Cost**	**Included**	**Related Project ID**	**Estimated Cost**	**Included**	**Budget Amount**
Project 1A	Mountain Top / Central Pressure Zone Improvements	1	$110,000.00	No	-	-	No	-
Project 1B	Oak Hill Drive / Deer Flats Pressure Improvements	1	$270,000.00	Yes	Project II-G	$130,000.00	Yes	$165,000.00
Project 1C	Mountain Top / Central Pressure Zone Improvements	1	$190,000.00	No	-	-	No	-
Project 1D	Mickan Mountain 24-Inch Transmission Line	1	$450,000.00	Yes	Projects II-F, II-H & II-K	(refer to total cost below)	No	-
Project 1E	Mickan Mountain Elevated Storage Tank	1	$3,380,000.00	Yes	Project I-C	$3,560,000.00	Yes	$3,562,000.00
Project 1F	Turkey Run Pump Station Expansion	1	$260,000.00	Yes	Project II-J	$380,000.00	Yes	$400,000.00
Project 2A	Southwest Water Improvements Phase II/III	1	$2,710,000.00	Yes	Project II-B	$2,560,000.00	Yes	currently funded
Project 2B	Rattlesnake Mountain Elevated Storage Tank	2	$1,920,000.00	Yes	Project II-D	$1,530,000.00	Yes	$1,500,000.00
Project 2C	Killeen/Cove 20-Inch Transmission Line Relocation	2	$6,940,000.00	Yes	Projects II-E	$6,660,000.00	Yes	$6,700,000.00
Project 2D	Killeen 20-Inch Pump Station Improvements	2	$160,000.00	Yes	Projects II-N	$150,000.00	No	-
Project 3A	Central Transmission Line 'A'	2	$1,280,000.00	Yes	Projects II-F, II-H & II-K		No	-
Project 3B	Central Transmission Line 'B'	2	$2,730,000.00	Yes	Projects II-F, II-H & II-K		No	-
Project 3C	Central Transmission Line 'C'	2	$1,500,000.00	Yes	Projects II-F, II-H & II-K	$7,920,000.00	No	-
Project 3D	Central Transmission Line 'D'	2	$2,910,000.00	Yes	Projects II-F, II-H & II-K		No	-
Project 3E	Central Transmission Line 'E'	2	$600,000.00	Yes	Projects II-F, II-H & II-K		No	-

Water System Study - 2017 Update				Water System Study - 2012 Update			FY 2016-2020 Capital Improvement Plan	
Project ID	**Project Description**	**Priority [1]**	**Estimated Cost**	**Included**	**Related Project ID**	**Estimated Cost**	**Included**	**Budget Amount**
Project 3F	Highway 190 South Transmission Line	2	$4,190,000.00	Yes	Project II-I	$3,500,000.00	No	-
Project 3G	Central Pressure Plane Elevated Storage Capacity Expansion	2	$2,340,000.00	Yes	Projects II-A & II-B	$4,560,000.00	Yes	$1,661,000.00
Project 3H	Turkey Run Pump Station Rehabilitation and Expansion	2	$590,000.00	No	-	-	No	-
Project 1G	High Chaparral Water Line Replacement	3		Yes	Phase III Improvements		No	-
Project 1H	Buckboard Trail Water Line Replacement	3		Yes	Phase III Improvements		No	-
Project 1J	Post Office Road and Alan Arbor Lane Water Line Replacement	3	(Priority 3 project costs to be identified on an individual basis)	Yes	Phase III Improvements	(Phase III project costs not identified)	No	-
Project 1K	Hughes Elevated Storage Tank Water Line	3		Yes	Phase III Improvements		No	-
Project 1L	Robertson Avenue Water Line Replacement	3		Yes	Phase III Improvements		No	-
Project 1M	Annual Water Line Replacement Projects	3		Yes	Phase III Improvements		Yes	$625,000.00
		Total	$32,530,000.00		Total	$30,950,000.00		

[1] Priority is a relative categorization of project priority. Priority 1 projects are identified to correct existing problems that may affect the City's ability to meet minimum system capacity requirements. Priority 2 projects are identified to expand system capacity to accomodate increasing system demands. Priority 3 projects are identified to maintain existing facilities or improve water service.

Water System Study - 2017 Update				Water System Study - 2012 Update			FY 2016-2020 Capital Improvement Plan	
Project ID	**Project Description**	**Priority [1]**	**Estimated Cost**	**Included**	**Related Project ID**	**Estimated Cost**	**Included**	**Budget Amount**
Recommended Maintenance and Other Water System Improvements								
Other	Taylor Mountain Tank Rehabilitation	2	$1,630,000.00	Yes	Projects II-C	$1,630,000.00	No	-
Other	Turkey Run 1 MG Steel Ground Storage Tank Rehabiliation	2	$425,000.00	No	-	-	Yes	$425,000.00
Other	Turkey Run 350,000 Gallon Steel Ground Storage Tank Rehabiliation	2	$140,000.00	No	-	-	Yes	$140,000.00
Other	Hughes Mountain Elevated Storage Tank Rehabiliation	2	$520,000.00	No	-	-	Yes	$520,000.00
Other	South FM 116 12" Water Line Extension	2	$755,000.00	No	-	-	Yes	$755,000.00

[1] Priority is a relative categorization of project priority. Priority 1 projects are identified to correct existing problems that may affect the City's ability to meet minimum system capacity requirements. Priority 2 projects are identified to expand system capacity to accomodate increasing system demands. Priority 3 projects are identified to maintain existing facilities or improve water service.

Table 7.2
Recommended Improvements - Category 1
Cost Estimate

Project 1A - Mountain Top / Central Pressure Zone Improvements							
ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT		UNIT PRICE		ITEM TOTAL
1	Pressure Reducing Valve Assembly w/ Bypass & Vault	2	EA	$	25,000.00	$	50,000.00
2	Check Valve Assembly and Vault	2	EA	$	15,000.00	$	30,000.00
Total Estimated Construction Cost						$	80,000.00
Contingency, Engineering, Surveying, Permitting (30%)						$	24,000.00
Total Project 1-A						**$**	**110,000.00**
Project 1B - Oak Hill / Deer Flats Pressure Improvements							
ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT		UNIT PRICE		ITEM TOTAL
1	8" Water Line (Babb St)	250	LF	$	100.00	$	25,000.00
2	8" Water Line (Veterans Ave)	950	LF	$	100.00	$	95,000.00
3	8" Water Line (27th Street)	650	LF	$	100.00	$	65,000.00
4	Pressure Reducing Valve w/ Vault	1	EA	$	20,000.00	$	20,000.00
Total Estimated Construction Cost						$	205,000.00
Contingency, Engineering, Surveying, Permitting (30%)						$	61,500.00
Total Project 1B						**$**	**270,000.00**
Project 1C - Mountain Top / Central Pressure Zone Improvements							
ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT		UNIT PRICE		ITEM TOTAL
1	8" Water Line (23rd Street)	850	LF	$	100.00	$	85,000.00
1	8" Water Line (Veterans Ave)	600	LF	$	100.00	$	60,000.00
Total Estimated Construction Cost						$	145,000.00
Contingency, Engineering, Surveying, Permitting (30%)						$	43,500.00
Total Project 1C						**$**	**190,000.00**
Project 1D - Mickan Mountain 24-Inch Transmission Line							
ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT		UNIT PRICE		ITEM TOTAL
1	24" Water Line	1,700	LF	$	200.00	$	340,000.00
Total Estimated Construction Cost						$	340,000.00
Contingency, Engineering, Surveying, Permitting (30%)						$	102,000.00
Total Project 1D						**$**	**450,000.00**
Project 1E - Mickan Mountain Elevated Storage Tank							
ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT		UNIT PRICE		ITEM TOTAL
1	1.5 MG Composite Elevated Tank	1	LS	$	2,250,000.00	$	2,250,000.00
2	Site Work and Yard Piping	1	LS	$	200,000.00	$	200,000.00
3	Long Mountain Pump Station Improvements	1	LS	$	150,000.00	$	150,000.00
Total Estimated Construction Cost						$	2,600,000.00
Contingency, Engineering, Surveying, Permitting (30%)						$	780,000.00
Total Project 1E						**$**	**3,380,000.00**
Project 1F - Turkey Run Pump Station Expansion							
ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT		UNIT PRICE		ITEM TOTAL
1	Install 250 HP Pumps	2	EA	$	100,000.00	$	200,000.00
Total Estimated Construction Cost						$	200,000.00
Contingency, Engineering, Surveying, Permitting (30%)						$	60,000.00
Total Project 1F						**$**	**260,000.00**
Grand Total Category 1						**$**	**4,660,000.00**

This Construction Cost Estimate is based on Trihydro's experience and qualifications, and represents Trihydro's best judgement. However, since Trihydro has no control over the cost of labor, materials, equipment or services furnished by others, Trihydro does not guarantee that the actual construction cost will not vary from the Construction Cost Estimate.

Table 7.3
Recommended Improvements - Category 2
Cost Estimate

Project 2A - Southwest Water Improvements (Phase II)							
ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT		UNIT PRICE		ITEM TOTAL
1	500,000 gal Pre-stressed Concrete Ground Storage Tank	1	LS	$	750,000.00	$	750,000.00
2	300,000 gal Elevated Storage Tank (~205' tall)	1	LS	$	1,100,000.00	$	1,100,000.00
3	Booster Pump Station	1	LS	$	250,000.00	$	250,000.00
4	16" Water Line	1000	LF	$	160.00	$	160,000.00
Total Estimated Construction Cost						$	2,260,000.00
Total Project 1-A						$	452,000.00
Total Project 2A						**$**	**2,710,000.00**
Project 2B - Rattlesnake Mountain Elevated Storage Tank							
ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT		UNIT PRICE		ITEM TOTAL
1	600,000 Elevated Storage Tank (~150' tall)	1	LS	$	1,200,000.00	$	1,200,000.00
2	Seven Mile Pump Station Expansion	1	LS	$	250,000.00	$	250,000.00
3	Pressure Reducing Valve w/ Vault	1	EA	$	20,000.00	$	20,000.00
Total Estimated Construction Cost						$	1,470,000.00
Contingency, Engineering, Surveying, Permitting (30%)						$	441,000.00
Total Project 2B						**$**	**1,920,000.00**
Project 2C - Killeen/Cove 20" Transmission Line Relocation							
ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT		UNIT PRICE		ITEM TOTAL
1	20" Water Line	29,500	LF	$	180.00	$	5,310,000.00
Total Estimated Construction Cost Project						$	5,310,000.00
Contingency, Engineering, Surveying, Permitting (30%)						$	1,593,000.00
Water Line Easement		3.39	Ac	$	8,000.00	$	28,000.00
Total Project 2C						**$**	**6,940,000.00**
Project 2D - Killeen 20" Pump Station Improvements							
ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT		UNIT PRICE		ITEM TOTAL
1	Install Additional Pump	1	LS	$	120,000.00	$	120,000.00
Total Estimated Construction Cost						$	120,000.00
Contingency, Engineering, Surveying, Permitting (30%)						$	36,000.00
Total Project 2D						**$**	**160,000.00**
Grand Total Category 2						**$**	**4,630,000.00**

This Construction Cost Estimate is based on Trihydro's experience and qualifications, and represents Trihydro's best judgement. However, since Trihydro has no control over the cost of labor, materials, equipment or services furnished by others, Trihydro does not guarantee that the actual construction cost will not vary from the Construction Cost Estimate.

Table 7.4
Recommended Improvements - Category 3
Cost Estimate

Project 3A - Central Transmission Line 'A'							
ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT		UNIT PRICE		ITEM TOTAL
1	36" Water Line	500	LF	$	350.00	$	175,000.00
2	24" Water Line	3500	LF	$	230.00	$	805,000.00
Total Estimated Construction Cost						$	980,000.00
Contingency, Engineering, Surveying, Permitting (30%)						$	294,000.00
Total Project 3A						**$**	**1,280,000.00**
Total Project 1-A							
Project 3B - Central Transmission Line 'B'							
ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT		UNIT PRICE		ITEM TOTAL
1	30" Water Line	7,000	LF	$	300.00	$	2,100,000.00
Total Estimated Construction Cost						$	2,100,000.00
Contingency, Engineering, Surveying, Permitting (30%)						$	630,000.00
Total Project 3B						**$**	**2,730,000.00**
Project 3C - Central Transmission Line 'C'							
ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT		UNIT PRICE		ITEM TOTAL
1	24" Water Line	5000	LF	$	230.00	$	1,150,000.00
Total Estimated Construction Cost Project						$	1,150,000.00
Contingency, Engineering, Surveying, Permitting (30%)						$	345,000.00
Total Project 3C						**$**	**1,500,000.00**
Project 3D - Central Transmission Line 'D'							
ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT		UNIT PRICE		ITEM TOTAL
1	24" Water Line	9700	LF	$	230.00	$	2,231,000.00
Total Estimated Construction Cost Project						$	2,231,000.00
Contingency, Engineering, Surveying, Permitting (30%)						$	669,300.00
Total Project 3D						**$**	**2,910,000.00**
Project 3E - Central Transmission Line 'E'							
ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT		UNIT PRICE		ITEM TOTAL
1	24" Water Line	2,000	LF	$	230.00	$	460,000.00
Total Estimated Construction Cost Project						$	460,000.00
Contingency, Engineering, Surveying, Permitting (30%)						$	138,000.00
Total Project 3E						**$**	**600,000.00**
Project 3F - Highway 190 South Transmission Line							
ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT		UNIT PRICE		ITEM TOTAL
1	24" Water Line	14,000	LF	$	230.00	$	3,220,000.00
Total Estimated Construction Cost Project						$	3,220,000.00
Contingency, Engineering, Surveying, Permitting (30%)						$	966,000.00
Total Project 3F						**$**	**4,190,000.00**
Project 3G - Central Pressur Plane Elevated Storage Capacity Expansion							
ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT		UNIT PRICE		ITEM TOTAL
1	600,000 Gal. Pre-stressed Conc. GST - Mountain Top North	1	LS	$	900,000.00	$	900,000.00
2	600,000 Gal. Pre-stressed Conc. GST - Southwest	1	LS	$	900,000.00	$	900,000.00
Total Estimated Construction Cost Project						$	1,800,000.00
Contingency, Engineering, Surveying, Permitting (30%)						$	540,000.00
Total Project 3G						**$**	**2,340,000.00**

Table 7.4
Recommended Improvements - Category 3
Cost Estimate

Project 3H - Turkey Run Pump Station Rehabiliation and Expansion							
ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT		UNIT PRICE		ITEM TOTAL
1	Replace original 200 HP pump w/ new 250 HP pump	3	EA	$	150,000.00	$	450,000.00
Total Estimated Construction Cost Project						$	450,000.00
Contingency, Engineering, Surveying, Permitting (30%)						$	135,000.00
Total Project 3H						**$**	**590,000.00**
Grand Total Category 3						**$**	**16,140,000**

This Construction Cost Estimate is based on Trihydro's experience and qualifications, and represents Trihydro's best judgement. However, since Trihydro has no control over the cost of labor, materials, equipment or services furnished by others, Trihydro does not guarantee that the actual construction cost will not vary from the Construction Cost Estimate.

EXHIBIT A-1

FACILITIES SUMMARY – EXISTING

EXHIBIT A-1

Facilities Summary - Existing

City of Copperas Cove, Texas

Water System Study - 2017 Update

CENTRAL PRESSURE PLANE

Elevated Storage

Service Area = up to 1,170' elevation

Elevated Storage = All storage above 1,250' (1,170' + 80')

Elevated Strg Starts at: 1250

Hogg Mountain:

Dia =	65.3	ft
Overflow =	1261	ft
Base =	1221	ft
Capacity =	1,000,000	Gal.
Elevated =	276,000	Gal.
Dia =	38	ft
Overflow =	1261	ft
Base =	1221	ft
Capacity =	339,000	Gal.
Elevated =	93,000	Gal.
Hogg Total Storage =	1,339,000	Gal.
Hogg Elevated Storage =	369,000	Gal.

Turkey Run:

Dia =	73	ft
Overflow =	1065	ft
Base =	1033	ft
Capacity =	1,000,000	Gal.
Elevated =	-	Gal.
Dia =	38.6	ft
Overflow =	1065	ft
Base =	1025	ft
Capacity =	350,000	Gal.
Elevated =	-	Gal.
Turkey Run Total Storage =	1,350,000	Gal.
Turkey Run Elevated Storage =	-	Gal.

Taylor Mountain:

Dia =	76.6	ft
Overflow =	1261	ft
Base =	1232	ft
Capacity =	1,000,000	Gal.
Elevated =	379,000	Gal.
Dia =	38.3	ft
Overflow =	1261	ft
Base =	1232	ft
Capacity =	250,000	Gal.
Elevated =	95,000	Gal.
Taylor Total Storage =	1,250,000	Gal.
Taylor Elevated Storage =	474,000	Gal.

Mickan Mountain:

Dia =	65.3	ft
Overflow =	1207	ft
Base =	1167	ft
Capacity =	1,000,000	Gal.
Elevated =	-	Gal.
Dia =	32.7	ft
Overflow =	1207	ft
Base =	1175	ft
Capacity =	200,000	Gal.
Elevated =	-	Gal.
Mickan Total Storage =	1,200,000	Gal.
Mickan Elevated Storage =	-	Gal.

Seven Mile:

Dia =	56	ft
Overflow =	1263	ft
Base =	1208	ft
Capacity =	1,010,000	Gal.
Elevated =	240,000	Gal.
Seven Mile Total Storage =	1,010,000	Gal.
Seven Mile Elevated Storage =	240,000	Gal.

Eastside:

Dia =	50	ft
Overflow =	1047	ft
Base =	1012	ft
Capacity =	500,000	Gal.
Elevated =	-	Gal.
Eastside Total Storage =	500,000	Gal.
Eastside Elevated Storage =	-	Gal.

Central Plane Total Storage =	**6,649,000**	**Gal.**
Central Plane Elevated Storage =	**1,083,000**	**Gal.**

EXHIBIT A-1

Facilities Summary - Existing

City of Copperas Cove, Texas

Water System Study - 2017 Update

Service Pump Capacity (Central)

Turkey Run

No.of Pumps = 4

Pumps 1 & 2 & 3			Pump 4		
Rated Flow =	2118	* gpm	Rated Flow =	3000	* gpm
Rated Head =	200	* ft	Rated Head =	265	* ft
Horsepower =	200	HP	Horsepower =	250	HP

Firm Capacity = 6354 gpm

Mickan Mountain

No.of Pumps = 4

Pump 1			Pump 3		
Rated Flow =	575	gpm	Rated Flow =	1000	gpm
Rated Head =	165	ft	Rated Head =	192	ft
Horsepower =	40	HP	Horsepower =	60	HP

Pump 2			Pump 4		
Rated Flow =	300	gpm	Rated Flow =	2000	gpm
Rated Head =	130	ft	Rated Head =	162	ft
Horsepower =	15	HP	Horsepower =	100	HP

Firm Capacity = 1875 gpm

Eastside

No.of Pumps =	3	
Rated Flow =	1500	gpm
Rated Head =	215	ft
Horsepower =	125	HP

Firm Capacity = 3000 gpm

Service Pump Capacity (Firm) = 11,229 gpm

EXHIBIT A-1
Facilities Summary - Existing
City of Copperas Cove, Texas
Water System Study - 2017 Update

MOUNTAIN TOP PRESSURE PLANE

Elevated Storage

Service Area = up to 1,290' elevation
Elevated Storage = All storage above 1,370' (1,290' + 80')

Elevated Strg Starts at: 1370

Hughes Mountain:			**Mountain Top North EST:**		
Dia =	43	ft	Dia =	43	ft
Overflow =	1392	ft	Overflow =	1392	ft
Bottom Level =	1364	ft	Bottom Level =	1364	ft
Ground =	1268	ft	Ground =	1254	ft
Capacity =	300,000	Gal.	Capacity =	300,000	Gal.
Elevated =	239,000	Gal.	Elevated =	239,000	Gal.
Hughes Total Storage =	300,000	Gal.	MTN EST Total Storage =	300,000	Gal.
Hughes Elevated Storage =	239,000	Gal.	MTN Elevated Storage =	239,000	Gal.

Pressure Plane Total Storage = 600,000 Gal.
Pressure Plane Elevated Storage = 478,000 Gal.

Service Pump Capacity

Taylor Mountain			**Mountain Top North**		
No.of Pumps =	2		No.of Pumps =	3	
Rated Flow =	1180	* gpm	Rated Flow =	700	gpm
Rated Head =	156	* ft	Rated Head =	200	ft
Horsepower =	100	HP	Horsepower =	50	HP
Firm Capacity =	1,180	gpm	Firm Capacity =	1,400	gpm

Service Pump Capacity (Firm) = 2,580 gpm

EXHIBIT A-1
Facilities Summary - Existing
City of Copperas Cove, Texas
Water System Study - 2017 Update

RATTLESNAKE PRESSURE PLANE

Elevated Storage

Service Area = up to 1,220' elevation
Elevated Storage = All storage above 1,300' (1,220' + 80')

Elevated Strg Starts at: 1300

Rattlesnake Standpipe:

Dia =	30	ft
Overflow =	1346	ft
Base =	1220	ft
Capacity =	670,000	Gal.
Elevated =	243,000	Gal.
Rattlesnake Total Storage =	670,000	Gal.
Rattlesnake Elevated Storage =	243,000	Gal.
Pressure Plane Total Storage =	670,000	Gal.
Pressure Plane Elevated Storage =	**243,000**	**Gal.**

Service Pump Capacity

Seven Mile			**Long Mountain**		
No.of Pumps =	2		No.of Pumps =	2	
Rated Flow =	1000	gpm	Rated Flow =	1000	*gpm
Rated Head =	110	ft	Rated Head =	180	*ft
Horsepower =	40	HP	Horsepower =	75	HP
Firm Capacity =	1000	gpm	Firm Capacity =	1000	gpm

Service Pump Capacity (Firm) = 2000 gpm

EXHIBIT A-1

Facilities Summary - Existing

City of Copperas Cove, Texas

Water System Study - 2017 Update

COPPERAS COVE WATER SYSTEM

Total Storage

Hughes EST :	300,000	gal.
Mtn Top North EST :	300,000	gal.
Taylor Mountain (2) :	1,250,000	gal.
Hogg Mountain (2) :	1,339,000	gal.
Mickan Mountain (2) :	1,200,000	gal.
Seven Mile :	1,010,000	gal.
Rattlesnake Mnt. :	670,000	gal.
Turkey Run (2) :	1,350,000	gal.
Eastside :	500,000	gal.
Mtn Top North GST :	0	gal.
Total Storage =	**7,919,000**	**gal.**

Supply Pump Capacity

Killeen/Cove 30-inch Pump Station

No.of Pumps =	3	
Rated Flow =	3500	gpm
Rated Head =	270	ft
Horsepower =	300	HP
Firm Capacity =	7000	gpm

Killeen 20-inch Pump Station

No.of Pumps =	2	
Rated Flow =	2118	* gpm
Rated Head =	329	* ft
Horsepower =	450	HP
Firm Capacity =	2118	gpm

Total Supply Pump Capacity = 9,118 gpm

EXHIBIT A-2

FACILITIES SUMMARY – NEAR-TERM
(10-YEAR PLANNING)

EXHIBIT A-2

Facilities Summary - Near Term (10-Year Planning)

City of Copperas Cove, Texas

Water System Study - 2017 Update

CENTRAL PRESSURE PLANE

Elevated Storage

Service Area = up to 1,152' elevation

Elevated Storage = All storage above 1,232' (1,152' + 80')

Elevated Strg Starts at: 1232

Hogg Mountain:

Dia =	65.3	ft
Overflow =	1261	ft
Base =	1221	ft
Capacity =	1,000,000	Gal.
Elevated =	727,000	Gal.
Dia =	38	ft
Overflow =	1261	ft
Base =	1221	ft
Capacity =	339,000	Gal.
Elevated =	246,000	Gal.
Hogg Total Storage =	1,339,000	Gal.
Hogg Elevated Storage =	973,000	Gal.

Turkey Run:

Dia =	73	ft
Overflow =	1065	ft
Base =	1033	ft
Capacity =	1,000,000	Gal.
Elevated =	-	Gal.
Dia =	38.6	ft
Overflow =	1065	ft
Base =	1025	ft
Capacity =	350,000	Gal.
Elevated =	-	Gal.
Turkey Run Total Storage =	1,350,000	Gal.
Turkey Run Elevated Storage =	-	Gal.

Taylor Mountain:

Dia =	76.6	ft
Overflow =	1261	ft
Base =	1232	ft
Capacity =	1,000,000	Gal.
Elevated =	1,000,000	Gal.
Dia =	38.3	ft
Overflow =	1261	ft
Base =	1232	ft
Capacity =	250,000	Gal.
Elevated =	250,000	Gal.
Taylor Total Storage =	1,250,000	Gal.
Taylor Elevated Storage =	1,250,000	Gal.

Mickan Mountain:

Dia =	80.0	ft
Overflow =	1270	ft
Base =	1230	ft
Capacity =	1,500,000	Gal.
Elevated =	1,429,000	Gal.
Mickan Total Storage =	1,500,000	Gal.
Mickan Elevated Storage =	1,429,000	Gal.

Seven Mile:

Dia =	56	ft
Overflow =	1263	ft
Base =	1208	ft
Capacity =	1,010,000	Gal.
Elevated =	571,000	Gal.
Seven Mile Total Storage =	1,010,000	Gal.
Seven Mile Elevated Storage =	571,000	Gal.

Eastside:

Dia =	50	ft
Overflow =	1047	ft
Base =	1012	ft
Capacity =	500,000	Gal.
Elevated =	-	Gal.
Eastside Total Storage =	500,000	Gal.
Eastside Elevated Storage =	-	Gal.

Central Plane Total Storage =	6,949,000	Gal.
Central Plane Elevated Storage =	**4,223,000**	**Gal.**

EXHIBIT A-2

Facilities Summary - Near Term (10-Year Planning)

City of Copperas Cove, Texas

Water System Study - 2017 Update

Service Pump Capacity (Central)

Turkey Run

No.of Pumps = 6

Pumps 1 & 2 & 3			Pump 4 & 5 & 6		
Rated Flow =	2000	* gpm	Rated Flow =	3000	gpm
Rated Head =	265	* ft	Rated Head =	265	ft
Horsepower =	200	HP	Horsepower =	250	HP
Firm Capacity =	6000	* gpm	Firm Capacity =	6000	gpm

* A reduction in pumping capacity of the existing Pumps 1 - 3 is expected due to pump age and increased pumping head of new Mickan Elevated Tank.

Eastside

No.of Pumps =	3	
Rated Flow =	1500	gpm
Rated Head =	215	ft
Horsepower =	125	HP
Firm Capacity =	3000	gpm

Service Pump Capacity (Firm) = 15,000 gpm

EXHIBIT A-2

Facilities Summary - Near Term (10-Year Planning)

City of Copperas Cove, Texas

Water System Study - 2017 Update

MOUNTAIN TOP PRESSURE PLANE

Elevated Storage

Service Area = up to 1,290' elevation

Elevated Storage = All storage above 1,370' (1,290' + 80')

Elevated Strg Starts at: 1370

Hughes Mountain:			**Mountain Top North EST:**		
Dia =	43	ft	Dia =	43	ft
Overflow =	1392	ft	Overflow =	1392	ft
Bottom Level =	1364	ft	Bottom Level =	1364	ft
Ground =	1268	ft	Ground =	1254	ft
Capacity =	300,000	Gal.	Capacity =	300,000	Gal.
Elevated =	239,000	Gal.	Elevated =	239,000	Gal.
Hughes Total Storage =	300,000	Gal.	MTN EST Total Storage =	300,000	Gal.
Hughes Elevated Storage =	239,000	Gal.	MTN Elevated Storage =	239,000	Gal.

Pressure Plane Total Storage =	600,000	Gal.
Pressure Plane Elevated Storage =	**478,000**	**Gal.**

Service Pump Capacity

Taylor Mountain			**Mountain Top North**		
No.of Pumps =	2		No.of Pumps =	3	
Rated Flow =	1180	* gpm	Rated Flow =	700	gpm
Rated Head =	156	* ft	Rated Head =	200	ft
Horsepower =	100	HP	Horsepower =	50	HP
Firm Capacity =	1,180	gpm	Firm Capacity =	1,400	gpm

Service Pump Capacity (Firm) =	**2,580**	**gpm**

EXHIBIT A-2

Facilities Summary - Near Term (10-Year Planning)

City of Copperas Cove, Texas

Water System Study - 2017 Update

SOUTHWEST PRESSURE PLANE

Elevated Storage

Service Area = up to 1,300' elevation

Elevated Storage = All storage above 1,380' (1,300' + 80')

Elevated Strg Starts at: 1385

Southwest EST:			**Southwest GST:**		
Dia =	41	ft	Dia =	TBD	ft
Overflow =	1415	ft	Overflow =	TBD	ft
Bottom Level =	1385	ft	Bottom Level =	TBD	ft
Ground =	1210	ft	Ground =	TBD	ft
Capacity =	300,000	Gal.	Capacity =	300,000	Gal.
Elevated =	300,000	Gal.	Elevated =	-	Gal.
Southwest EST Total Storage =	300,000	Gal.	Southwest GST Total Storage =	300,000	Gal.
Southwest EST Elevated Storage =	300,000	Gal.	Southwest GST Elevated Storage =	-	Gal.

Pressure Plane Total Storage =	600,000	Gal.
Pressure Plane Elevated Storage =	**300,000**	**Gal.**

Service Pump Capacity

Southwest Pump Station

No.of Pumps =	TBD	
Rated Flow =	TBD	gpm
Rated Head =	TBD	ft
Horsepower =	TBD	HP
Firm Capacity =	1,200	gpm
Service Pump Capacity (Firm) =	**1,200**	**gpm**

EXHIBIT A-2

Facilities Summary - Near Term (10-Year Planning)

City of Copperas Cove, Texas

Water System Study - 2017 Update

RATTLESNAKE PRESSURE PLANE

Elevated Storage

Service Area = up to 1,250' elevation

Elevated Storage = All storage above 1,330' (1,220' + 80')

Elevated Strg Starts at: 1335

Rattlesnake Elevated Tank:

Dia =	54	ft
Overflow =	1370	ft
Base =	1335	ft
Capacity =	600,000	Gal.
Elevated =	600,000	Gal.
Rattlesnake EST Total Storage =	600,000	Gal.
Rattlesnake EST Elevated Storage =	600,000	Gal.
Pressure Plane Total Storage =	600,000	Gal.
Pressure Plane Elevated Storage =	**600,000**	**Gal.**

Service Pump Capacity

	Seven Mile			**Long Mountain**		
No.of Pumps =	3			No.of Pumps =	2	
Rated Flow =	1000	gpm		Rated Flow =	1000	gpm
Rated Head =	TBD	ft		Rated Head =	TBD	ft
Horsepower =	TBD	HP		Horsepower =	TBD	HP
Firm Capacity =	2000	gpm		Firm Capacity =	1000	gpm
Service Pump Capacity (Firm) =	**3000**	**gpm**				

EXHIBIT A-2

Facilities Summary - Near Term (10-Year Planning)

City of Copperas Cove, Texas

Water System Study - 2017 Update

COPPERAS COVE WATER SYSTEM

Total Storage

Hughes EST :	300,000	gal.
Mtn Top North EST :	300,000	gal.
Taylor Mountain (2) :	1,250,000	gal.
Hogg Mountain (2) :	1,339,000	gal.
Mickan Mountain:	1,500,000	gal.
Seven Mile :	1,010,000	gal.
Rattlesnake Mnt. :	600,000	gal.
Turkey Run (2) :	1,350,000	gal.
Eastside :	500,000	gal.
Mtn Top North GST :	0	gal.
Southwest EST:	300,000	gal.
Southwest GST:	300,000	gal.
Total Storage =	**8,749,000**	**gal.**

Supply Pump Capacity

Killeen/Cove 30-inch Pump Station

No.of Pumps =	3	
Rated Flow =	3500	gpm
Rated Head =	270	ft
Horsepower =	300	HP
Firm Capacity =	7000	gpm

Killeen 20-inch Pump Station

No.of Pumps =	2	
Rated Flow =	2118	* gpm
Rated Head =	329	* ft
Horsepower =	450	HP
Firm Capacity =	2118	gpm

Total Supply Pump Capacity = 9,118 gpm

EXHIBIT A-3

FACILITIES SUMMARY – LONG-TERM
(20-YEAR PLANNING)

EXHIBIT A-3

Facilities Summary - Long Term (20-Year Planning)

City of Copperas Cove, Texas

Water System Study - 2017 Update

CENTRAL PRESSURE PLANE

Elevated Storage

Service Area = up to 1,152' elevation

Elevated Storage = All storage above 1,232' (1,152' + 80')

Elevated Strg Starts at: 1232

Hogg Mountain:

Dia =	65.3	ft
Overflow =	1261	ft
Base =	1221	ft
Capacity =	1,000,000	Gal.
Elevated =	727,000	Gal.
Dia =	38	ft
Overflow =	1261	ft
Base =	1221	ft
Capacity =	339,000	Gal.
Elevated =	246,000	Gal.
Hogg Total Storage =	1,339,000	Gal.
Hogg Elevated Storage =	973,000	Gal.

Turkey Run:

Dia =	73	ft
Overflow =	1065	ft
Base =	1033	ft
Capacity =	1,000,000	Gal.
Elevated =	-	Gal.
Dia =	38.6	ft
Overflow =	1065	ft
Base =	1025	ft
Capacity =	350,000	Gal.
Elevated =	-	Gal.
Turkey Run Total Storage =	1,350,000	Gal.
Turkey Run Elevated Storage =	-	Gal.

Taylor Mountain:

Dia =	76.6	ft
Overflow =	1261	ft
Base =	1232	ft
Capacity =	1,000,000	Gal.
Elevated =	1,000,000	Gal.
Dia =	38.3	ft
Overflow =	1261	ft
Base =	1232	ft
Capacity =	250,000	Gal.
Elevated =	250,000	Gal.
Taylor Total Storage =	1,250,000	Gal.
Taylor Elevated Storage =	1,250,000	Gal.

Mickan Mountain:

Dia =	80.0	ft
Overflow =	1270	ft
Base =	1230	ft
Capacity =	1,500,000	Gal.
Elevated =	1,429,000	Gal.

Proposed Central Tanks:

Mickan Total Storage =	1,500,000	Gal.
Mickan Elevated Storage =	1,429,000	Gal.
MTN GST Total Storage =	600,000	Gal.
MTN Elevated Storage =	600,000	Gal.
Southwest GST Total Storage =	600,000	Gal.
Southwest GST Elevated Storage =	600,000	Gal.

Seven Mile:

Dia =	56	ft
Overflow =	1263	ft
Base =	1208	ft
Capacity =	1,010,000	Gal.
Elevated =	571,000	Gal.
Seven Mile Total Storage =	1,010,000	Gal.
Seven Mile Elevated Storage =	571,000	Gal.

Eastside:

Dia =	50	ft
Overflow =	1047	ft
Base =	1012	ft
Capacity =	500,000	Gal.
Elevated =	-	Gal.
Eastside Total Storage =	500,000	Gal.
Eastside Elevated Storage =	-	Gal.

Central Plane Total Storage =	8,149,000	Gal.
Central Plane Elevated Storage =	**5,423,000**	**Gal.**

EXHIBIT A-3

Facilities Summary - Long Term (20-Year Planning)

City of Copperas Cove, Texas

Water System Study - 2017 Update

Service Pump Capacity (Central)

Turkey Run

No.of Pumps = 6

Pumps 1 & 2 & 3			Pumps 4 & 5 & 6		
Rated Flow =	2000	* gpm	Rated Flow =	3000	gpm
Rated Head =	265	* ft	Rated Head =	265	ft
Horsepower =	200	HP	Horsepower =	250	HP
Firm Capacity =	6000	* gpm	Firm Capacity =	6000	gpm

* A reduction in pumping capacity of the existing Pumps 1 - 3 is expected due to pump age and increased pumping head of new Mickan Elevated Tank.

Eastside

No.of Pumps =	3	
Rated Flow =	1500	gpm
Rated Head =	215	ft
Horsepower =	125	HP
Firm Capacity =	3000	gpm

Service Pump Capacity (Firm) = 15,000 gpm

EXHIBIT A-3

Facilities Summary - Long Term (20-Year Planning)

City of Copperas Cove, Texas

Water System Study - 2017 Update

MOUNTAIN TOP PRESSURE PLANE

Elevated Storage

Service Area = up to 1,290' elevation

Elevated Storage = All storage above 1,370' (1,290' + 80')

Elevated Strg Starts at: 1370

Hughes Mountain:			**Mountain Top North EST:**		
Dia =	43	ft	Dia =	43	ft
Overflow =	1392	ft	Overflow =	1392	ft
Bottom Level =	1364	ft	Bottom Level =	1364	ft
Ground =	1268	ft	Ground =	1268	ft
Capacity =	300,000	Gal.	Capacity =	300,000	Gal.
Elevated =	239,000	Gal.	Elevated =	239,000	Gal.
Hughes Total Storage =	300,000	Gal.	MTN EST Total Storage =	300,000	Gal.
HughesElevated Storage =	239,000	Gal.	MTN Elevated Storage =	239,000	Gal.

Pressure Plane Total Storage =	600,000	Gal.
Pressure Plane Elevated Storage =	**478,000**	**Gal.**

Service Pump Capacity

	Taylor Mountain			**Mountain Top North**		
No.of Pumps =	2			No.of Pumps =	3	
Rated Flow =	1180	*	gpm	Rated Flow =	700	gpm
Rated Head =	156	*	ft	Rated Head =		ft
Horsepower =	100		HP	Horsepower =	50	HP
Firm Capacity =	1,180		gpm	Firm Capacity =	1,400	gpm

Service Pump Capacity (Firm) =	**2,580**	**gpm**

EXHIBIT A-3

Facilities Summary - Long Term (20-Year Planning)

City of Copperas Cove, Texas

Water System Study - 2017 Update

SOUTHWEST PRESSURE PLANE

Elevated Storage

Service Area = up to 1,300' elevation

Elevated Storage = All storage above 1,380' (1,300' + 80')

Elevated Strg Starts at: 1385

Southwest EST:			**Southwest GST:**		
Dia =	41	ft	Dia =	TBD	ft
Overflow =	1415	ft	Overflow =	TBD	ft
Bottom Level =	1385	ft	Bottom Level =	TBD	ft
Ground =	1210	ft	Ground =	TBD	ft
Capacity =	300,000	Gal.	Capacity =	300,000	Gal.
Elevated =	300,000	Gal.	Elevated =	-	Gal.
Southwest EST Total Storage =	300,000	Gal.	Southwest GST Total Storage =	300,000	Gal.
Southwest EST Elevated Storage =	300,000	Gal.	Southwest GST Elevated Storage =	-	Gal.

Pressure Plane Total Storage =	600,000	Gal.
Pressure Plane Elevated Storage =	**300,000**	**Gal.**

Service Pump Capacity

Southwest Pump Station

No.of Pumps =	TBD	
Rated Flow =	TBD	gpm
Rated Head =	TBD	ft
Horsepower =	TBD	HP
Firm Capacity =	1,200	gpm
Service Pump Capacity (Firm) =	**1,200**	**gpm**

EXHIBIT A-3

Facilities Summary - Long Term (20-Year Planning)

City of Copperas Cove, Texas

Water System Study - 2017 Update

RATTLESNAKE PRESSURE PLANE

Elevated Storage

Service Area = up to 1,250' elevation

Elevated Storage = All storage above 1,330' (1,220' + 80')

Elevated Strg Starts at: 1335

Rattlesnake Elevated Tank:

Dia =	54	ft
Overflow =	1370	ft
Base =	1335	ft
Capacity =	600,000	Gal.
Elevated =	600,000	Gal.
Rattlesnake EST Total Storage =	600,000	Gal.
Rattlesnake EST Elevated Storage =	600,000	Gal.
Pressure Plane Total Storage =	600,000	Gal.
Pressure Plane Elevated Storage =	**600,000**	**Gal.**

Service Pump Capacity

Seven Mile			**Long Mountain**		
No.of Pumps =	3		No.of Pumps =	2	
Rated Flow =	1000	gpm	Rated Flow =	1000	gpm
Rated Head =	TBD	ft	Rated Head =	TBD	ft
Horsepower =	TBD	HP	Horsepower =	TBD	HP
Firm Capacity =	2000	gpm	Firm Capacity =	1000	gpm

Service Pump Capacity (Firm) = 3000 gpm

EXHIBIT A-3

Facilities Summary - Long Term (20-Year Planning)

City of Copperas Cove, Texas

Water System Study - 2017 Update

COPPERAS COVE WATER SYSTEM

Total Storage

Hughes EST :	300,000	gal.
Mtn Top North EST :	300,000	gal.
Taylor Mountain (2) :	1,250,000	gal.
Hogg Mountain (2) :	1,339,000	gal.
Mickan Mountain:	1,500,000	gal.
Seven Mile :	1,010,000	gal.
Rattlesnake Mnt. :	600,000	gal.
Turkey Run (2) :	1,350,000	gal.
Eastside :	500,000	gal.
Proposed Central Tanks (2):	1,200,000	gal.
Mtn Top North GST :	0	gal.
Southwest EST:	300,000	gal.
Southwest GST:	300,000	gal.
Total Storage =	**9,949,000**	**gal.**

Supply Pump Capacity

Killeen/Cove 30-inch Pump Station

No.of Pumps =	3	
Rated Flow =	3500	gpm
Rated Head =	270	ft
Horsepower =	300	HP
Firm Capacity =	7000	gpm

Killeen 20-inch Pump Station

No.of Pumps =	2	
Rated Flow =	2118	* gpm
Rated Head =	329	* ft
Horsepower =	450	HP
Firm Capacity =	2118	gpm

Total Supply Pump Capacity = 9,118 gpm

EXHIBIT B

WATER USAGE HISTORICAL DATA

EXHIBIT B

Water Usage Historical Data

City of Copperas Cove, Texas

Water System Study - 2017 Update

DATE	Average (MGD)	Max Day for Month (MGD)	Total Monthly (MG)	WATER CONNECTIONS	GPD/CONN. (Max Day)	GPD/CONN. (Avg Day)	GPD/CONN. (Max Day)	GPD/CONN. (Avg. Day)	Total Annual (MG)
Jan-06	2.85	3.80	88.40	11,449	332	249			
Feb-06	2.79	3.60	78.10	11,461	314	243			
Mar-06	2.96	3.70	91.80	11,499	322	258			
Apr-06	3.64	5.40	109.10	11,536	468	315			
May-06	3.70	5.40	114.70	11,415	473	324			
Jun-06	4.70	6.70	141.00	11,641	576	404			
Jul-06	4.84	6.40	150.00	11,747	545	412			
Aug-06	6.00	6.80	186.00	11,951	569	502			
Sep-06	4.45	6.60	133.50	11,860	556	375			
Oct-06	3.61	5.30	112.00	11,710	453	309			
Nov-06	3.18	4.30	95.40	11,708	367	272			
Dec-06	2.70	4.10	83.70	11,769	348	229	576	324	1,384
Jan-07	2.70	3.30	83.60	12,024	274	224			
Feb-07	2.78	3.40	77.80	11,775	289	236			
Mar-07	3.04	4.30	94.30	12,076	356	252			
Apr-07	3.05	4.10	91.50	11,343	361	269			
May-07	3.06	4.50	94.80	11,493	392	266			
Jun-07	3.33	4.60	99.80	11,309	407	294			
Jul-07	3.22	4.50	99.90	11,354	396	284			
Aug-07	5.13	6.70	159.10	10,955	612	468			
Sep-07	5.16	7.00	154.70	11,675	600	442			
Oct-07	4.60	5.80	142.70	11,237	516	410			
Nov-07	3.98	5.20	119.50	11,473	453	347			
Dec-07	3.52	4.90	109.20	11,604	422	304	612	316	1,327
Jan-08	3.28	4.20	101.60	11,990	350	273			
Feb-08	3.10	4.10	90.00	11,930	344	260			
Mar-08	3.15	3.80	97.60	11,727	324	268			
Apr-08	3.44	5.10	103.30	12,183	419	283			
May-08	4.12	5.80	127.70	11,982	484	344			
Jun-08	6.16	7.90	184.70	11,773	671	523			
Jul-08	6.68	8.20	207.20	12,358	664	541			
Aug-08	6.04	8.40	187.30	12,037	698	502			
Sep-08	5.18	6.40	155.30	12,068	530	429			
Oct-08	4.37	6.20	135.60	12,098	512	362			
Nov-08	3.95	5.20	118.60	12,064	431	328			
Dec-08	3.57	4.52	110.80	11,986	377	298	698	368	1,620
Jan-09	3.02	3.90	93.60	12,008	325	251			
Feb-09	3.24	6.30	90.80	11,870	531	273			
Mar-09	3.34	4.20	103.43	11,915	352	280			
Apr-09	3.54	4.20	106.27	11,998	350	295			
May-09	3.78	5.20	117.10	11,901	437	317			
Jun-09	5.46	6.76	163.94	11,853	571	461			
Jul-09	6.17	7.97	191.28	11,811	675	522			
Aug-09	**5.58**	**8.45**	**173.04**	**11,844**	**713**	**471**			
Sep-09	4.71	6.93	141.21	11,937	581	394			
Oct-09	4.44	6.17	137.58	11,938	517	372			
Nov-09	3.83	5.65	114.77	11,972	472	320			
Dec-09	3.17	5.25	98.24	12,017	437	264	713	352	1,531

EXHIBIT B

Water Usage Historical Data

City of Copperas Cove, Texas

Water System Study - 2017 Update

DATE	Average (MGD)	Max Day for Month (MGD)	Total Monthly (MG)	WATER CONNECTIONS	GPD/CONN. (Max Day)	GPD/CONN. (Avg Day)	GPD/CONN. (Max Day)	GPD/CONN. (Avg. Day)	Total Annual (MG)
Jan-10	3.33	4.95	103.19	12,030	411	277			
Feb-10	3.13	4.05	87.52	11,713	346	267			
Mar-10	3.09	4.14	95.93	12,352	335	251			
Apr-10	3.62	4.86	108.72	12,136	400	299			
May-10	4.43	5.95	137.22	12,158	489	364			
Jun-10	4.83	6.74	145.05	12,127	556	399			
Jul-10	4.35	6.13	134.76	12,125	505	359			
Aug-10	5.36	7.53	166.01	12,125	621	442			
Sep-10	3.89	*6.34*	116.68	12,145	522	320			
Oct-10	3.72	5.15	115.19	12,126	425	306			
Nov-10	2.68	4.60	80.49	12,180	378	220			
Dec-10	2.70	3.17	83.79	12,219	259	221	621	310	1,375
Jan-11	2.57	3.69	79.73	12,240	301	210			
Feb-11	2.96	8.38	82.93	12,217	686	242			
Mar-11	3.07	4.37	95.18	12,306	355	249			
Apr-11	3.89	5.17	116.63	12,328	420	315			
May-11	3.68	5.95	114.19	12,003	496	307			
Jun-11	5.09	6.60	152.62	12,049	548	422			
Jul-11	5.82	7.69	180.49	12,005	640	485			
Aug-11	5.58	6.80	172.90	12,042	565	463			
Sep-11	5.09	6.43	152.65	12,185	527	418			
Oct-11	3.65	4.68	113.29	12,185	384	300			
Nov-11	*(no data provided for month)*				-	-			
Dec-11	*(no data provided for month)*				-	-	686	341	-
Jan-12	2.63	3.57	81.41	12,359	289	212			
Feb-12	2.59	4.15	74.98	12,328	336	210			
Mar-12	2.80	3.54	86.89	12,388	286	226			
Apr-12	3.78	5.35	113.42	12,436	430	304			
May-12	4.63	6.40	143.43	12,382	517	374			
Jun-12	5.24	6.51	157.19	12,295	529	426			
Jul-12	5.18	6.63	160.68	12,298	539	421			
Aug-12	5.64	7.28	174.77	12,387	588	455			
Sep-12	4.63	7.89	138.80	12,434	634	372			
Oct-12	3.74	4.88	116.07	12,454	392	301			
Nov-12	3.58	4.54	107.46	12,535	362	286			
Dec-12	2.97	3.70	92.12	12,540	295	237	634	319	1,447
Jan-13	2.76	4.04	85.51	12,534	322	220			
Feb-13	2.81	3.45	78.67	12,500	276	225			
Mar-13	3.19	4.99	98.79	12,439	401	256			
Apr-13	3.57	4.98	106.98	12,516	398	285			
May-13	3.80	5.41	117.88	12,412	436	306			
Jun-13	4.68	6.61	140.54	12,298	538	381			
Jul-13	5.11	7.67	158.51	12,214	628	419			
Aug-13	5.14	7.27	159.30	12,297	591	418			
Sep-13	4.22	6.29	126.71	12,385	508	341			
Oct-13	3.28	5.12	101.53	12,596	406	260			
Nov-13	2.91	3.85	87.28	12,580	306	231			
Dec-13	2.76	4.03	85.60	12,508	322	221	628	297	1,347

EXHIBIT B

Water Usage Historical Data

City of Copperas Cove, Texas

Water System Study - 2017 Update

DATE	Average (MGD)	Max Day for Month (MGD)	Total Monthly (MG)	WATER CONNECTIONS	GPD/CONN. (Max Day)	GPD/CONN. (Avg Day)	GPD/CONN. (Max Day)	GPD/CONN. (Avg. Day)	Total Annual (MG)
Jan-14	2.77	4.19	85.88	12,462	336	222			
Feb-14	2.67	3.34	74.72	12,573	265	212			
Mar-14	2.88	3.86	89.30	12,420	311	232			
Apr-14	3.31	4.27	99.27	12,564	339	263			
May-14	3.68	4.90	114.09	12,690	386	290			
Jun-14	3.57	5.48	107.24	12,784	429	280			
Jul-14	4.14	7.26	128.46	12,416	585	334			
Aug-14	4.88	5.83	151.38	12,264	475	398			
Sep-14	4.40	6.54	131.95	12,279	532	358			
Oct-14	4.01	5.07	124.43	12,458	407	322			
Nov-14	3.12	5.36	93.60	12,503	428	249			
Dec-14	2.92	3.95	90.52	12,508	315	233	585	283	1,291
Jan-15	2.82	3.64	87.53	*12,465*	292	226			
Feb-15	2.82	4.36	78.97	12,421	351	227			
Mar-15	3.09	3.98	95.91	12,365	322	250			
Apr-15	3.13	3.96	94.04	12,490	317	251			
May-15	2.85	3.57	88.43	12,398	288	230			
Jun-15	3.78	4.78	113.44	*12,421*	385	304			
Jul-15	4.85	6.43	150.31	12,443	516	390			
Aug-15	5.18	7.72	160.64	12,485	619	415			
Sep-15	5.42	6.78	162.63	12,455	544	435			
Oct-15	4.48	6.68	138.94	12,600	530	356			
Nov-15	3.34	4.54	100.25	12,702	358	263			
Dec-15	3.03	4.53	93.94	12,699	357	239	619	299	1,365
Jan-16	2.80	3.41	86.89	12,623	270	222			
Feb-16	2.91	3.60	84.39	12,532	287	232			
Mar-16	3.19	4.13	99.01	10,853	380	294			
Apr-16	3.38	4.63	101.34	14,290	324	236			
May-16	3.32	4.14	102.99	12,753	324	260			
Jun-16	4.18	6.17	125.53	12,835	481	326			
Jul-16	5.25	6.60	162.75	12,456	530	421			
Aug-16	5.09	7.16	157.92	-	-	-			
Sep-16	4.15	5.92	124.52	-	-	-			

Note: Values in italics estimated for missing data by averaging preceding and following months.

Average Day Demand =	321	gallons / connection / day
Max Day Demand =	713	gallons / connection / day
Max Day Demand x 1.15 =	820	gallons / connection / day

Average Day Demand =	0.22	gpm / connection
Max Day Demand =	0.50	gpm / connection
Max Day Demand x 1.15 =	0.57	gpm / connection

EXHIBIT C-1

CATEGORY 1 WATER SYSTEM IMPROVEMENTS

EXHIBIT C-1
CATEGORY 1 WATER SYSTEM IMPROVEMENTS

MOUNTAIN TOP / CENTRAL PRESSURE PLANE IMPROVEMENTS

- **Project 1A – Mountain Top / Central Pressure Zone Improvements**
  - Recommendation: Installation of PRVs with check valve bypass lines at two locations (Colorado Drive and Winchester Lane) and installation of check valves at two locations (Taylor Creek Road and Ridgeline Road).
  - Need/Justification: The purpose of this project is to better isolate the backside of the Mountain Top Pressure Plane from the Central Pressure Plane by incrementally stepping down the system hydraulic grade line (HGL) from the Mountain Top HGL of 1,392 feet, to a new intermediate pressure zone, and finally to the Central HGL of 1,261 feet. Pressure within the new intermediate zones would be regulated by the existing pressure reducing valves on Colorado Drive and Freedom Lane. The HGL of the new intermediate pressure zones would be approximately 1,270 feet.

    The two new pressure reducing valves and check valves would be located at the boundary of the new intermediate pressure zone and the Central Pressure Plane and should be set at an HGL of approximately 1,245 feet (similar to existing operation). This would allow the new pressure reducing valves to open and provide pressure assistance to the 16-inch water main located along Big Divide Road in times of high demand and/or provide additional circulation of water within the system to improve water quality. The two new check valve installations would isolate the new intermediate pressure zone from the Central Pressure Plane but would still allow back flow of water from the Central Pressure Plane into the new pressure zone in a fire flow situation.

    The project would allow for utilization of storage and pumping capacity within the Mountain Top Pressure Plane to better serve areas between Colorado Drive and Ridgeline Road as well as areas along Freedom Lane that straddle the upper limits of what the Central pressure plane can serve. Additionally, redefining the upper limits of the Central Pressure Plane boundary would allow for better utilization of existing storage tanks.

- **Project 1B – Oak Hill Drive / Deer Flats Pressure Improvements**
  - Recommendation: Convert Oak Hill / Deer Flat area to Mountain Top Pressure Plane by extending a water line from the Mountain Top Pressure Plane to the existing Oak Hill Drive water line. The recommended project would include approximately 1,200 feet of 8-inch water line along Babb St and Veterans Ave (between Tank St and 27th Street) with a pressure reducing valve (HGL set to 1,325' to match other PRVs) and approximately 650 feet of 8-inch water line along 27th Street.
  - Need/Justification: The project would allow for utilization of storage and pumping capacity within the Mountain Top Pressure Plane to better serve this area. Additionally, redefining the upper limits of the Central Pressure Plane boundary would allow for better utilization of existing storage tanks.

- **Project 1C – Mountain Top / Central Pressure Zone Improvements**
    - Recommendation: Convert area between 23rd Street and 27th Street (between Urbantke Ln and Veterans Ave) from the Central Pressure Plane to the Mountain Top Pressure Plane by installing approximately 850 feet of 8-inch water line along 23 Street (between Urbantke Ln and Veterans Ave) and approximately 600 feet of 8-inch water line along Veterans Ave (between 23rd Street and 27th Street). Additionally, verify location and connectivity of existing 6-inch water lines at Terrace Dr and 23rd Street. If not connected, extend 6-inch water line along Terrace Drive to 23rd Street to loop system.
    - Need/Justification: The project would allow for utilization of storage and pumping capacity within the Mountain Top Pressure Plane to better serve the area. Additionally, redefining the upper limits of the Central Pressure Plane boundary would allow for better utilization of existing storage tanks.

CENTRAL PRESSURE PLANE CAPACITY IMPROVEMENTS

- **Project 1D – Mickan Mountain 24-Inch Transmission Line**
    - Recommendation: Increase water transmission capacity between the Turkey Run Pump Station and the Mickan Mountain tank and pump station site by replacing existing 12-inch water line with approximately 1,700 feet of 24-inch water line from Avenue D to the Mickan Mountain tank and pump station site. This project should be completed in conjunction with Projects 1E and 1F.
    - Need/Justification: The capacity of the existing 12-inch water line has been reached and additional water transmission capacity is needed to effectively convey water across the city's water distribution system.

- **Project 1E – Mickan Mountain Elevated Storage Tank**
    - Recommendation: Replace existing Mickan Mountain ground storage tank(s) and pump station with a new 1.5 MG elevated storage tank. The new elevated tank should have an operating range of approximately 40 feet corresponding to a water surface elevation range of approximately 1,230 feet to 1,270 feet. The anticipated tank bowl diameter is 82 feet. The recommended tank capacity and dimensions are based on the installation of a composite (steel tank bowl with concrete pedestal) style elevated tank.

      It is recommended that the maximum operating level of the new elevated tank be higher than the existing Hogg and Taylor ground tanks. This would allow the city to operate the new Mickan Mountain elevated tank at a higher level during peak water usage periods to better manage system pressures and tank levels in hydraulically remote portions of the water system. Alternatively, an altitude valve could be installed that would close and isolate the new elevated storage tank from the system and prevent overflow. This would effectively allow the Turkey Run Pump Station to pump water farther into the water distribution system in times of extended pumping operations, such as during peak water usage periods.

      Additionally, the project should include evaluation of and any necessary improvements to the existing Long Mountain Pump Station. The Long Mountain Pump Station boosts water to the Rattlesnake Pressure Plane. These pumps will remain necessary to provide pressure and fire flow support to adjacent areas at high ground elevations (Yucca Drive, Cedar Drive and Ash Street) that are served by the Rattlesnake Standpipe.

      This project should be completed in conjunction with Projects 1D and 1F.

- Need/Justification: The existing Mickan pump station is in need of expansion or replacement. The Mickan tanks and pump station currently serve as an intermediate pumping facility between the Turkey Run pump station and the Central Pressure Plane tanks. It is recommended to replace one or both ground tanks at the site with an elevated tank and ultimately eliminate the existing pump station.

- **Project 1F – Turkey Run Pump Station Expansion**
  - Recommendation: Increase pumping capacity at the Turkey Run Pump Station by installing two additional 250 HP, 3,000 gpm high service pumps. This project should be completed in conjunction with Projects 1D and 1E.
  - Need/Justification: To replace pumping capacity lost by eliminating the Mickan Mountain Pump Station and to increase high service pumping capacity and redundancy to the Central Pressure Plane.

IMPROVEMENTS TO INCREASE FIRE FLOW

- **Project 1G – High Chaparral Drive Water Line Replacement**
  - Recommendation: Install approximately 4,000 feet of 8-inch along High Chaparral Drive to replace existing un-looped 6-inch water line.
  - Need/Justification: Increase available fire flow along High Chaparral Drive.

- **Project 1H – Buckboard Trail Water Line Replacement**
  - Recommendation: Install approximately 2,200 feet of 8-inch along Buckboard Trail to replace existing 6-inch.
  - Need/Justification: Increase available fire flow in the area.

- **Project 1J – Post Office Road and Alan Arbor Lane Water Line Replacement**
  - Recommendation: Install approximately 1,650 feet of 8-inch along Post Office Rd and Alan Arbor Lane to replace existing un-looped 6-inch.
  - Need/Justification: Increase available fire flow in the area.

- **Project 1K – Hughes Elevated Storage Tank Water Line**
  - Recommendation: Install approximately 500 feet of 12-inch from Hughes EST to Freedom Ln at Buckboard Trail.
  - Need/Justification: Increase available fire flow in the area.

- **Project 1L – Robertson Avenue Water Line Replacement**
  - Recommendation: Install approximately 1,500 feet of 8-inch on Pamela Drive and Robertson Ave to replace existing, un-looped 6-inch.
  - Need/Justification: Increase available fire flow in the area.

- **Project 1M – Annual Water Line Replacement Projects**
  - Recommendation: Maintain annual water line replacement project to replace all water mains smaller than 6-inch diameter.
  - Need/Justification: Increase available fire flow to areas with additional benefit of potentially reducing water loss, system maintenance and increasing water quality and system pressures.

ADDITIONAL IMPROVEMENTS RELATED TO SYSTEM OPERATION

- Consider improvements to the control valve on Golf Course Road that regulates flow to the Hogg Mountain GSTs by integrating valve with SCADA system.
- As water system demands increase, continue operating tanks at highest levels possible to maintain balance of water quality and system pressures. The water model indicates the following:
    - Seven-Mile GST would need to operate at 1,245' water surface level to maintain minimum of 35 psi during 1.5 gpm per connection demand.
    - Central GSTs would need to operate at 1,255' to maintain minimum of 35 psi during 1.5 gpm per connection demand.

EXHIBIT C-2

CATEGORY 2 WATER SYSTEM IMPROVEMENTS

EXHIBIT C-2
CATEGORY 2 WATER SYSTEM IMPROVEMENTS

CENTRAL PRESSURE PLANE CAPACITY IMPROVEMENTS

- **Project 2A – Southwest Water Improvements Phase II**
  - Recommendation: Construction of 500,000 gallon ground storage tank, booster pump station and 300,000 gallon elevated storage tank.

  - Need/Justification: The purpose of this project is to provide additional storage capacity in the Central Pressure Plane for the southwest portion of the city's service area. The project would establish a higher pressure plane, similar to the Mountain Top Pressure Plane, which would better serve the areas with higher ground elevations along Highway 190 South near Big Divide Road. This project has been previously identified as Project IIB in the Water System Study and the City's Capital Improvement Plan. The redefinition of this project aims to minimize the amount of water stored in the Central Pressure Plane below the elevated storage limit. For the Central Pressure Plane, the elevated storage portion of a tank would be any storage above the 1,232' elevation (assuming Category 1 Improvements to the Mountain Top Pressure Plane and Central Pressure Plane have been completed).

    The proposed elevated storage tank is recommended to have a full tank water level corresponding to an elevation of 1,415 feet and an operating range of 30 feet. This would be adequate to serve ground elevations up to 1,300 feet in elevation with a maximum pressure of 50 psi at full tank levels and a minimum pressure of 35 psi at near empty tank levels. The water model assumes a minimum of a 12-inch water distribution mains serving the area for estimating anticipated pressure losses within the distribution system. Zones of lower hydraulic grades (i.e., areas isolated by pressure reducing valves) are anticipated to be needed to serve intermediate and lower ground elevations within the area to be served by the proposed elevated tank. Modeling of any internal subdivision distribution mains is beyond the scope of this study.

    The proposed ground storage tank should have a minimum capacity of 300,000 gallons. Using the recommended design criteria of 400 gallons per connection of total storage and 200 gallons per connection elevated storage, the proposed ground storage tank and elevated tank would have adequate capacity to serve 1,500 connections. Using the recommended design criteria of 0.8 gpm per connection, the proposed Southwest Pump Station should have a minimum firm pumping capacity of 1,200 gpm. If the city desires to construct a pre-stressed concrete ground storage tank at this site, a larger ground storage tank capacity, such as 500,000 gallons, is recommended to increase efficiency of design.

For operation within the initial 10-year planning period, it is recommended that the proposed ground storage tank have a lower operating range than the existing Central Pressure Plane tanks. The tank would require an altitude valve to prevent overfilling and a flow limiting valve on the tank inlet is recommended to prevent rapid filling of the tank. The purpose of this is to give the city more flexibility with tank operating levels, minimize demand impacts on the existing system, and minimize excess water storage in the system during low demand periods.

RATTLESNAKE PRESSURE PLANE CAPACITY IMPROVEMENTS

- **Project 2B – Rattlesnake Mountain Elevated Storage Tank**
  - Recommendation: Replace existing Rattlesnake Mountain Standpipe (670,000 gallon capacity) with an elevated storage tank of similar capacity but slightly higher maximum water surface elevation. The project assumes construction of the new elevated storage tank at or adjacent to the existing standpipe site and decommissioning of the existing Rattlesnake Mountain Standpipe. This project would also include improvements to the Seven Mile Pump Station and installation of pressure reducing valves to better manage pressures in the Rattlesnake Pressure Plane.

  - Need/Justification: The proposed project is needed to provide additional system capacity in the southeast portions of the city. Additionally, an elevated tank would improve water quality issues experienced at the existing standpipe by minimizing the amount of water stored below the elevated storage limits for the pressure plane.

    The proposed elevated storage tank is recommended to have a maximum tank water level corresponding to an elevation of 1,370 feet and a minimum operating range of approximately 35 feet. This would be adequate to serve ground elevations up to 1,250 feet in elevation with a maximum pressure of 50 psi at full tank levels and a minimum pressure of 35 psi at near empty tank levels. The water model assumes a minimum of a 12-inch water distribution mains serving the area to estimate anticipated pressure losses within the distribution system. Modeling of any internal subdivision distribution mains is beyond the scope of this study.

    The existing standpipe has a maximum water level that corresponds to an elevation of 1,346 feet and is currently operated at an average water level corresponding to an elevation of 1,314 feet. To ensure pressures in the northern portions of the pressure plane do not become excessive due to the taller tank, the project also includes installation of pressure reducing valves at two locations to form upper and lower pressure zones for the Rattlesnake Mountain Pressure Plane. The first location is at the existing 8-inch water line along Northern Dancer Drive between Joe Morse Drive and the existing/proposed storage tank. The second location is at the existing 8-inch water line along Jonathan Lane between Bowen Lane and the Seven Mile Pump Station. It is assumed that these two 8-inch distribution lines are the primary feed to the northern portions of the Rattlesnake Pressure Plane, however, additional review/confirmation of the existing distribution system water line locations may be necessary to ensure isolation of the proposed upper and lower pressure zones.

The proposed elevated storage tank is recommended to have a minimum capacity of 600,000 gallons. Using the recommended design criteria of 200 gallons per connection elevated storage, the proposed elevated tank would have adequate capacity to serve 3,000 connections. Using the recommended design criteria of 0.8 gpm per connection, the proposed pump station improvements in conjunction with the Long Mountain Pump Station at the Mickan site should provide a minimum firm pumping capacity of 2,400 gpm. The number of existing connections served by the Rattlesnake Pressure Plane is approximately 1,000. Therefore, the proposed project would provide capacity for an additional 2,000 connections.

WATER SUPPLY/TRANSMISSION IMPROVEMENTS

- **Project 2C – Killeen / Cove 20-Inch Transmission Line Relocation**
  - Recommendation: This project consists of relocating the existing 20-inch transmission line. This project would involve installing approximately 29,500 linear feet of 20-inch water line in a location that is accessible to the City. It is anticipated that 5-feet of additional easement, parallel to the existing 30-inch waterline easement, will be required (3.39-ac).
  - Need/Justification: The existing 20-inch concrete cylinder pipe waterline was constructed in the mid 1970's. It currently is located through Fort Hood property and accessibility for maintenance or repair is difficult. It also has an inadequate number of isolation valves. The need for replacing and relocating this line is to install it in a location and in a manner which allows for its maintenance and repair.

- **Project 2D – Killeen 20-Inch Pump Station Improvements**
  - Recommendation: The firm pumping capacity of the Killeen 20-in Pump Station should be increased by adding a backup pump at this location.
  - Need/Justification: Existing combined firm pumping capacity of the Killeen / Cove Joint (30-in) Pump Station and the Killeen 20-in Pump Station is 11,236 gpm. This firm pumping capacity is based on two of the three Killeen / Cove pumps in service as well as both of the Killeen 20-in pumps in service. A projected future growth of 22,713 connections would require a supply pump capacity of 13,630 gpm based on a supply capacity of 0.6 gpm per connection. The backup pump should be sized so that it is equivalent in capacity to the Killeen / Cove Joint Pump Station pumps. We anticipate that this would involve installing a 300 HP, 3,500-gpm pump. This would increase the firm pumping capacity of the Killeen pump stations to 14,736 gpm.

OTHER SYSTEM IMPROVEMENTS

- Recommendation: Highway 190 Water Line Replacement
  - Need/Justification: Replace aging 8" & 12" cast iron lines from Eastside Facilities to Elm St.
- Recommendation: Old Kempner / Copperas Cove Tie-In Improvement
  - Need/Justification: Provide 12" connection to replace existing 6" connection.
- Recommendation: South Meadows Water Improvement Project
  - Need/Justification: Provide a looped system for South Meadows area South WWTP.

EXHIBIT C-3

CATEGORY 3 WATER SYSTEM IMPROVEMENTS

EXHIBIT C-3
CATEGORY 3 WATER SYSTEM IMPROVEMENTS

OVERALL SYSTEM CAPACITY IMPROVEMENTS

- **Project 3A – Central Transmission Line 'A'**
  - Recommendation: Construction of approximately 3,500 feet of 24-inch transmission main along Wolf Road and Avenue D and approximately 500 feet of 36-inch transmission main to connect to existing 20-inch and 30-inch transmission mains on Golf Course Road.
  - Need/Justification: The purpose of this project is to provide additional water transmission capacity in the water system, primarily to extend transmission capacity to the proposed Mickan Mountain Elevated Storage Tank (Project 1E).

- **Project 3B – Central Transmission Line 'B'**
  - Recommendation: Construction of approximately 7,000 feet of 30-inch transmission main along primarily along Avenue A.
  - Need/Justification: The purpose of this project is to provide additional water transmission capacity in the water system, primarily to extend transmission capacity to a point central to the Hogg, Taylor and Mountain Top North tank sites.

- **Project 3C – Central Transmission Line 'C'**
  - Recommendation: Construction of approximately 5,000 feet of 24-inch transmission main.
  - Need/Justification: The purpose of this project is to provide additional water transmission capacity in the water system, primarily to extend transmission capacity to the Taylor tank site.

- **Project 3D – Central Transmission Line 'D'**
  - Recommendation: Construction of approximately 9,700 feet of 24-inch transmission main along FM 1113 westerly to the intersection of Summers Road.
  - Need/Justification: The purpose of this project is to provide additional water transmission capacity in the water system, primarily to extend transmission capacity to the far west portions of the city including the Mountain Top North tank site.

- **Project 3E – Central Transmission Line 'E'**
  - Recommendation: Construction of approximately 2,000 feet of 24-inch transmission main along North 11th Street.
  - Need/Justification: The purpose of this project is to provide additional water transmission capacity in the water system, primarily to extend transmission capacity to the Hogg Mountain tank site.

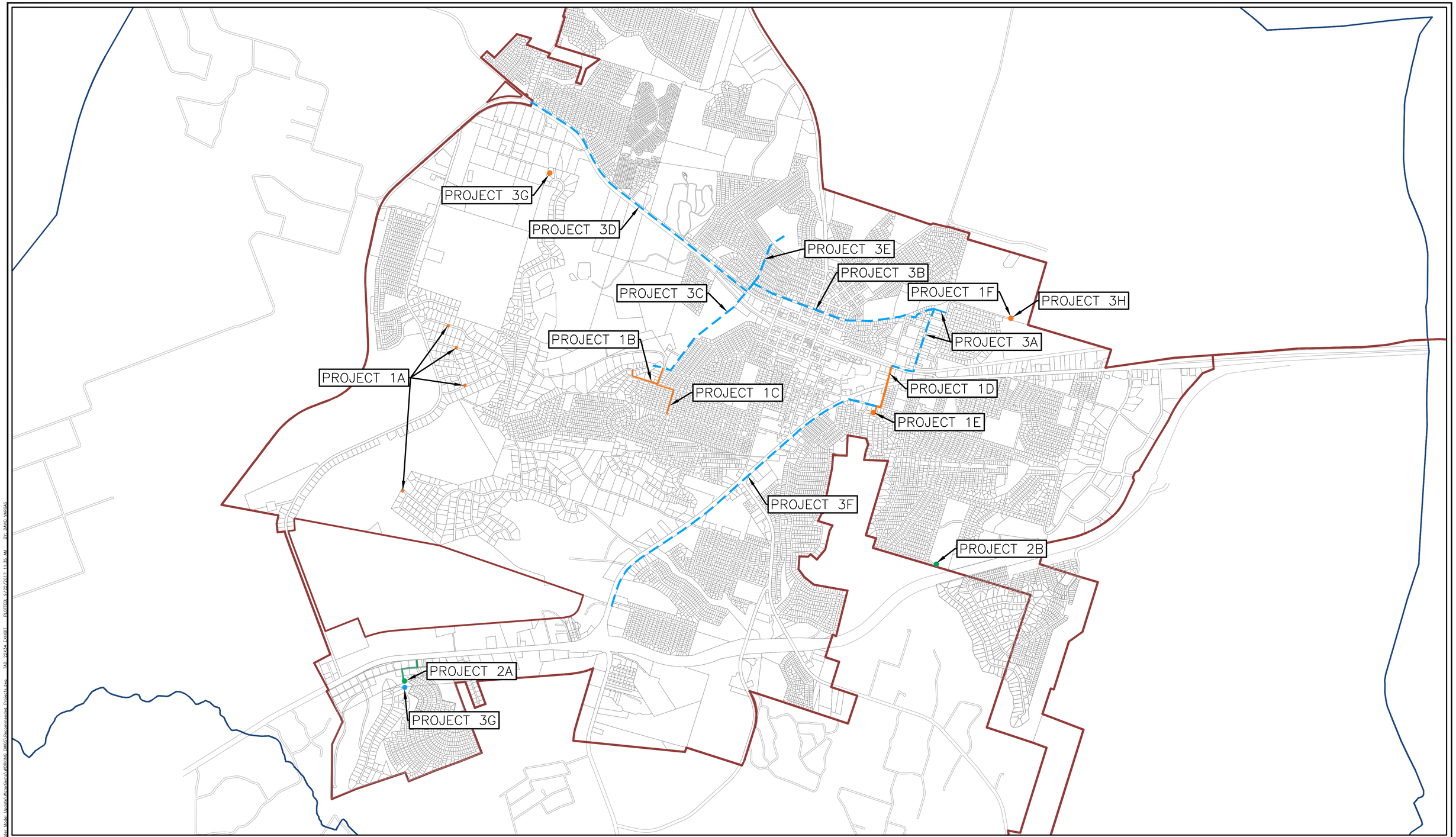
- **Project 3F – Highway 190 South Transmission Line**
  - Recommendation: Construction of approximately 14,000 feet of 24-inch transmission main along Highway 190 South to the intersection of Cline Drive.
  - Need/Justification: The purpose of this project is to provide additional water transmission capacity in the water system, primarily to extend transmission capacity to the far southwestern portions of the city.

- **Project 3G – Central Pressure Plane Water Elevated Storage Capacity Expansion**
    - Recommendation: Construction of approximately 1.2 MG storage capacity within the Central Pressure Plane at the Mountain Top North and Southwest tank sites. At this time it is anticipated that 600,000 gallons of storage, in the form of elevated storage for the Central Pressure Plane (water volume stored above 1,232 feet), be provided at each site, however, the timing and allocation of the additional required storage in the Central Pressure Plane will be dependent on actual growth realized. Therefore, it is recommended that the priority and capacity of this project be evaluated on a periodic basis as growth in and around the city progresses.
    - Need/Justification: The purpose of this project is to provide additional total and elevated storage for the Central Pressure Plane to meet recommended minimum system capacity requirements.

- **Project 3H – Turkey Run Pump Station Rehabilitation and Expansion**
    - Recommendation: Rehabilitation and expansion of the Turkey Run Pump by replacing Pumps 1, 2 and 3 with pumps of similar capacity to Pumps 4, 5 and 6.
    - Need/Justification: The purpose of this project is to replace the aging pumps at the Turkey Run Pump Station with pumps of equal capacity to the newer Pumps 4, 5 and 6 to increase reliability and capacity of the overall pump station.

EXHIBIT D

RECOMMENDED WATER SYSTEM IMPROVEMENTS



SCALE: 1" = 10'

10 0 10 20 30

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EXHIBIT 'D'

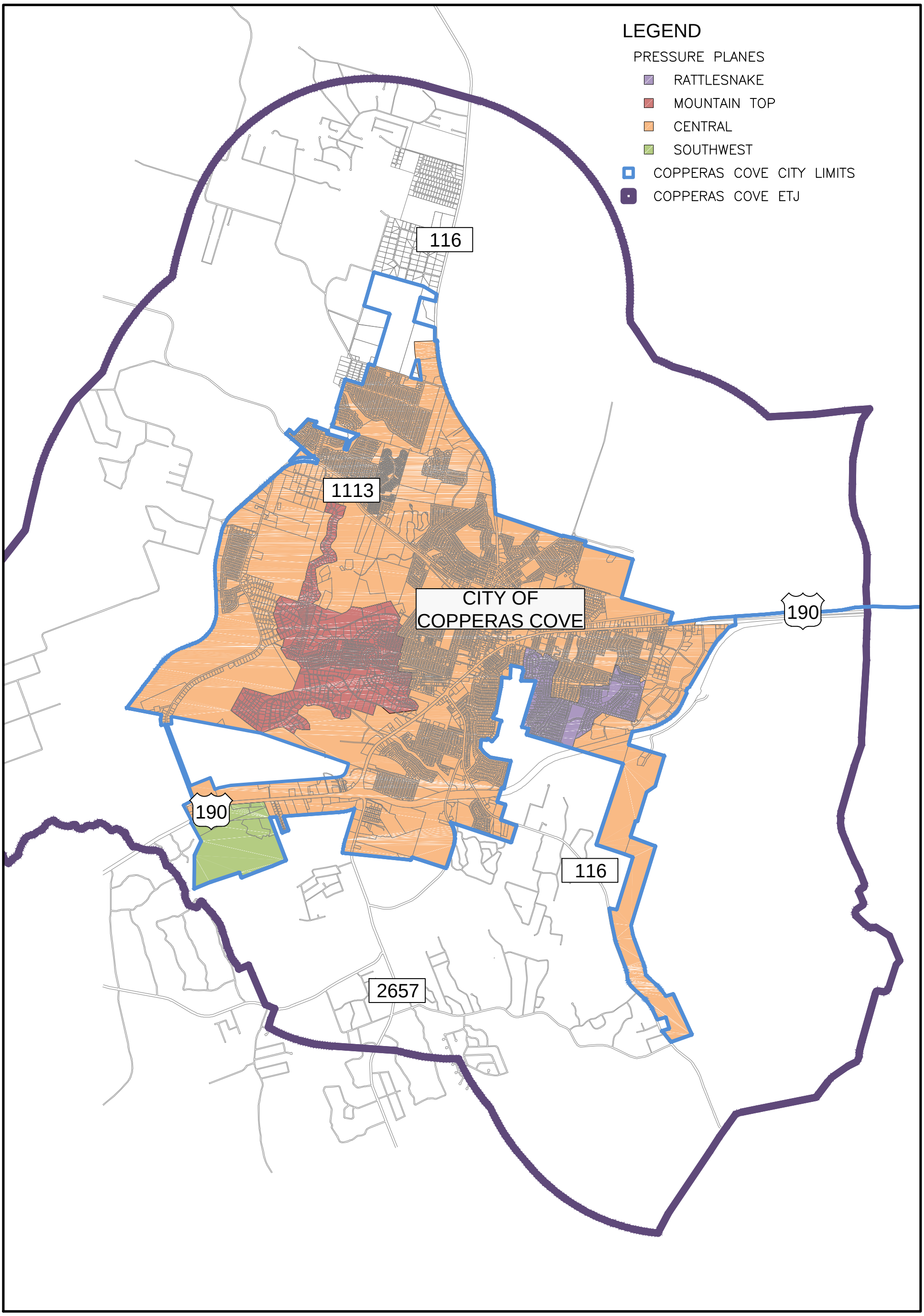
RECOMMENDED WATER SYSTEM IMPROVEMENTS

CITY OF COPPERAS COVE
2017 WATER DISTRIBUTION MASTER PLAN

Drawn By:JM	Checked By:JM	Scale:AS SHOWN	Date:JULY 2017

EXHIBIT E

PRESSURE PLANE BOUNDARY MAP



SCALE: 1" = 5000'

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EXHIBIT 'E'

PRESSURE PLANE
BOUNDARY MAP

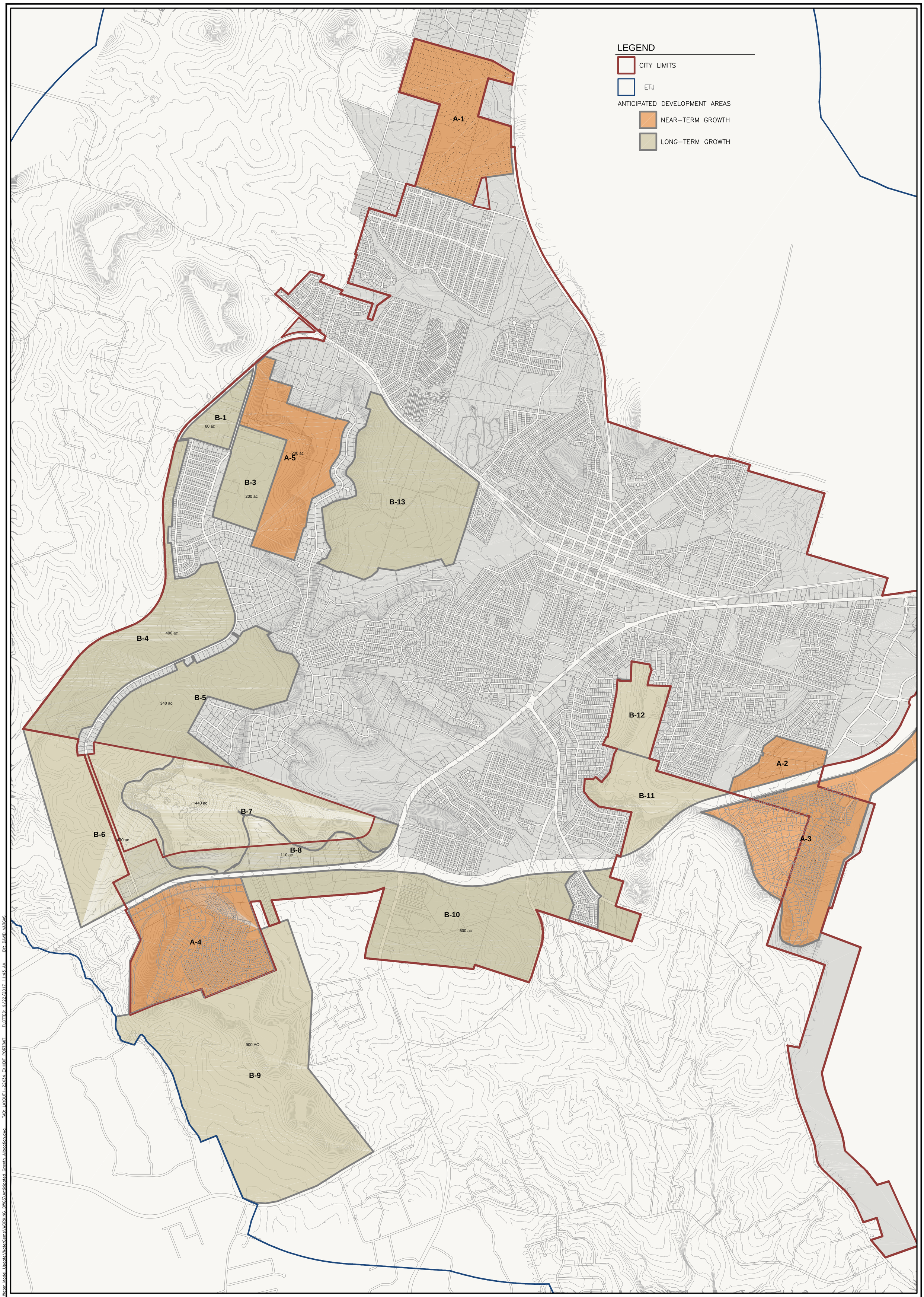
CITY OF COPPERAS COVE
2017 WATER DISTRIBUTION MASTER PLAN

Drawn By: GDP	Checked By: JM	Scale: AS NOTED	Date: JULY 2017

FILE: P:\Projects\5019 (Copperas Cove)\119-2016 Water Model Update\CAD\Exhibits\PRESSURE PLANE BOUNDARY MAP.dwg TAB: 11X17 PORTRAIT PLOTTED: 9/22/2017 11:28 AM BY: DAVID VARGAS

EXHIBIT F

ANTICIPATED DEVELOPMENT AREAS



SCALE: 1" = 1500'

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EXHIBIT 'F'

ANTICIPATED DEVELOPMENT AREAS

CITY OF COPPERAS COVE
2017 WATER DISTRIBUTION MASTER PLAN

Drawn By:JM	Checked By:JM	Scale:AS SHOWN	Date:JULY 2017

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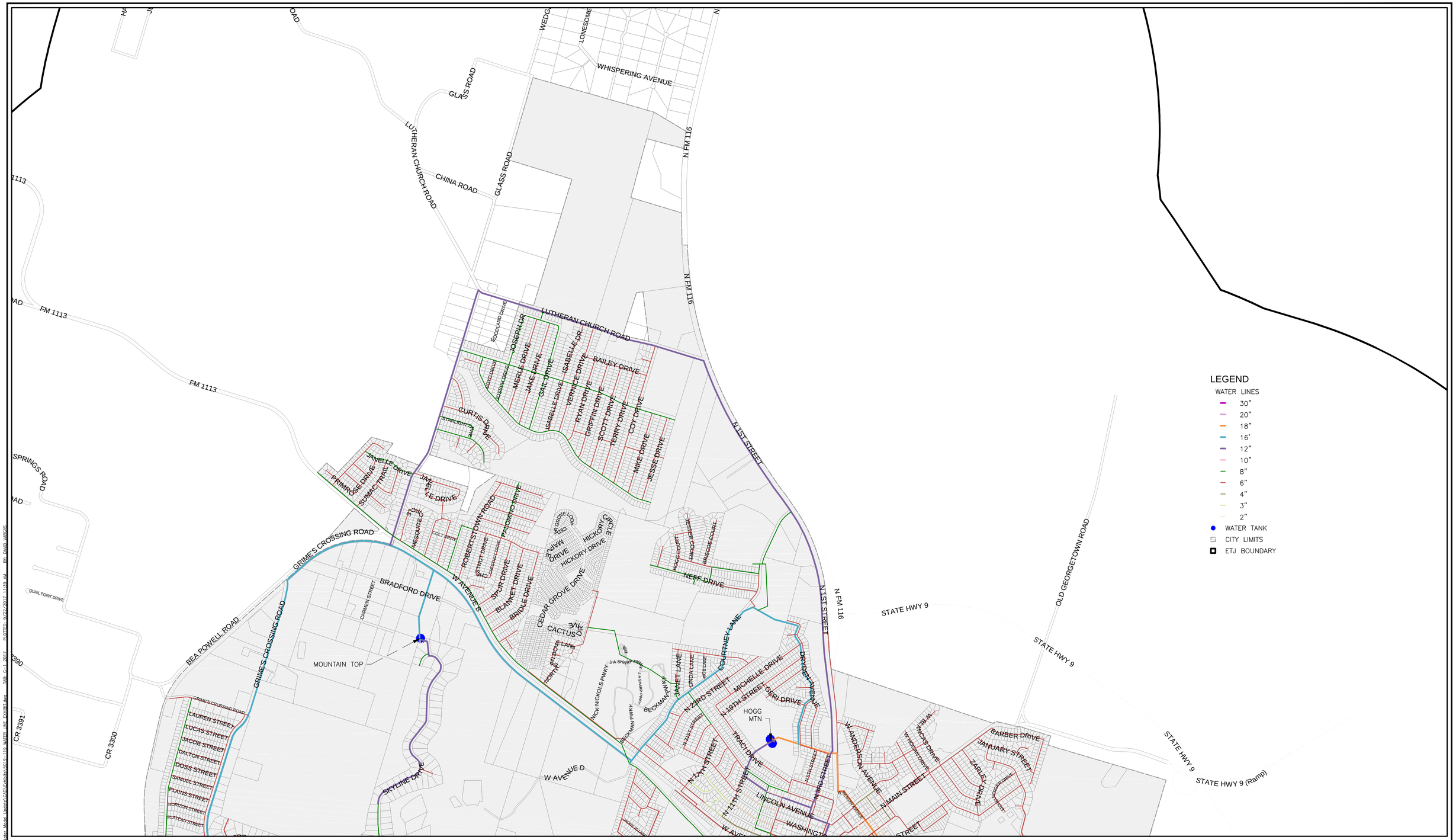
EXHIBIT G-1

EXISTING WATER LINE MAP (SHEET 1 OF 2)



SCALE: 1" = 1000'

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EXHIBIT 'G-1'

EXISTING WATER LINE MAP

CITY OF COPPERAS COVE
2017 WATER DISTRIBUTION MASTER PLAN

Drawn By:DV	Checked By:JM	Scale:AS SHOWN	Date:JULY 2017

EXHIBIT G-2

EXISTING WATER LINE MAP (SHEET 2 OF 2)

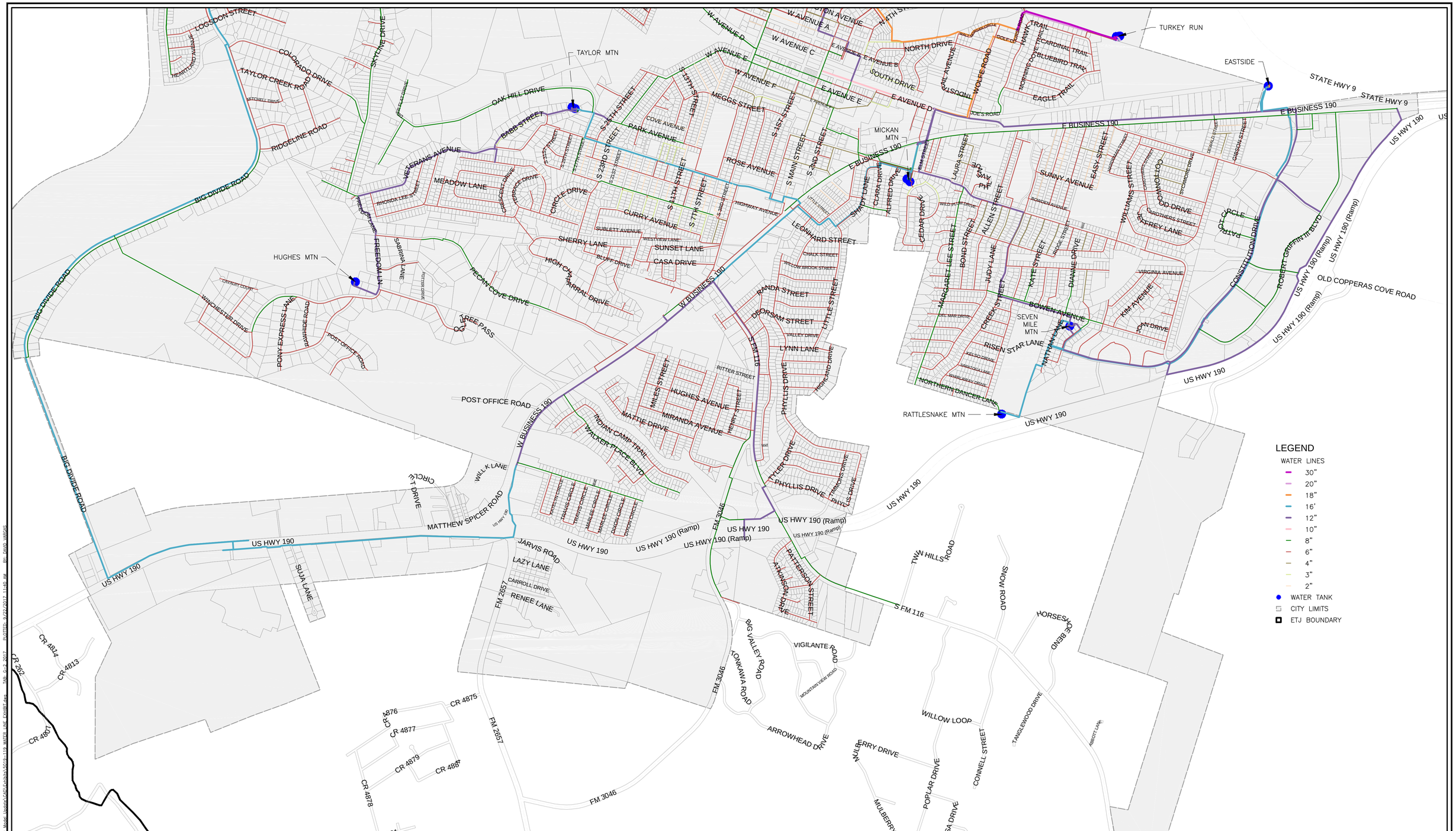

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EXHIBIT 'G-2'

EXISTING WATER LINE MAP

CITY OF COPPERAS COVE
2017 WATER DISTRIBUTION MASTER PLAN

Drawn By:DV	Checked By:JM	Scale:AS SHOWN	Date:JULY 2017

FILE: P:\Projects\5019 (Copperas Cove)\119-2016 Water Model Update\CAD\Exhibits\5019-119_WATER_LINE_EXHIBIT.dwg TAB: G-2 2017 PLOTTED: 9/22/2017 11:40 AM BY: DAVID VARGAS

EXHIBIT H

WATER AGE ANALYSIS – KEY NODE LOCATION MAP

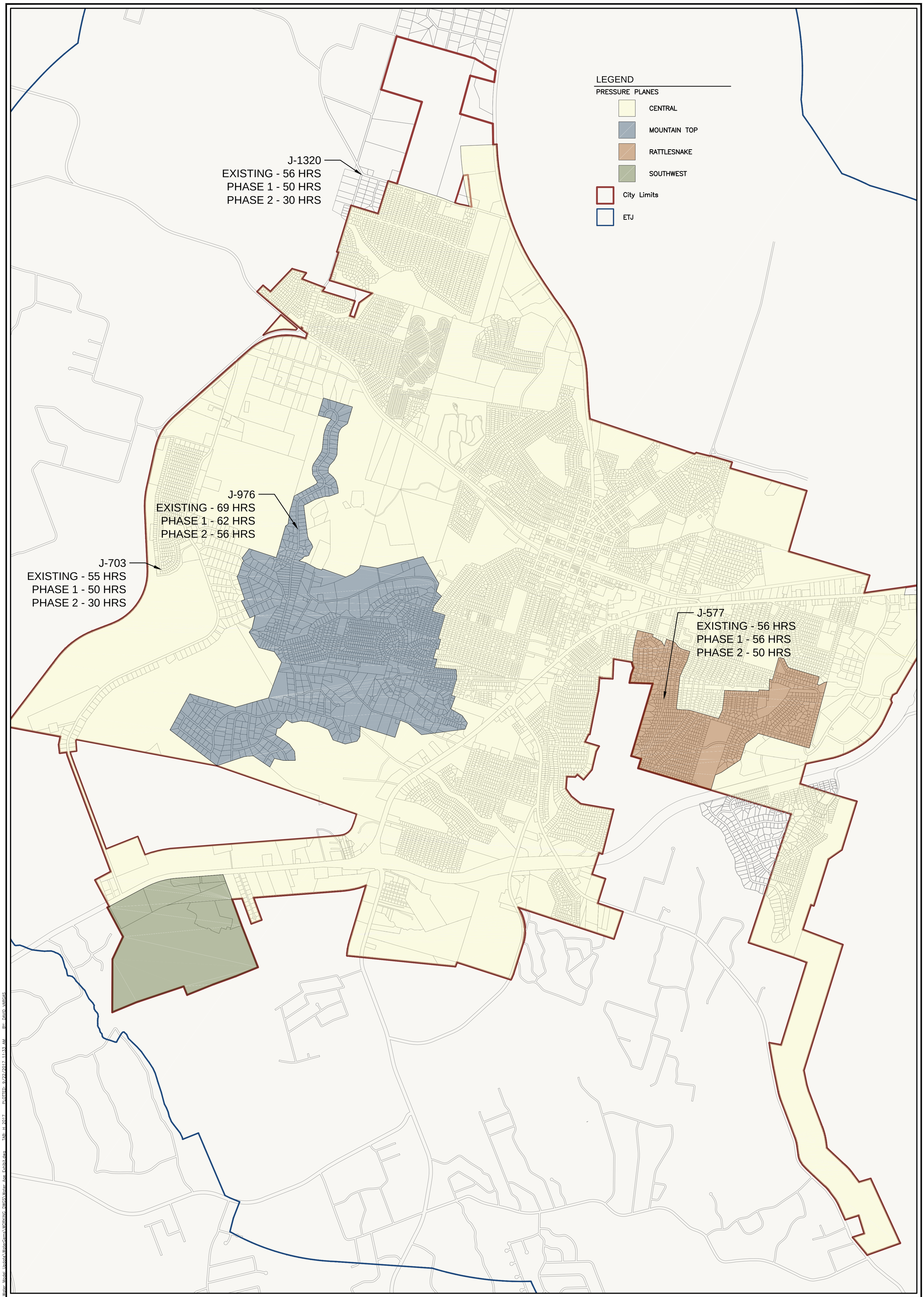

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EXHIBIT 'H'

WATER AGE ANALYSIS KEY NOTE LOCATION MAP

CITY OF COPPERAS COVE
2017 WATER DISTRIBUTION MASTER PLAN

Drawn By:JM	Checked By:JM	Scale:AS SHOWN	Date:JULY 2017

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